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Key Features for Successful Swedish Primary Diabetes Care – Reality or Fiction?

Nationwide studies of longitudinal follow-up, HbA1c levels and all-cause mortality in an organizational context

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Abstract
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Aims To extend knowledge about the changes in Swedish primary diabetes care from 2006 to 2013 and investigate associations of personnel resources, organizational features and quality-of-work conditions of primary health-care centres (PHCCs) with individual HbA1c levels and all-cause mortality in people with type 2 diabetes mellitus (T2DM).

Methods Information about organizational features, personnel resources and quality-of-work conditions were collected from responses of PHCC managers to the Swedish National Survey of the Quality and Organisation of Diabetes Care in Primary HealthCare (Swed-QOP) questionnaire. The longitudinal cross-sectional study included 74.3% and 76.4% of PHCCs in 2006 and 2013, respectively. Individual clinical data for 230,958 people with T2DM obtained from the Swedish National Diabetes Register were linked to the data from the Swed-QOP questionnaire. Individual data were linked to socio-economic and comorbidity data. All-cause mortality was followed up for a median of 4.2 years for 187,570 people with T2DM.

Results The longitudinal follow-up study showed a decreased median PHCC list size but an increased median number of people with T2DM. The mean European Credit Transfer and Accumulation System (ECTS) credits in diabetes-specific education for registered nurses (RNs) increased. The number of PHCCs providing group education programs and involving the patient in goal setting remained low (I). PHCCs having diabetes teams and group education programs were associated with decreased HbA1c levels. Using call-recall system to general practitioners (GPs) was associated with increased HbA1c levels (II). Seven quality-of-work features were identified, of which Individualized treatment was associated with decreased HbA1c levels in people with controlled (≤ 52 mmol/mol), intermediate (53–69 mmol/mol) and uncontrolled (≥ 70 mmol/mol) HbA1c (III). GP staffing was associated with a decreased risk of early death and the mean ECTS credits in diabetes-specific and pedagogical education of RNs was associated with a decreased risk of early death in people aged ≥ 55 years and in men, respectively (IV).

Conclusion This thesis adds to previous work on significant but less pronounced key features for successful organization of primary diabetes care, and indicates that the complexity of diabetes disease makes it difficult to identify success factors applicable to all people living with T2DM.

Keywords: Epidemiology, Organization, Personnel resources, Primary health-care, Type 2 diabetes mellitus

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To my family

"Most things still remain to be done.
A glorious future!"
Ingvar Kamprad

List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

I Husdal, R**.**, Rosenblad, A., Leksell, J., Eliasson, B., Jansson, S., Jerdén, L., Stålhammar, J., Steen, L., Wallman, T., Thors Adolfsson, E. (2017) Resource allocation and organisational features in Swedish primary diabetes care: Changes from 2006 to 2013. *Primary Care Diabetes*, 11(1): 20–28

II Husdal, R., Rosenblad, A., Leksell, J., Eliasson, B., Jansson, S., Jerdén, L., Stålhammar, J., Steen, L., Wallman, T., Svensson, A-M., Thors Adolfsson, E. (2018) Resources and organisation in primary health care are associated with HbA_{1c} level: A nationwide study of 230 958 people with Type 2 diabetes mellitus. *Primary Care Diabetes,* 12 (1): 23-33

III Husdal, R., Thors Adolfsson, E., Leksell, J., Eliasson, B., Jansson, S., Jerdén, L., Stålhammar, J., Steen, L., Wallman, T., Svensson, A-M., Rosenblad, A. (2018) Quality of work features in primary health care are associated with HbA1c level in people with type 2 diabetes mellitus: A nationwide survey. *Primary Care Diabetes* (Epub ahead of print).

IV Husdal, R., Thors Adolfsson, E., Leksell, J., Eliasson, B., Jansson, S., Jerdén, L., Stålhammar, J., Steen, L., Wallman, T., Svensson, A-M., Rosenblad, A. (2018). Organisation of primary diabetes care in people with type 2 diabetes mellitus in relation to all-cause mortality: A nationwide register-based cohort study (Manuscript).

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Contents

Introduction 11
History of the Sweden's primary health-care system 11
Swedish primary diabetes care 12
The National Diabetes Register: a tool for quality assurance 13
Swedish national diabetes guidelines 14
National perspective of knowledge management 15
Type 2 diabetes mellitus: a heterogeneous disease 16
HbA1c and modifiable risk factors 17
The importance of multifactorial risk-factor control 17
Micro- and macrovascular complications and all-cause mortality 17
Health expenditure, socio-economic status and ethnicity 18
Care for people with type 2 diabetes mellitus 19
Quality of care – an explanation of the model 19
Features of successful organization of primary diabetes care 20
Organization of diabetes care – a complicated matter 21

Rationale 25

Aims 26

Methods 27
Setting and study design 29
Participants 29
Data collection procedure 31
Data sources 31
Swed-QOP questionnaire 31
Registries 34
Ethical considerations 35
Statistical analysis 36
Survival analysis 37
Handling of missing data 38
Role of bias 38

Results 39
Study I 39
Study II and III 41
Study IV 47

Discussion 50
Key findings 50
Personnel resources 51
Organizational features 52
Quality of work 54
General discussion 54
Time to go beyond glycaemic control 56
Methodological considerations 57
Strengths 57
Limitations 58

Conclusions 60

Future studies 61

Svensk sammanfattning (Summary in Swedish) 62

Acknowledgements 65

References 68

Appendix 1: The 2006 questionnaire in Swedish 78

Appendix 2: The 2013 questionnaire in Swedish 83

Abbreviations

ACCORD	Action to Control Cardiovascular Risk in Diabetes
ADVANCE	Action in Diabetes and Vascular Disease–Preterax and Diamicron Modified Release Controlled Evaluation
BMI	Body mass index
CI	Confidence interval
CVD	Cardiovascular disease
eGFR	Estimated glomerular filtration rate
ECTS	European Credit Transfer and Accumulation System
GEE	Generalized estimating equations
GP	General practitioner
HR	Hazard ratio
HSA-ID	Health-care address registry identity number
ICD-10	International Statistical Classification of Diseases and Related Health Problems, 10th revision
IDF	International Diabetes Federation
LISA	Longitudinal Integration Database for Health Insurance and Labour Market Studies
LOCF	Last observation carried forward
NDR	National Diabetes Register
NBHW	National Board of Health and Welfare
NPR	National Patient Register
OHA	Oral hypoglycaemic agents
PHC	Primary health care
PHCC	Primary health-care centre
PREM	Patient-reported experience measures
PROM	Patient-reported outcome measures
QI	Quality improvement
RCT	Randomized controlled trial
RN	Registered nurse
SALAR	Swedish Association of Local Authorities and Regions
SD	Standard deviation
Swed-QOP	Swedish National Survey of the Quality and Organisation of Diabetes Care in Primary Healthcare
T1DM	Type 1 diabetes mellitus
T2DM	Type 2 diabetes mellitus
VADT	Veterans Affairs Diabetes Trial
WHO	World Health Organization
WTE	Whole-time equivalent

Thesis at a glance

	Study I	Study II	Study III	Study IV
Aims	Comparison of the resource allocation and organizational features in Swedish primary diabetes care for people with T2DM between 2006 and 2013.	Examine association between personnel resources and organizational features of PHCCs and HbA1c level in people with T2DM.	Describe and analyse associations between PHCCs' quality of work and HbA1c levels in people with T2DM.	Identify associations between personnel resources and organizational features in Swedish PHCCs and all-cause mortality in people with T2DM.
Methods	Longitudinal cross-sectional study of 684 (74.3%) PHCCs in 2006 and 880 (76.4%) PHCCs in 2013 that responded to the Swed-QOP questionnaire.	Cross-sectional study of 846 (73.4%) PHCCs and 230 958 people with T2DM. PHCC-level data was retrieved from the Swed-QOP questionnaire and individual-level clinical data from the Swedish National Diabetes Register. These data were linked to other registries containing individual-level data about socioeconomics and comorbidity.		Register-based cohort study with follow-up of all-cause mortality. The final sample comprised 187,570 people with T2DM at 787 PHCCs. Swed-QOP questionnaire was used to assess the organization of diabetes care.
Results	Compared with 2006, time devoted to people with T2DM and RNs' diabetes-specific education had increased in 2013. However, providing group education programs and involvement of patients in setting treatment targets remained low.	The RNs' diabetes-specific education level and length of regular visits were associated with lower HbA1c. Having diabetes teams and providing group education programs were associated with lower HbA1c levels. Length of regular visits to GPs and computerized call-recall systems to GPs were associated with increased HbA1c levels.	Seven quality-of-work features were identified. PHCCs having individualized treatment plans were associated with lower HbA1c levels in all groups i.e., controlled (≤ 52 mmol/mol), intermediate (53–69 mmol/mol), and uncontrolled (≥ 70 mmol/mol).	There was an association between the WTE GPs per 500 people with T2DM and lower risk of early death. Also, RNs diabetes-specific and pedagogical education were associated with decreased risk of early death. Group education and call-recall systems were associated with increased risk of early death.
Conclusions	Although RNs' diabetes-specific education increased, the arrangement of group education as well as patient participation remained low.	Evaluating the care for people with T2DM is complex. However, some personnel resources and organizational features were associated with HbA1c level.	PHCCs' quality of work may only benefit people with controlled HbA1c. More strategies are required for people with uncontrolled HbA1c.	A significant but less pronounced decrease in risk of early death was observed when PHCCs had access to sufficient GPs and had RNs with diabetes-specific and pedagogical education.

Note: GP, general practitioner; PHCC, primary health-care centre; RN, registered nurse; 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.

Introduction

Diabetes mellitus is recognized as a global epidemic. The prevalence of type 2 diabetes mellitus (T2DM) is increasing dramatically, with projections of even higher growth over coming decades (1). The first point of contact for people with T2DM the primary health care (PHC) system. Research in the PHC setting has increased in the last 50 years with a 13.7-times increase in the number of diabetes articles mentioning PHC. However, there is still scope for more evidence to allow full understanding of the population-level benefits of managing people with T2DM in this setting (2). The World Health Organization (WHO) stated in a report that the PHC system worldwide needs to be strengthened (3), while the International Diabetes Federation (IDF) stated

> Europe is making progress, but it is simply too slow and too limited to stem the tide of diabetes (4, p. 13).

This thesis will describe how Swedish primary diabetes care changed between 2006 and 2013 and how the personnel resources and organizational features of primary health-care centres (PHCCs) are related to individual HbA1c levels and all-cause mortality in people with T2DM. No previous large-scale Swedish study has examined whether the organization of primary diabetes care increases the possibility that people with T2DM will reach national treatment targets for HbA1c or decreases the risk of early death. Such knowledge may provide support for decision makers to provide equal care for people with T2DM treated within the Swedish PHC system.

History of the Sweden's primary health-care system

The Swedish national system of district medical officers (*Provinsialläkarväsendet*) in the 17th century was the beginning of today's PHC system. At that time health care was managed by the Swedish government. General practitioners (GPs) were responsible for patients with all conditions and mainly worked alone. In 1862, because of legislation establishing local government county councils, the responsibility for health care was devolved to each of the county councils. During the first half of the 20th century, the national system of district medical officers was considered to function well. However, after World War II, inpatient care was rearranged and health-care

centres were established that were intended to prevent and treat illness in all people. The national system of district medical officers was in severe crisis at that time because of difficulties in recruiting GPs, which were related to high workload and the very limited possibilities for professional advancement.In the 1960s, hospital directors realized that the health-care system needed a radical change because of the overload of patients attending specialist clinics in the hospitals, many of whom could be monitored in less expensive forms of care. One of the most important events of the 1960s was the launch by the Swedish National Board of Health and Welfare (NBHW; *Socialstyrelsen*) of the PHCCs concept, in which not only GPs but also other health-care professionals were available. In 1976, 677 GP clinics and PHCCs existed and nearly half were staffed solely by one GP. A report by NBHW (Health care facing the 80s: HS 80) described the need for PHCCs to be in the geographical area in which the people lived, and proposed that each municipality should have at least one PHCC (5). According to paragraph 5 of Swedish Health Care Law (SFS, 1982:763), the PHC system was and still is defined as follows:

> Primary health care—as part of inpatient care irrespective of the disease, age, or patient groups—should account for the needs for basic medical treatment, care, prevention and rehabilitation that do not require the medical and technical resources of hospitals, or other special skills (6).

In the 1980s, several large PHCCs were established, each including 10–15 GPs. These were subsequently perceived as difficult to manage and PHCCs gradually became smaller and more independent. In addition, more specialized registered nurses (RNs) were employed to support and guide patients between medical visits (7). Since 2010, when the Swedish government initiated a freedom of choice system (2008:962) (8) which all of Sweden's county councils are obligated to follow, people could freely choose their PHCC (i.e., private or public PHCC). Competency requirements for PHCCs to be approved were introduced; these mandated that at least 50% of the GPs must be specialized in general medicine and at least 50% of the RNs must be district RNs. However, the Swedish PHC system has no common definition of the details of assignments, which results in regional differences and the freedom for each county council/region to decide on the organization of primary diabetes care (9).

Swedish primary diabetes care

The Swedish Diabetes Association was established in 1943 and contributed to considerable progress in the development of Swedish diabetes care. In 1948 a proposal was sent to the government by the Swedish Diabetes Association that

insulin be free of charge regardless of patient income. The proposal was accepted in 1955, concomitant with the introduction of Swedish health insurance (10). During the second half of the 20th century, treatment of diabetes mellitus in the health-care system gained more interest, which was the start of quality improvement (11). However, diabetes mellitus was first formally recognized as a major public health issue in Italy in 1989 with the St Vincent declaration (12). Representatives from all European countries agreed on the following:

> Countries should give formal recognition to the diabetes problem and deploy resources for its solution. Plans for the prevention, identification and treatment of diabetes and in particular its complications […] should be formulated at local, national and European levels. (12, p. 360).

Thus, the developments in the field of diabetes mellitus led to the first comprehensive international action program for diabetes mellitus being adopted by the WHO and IDF (13). The action program included medical, social, educational and psychological aspects. After the St. Vincent declaration, the Swedish NBHW reviewed the organization of diabetes care in eight of Sweden's county councils. The review identified noteworthy differences in the quality of care. Information from this review contributed to the development of the first national Swedish guidelines for diabetes care in 1996 (11). The Swedish National Diabetes Register (NDR) was also introduced at this time (14).

The National Diabetes Register: a tool for quality assurance

In the early 1990s, as a response to the St Vincent declaration, the Swedish Society for Diabetology (*Svensk Förening för Diabetologi*), with support from the NBHW, initiated the Swedish NDR. The aim was to use the registry as a tool for monitoring and quality control of Swedish diabetes care (15). The first people with diabetes mellitus were registered in 1996. The information reported to the registry comprises clinical data, risk factor control and the occurrence of comorbidities in people with diabetes mellitus. GPs or RNs at PHCCs report each individual's clinical data to the registry at least once a year (14). All clinical data are reported online or by electronic transmission from individual medical charts (16) and all participants had given their informed consent to be registered in the NDR. The number of registered people with diabetes mellitus who are treated in the PHC setting has increased dramatically during the past decade. In 2006, about 80% of all PHCCs reported data to NDR but only 115,000 people (50% of all people with T2DM in Sweden)

were registered (17) whereas in 2013, about 90% of all Swedish PHCCs reported data to the NDR and roughly 300,000 people (90% of all people with T2DM in Sweden) were enrolled (18) (Figure 1).

The NDR undergoes ongoing validation, including checking data from different sources following updates of the medical record system. This registry provides real-life data on the current situation and trends over time for diabetes outcome measures, which can be used for quality improvement at both the PHCC and county council/regional levels (14). In recent years, the NDR has also focused on developing and implementing a disease-specific questionnaire for measuring patient-reported outcomes and experiences. The questions consider an individual's own perspective of living with diabetes mellitus (patient-reported outcome measures [PROM]) and their perceived situation and perspective of their diabetes care (patient-reported experience measures [PREM]) (19).

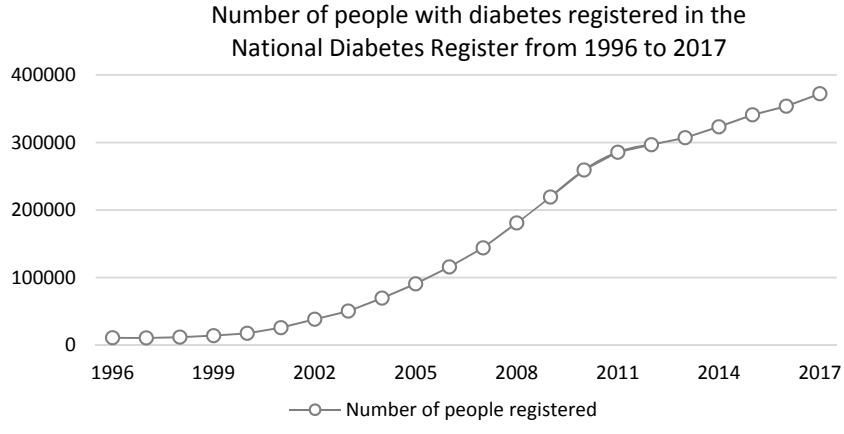


Figure 1. Timeline of registered people with diabetes mellitus treated in the primary health-care system from 1996 to 2017 (Data obtained from the National Diabetes Register annual report 2017 (18)).

Swedish national diabetes guidelines

The first Swedish national guidelines for diabetes care were published in 1996 by the Swedish NBHW (20), after the St. Vincent declaration emphasizing the importance of all European countries taking responsibility for the global issue of diabetes mellitus (12). The Swedish guidelines for diabetes care were updated in 1999, 2010, 2015, 2017 and 2018. The target audience of the guidelines is politicians, executives and managers, and the guidelines should mainly be used as a scientific basis for actions and priorities in the health-care system.

There are three different types of recommendations. The first type is the recommendations ranked 1–10, which are expected to affect resource allocation in the health-care system, focusing more resources on high priority recommendations rather than those with low priority. The second type is those recommendations requiring a greater body of evidence and the third are recommendations of inaction. The aim of the guidelines is to assure equal diabetes care for all people with diabetes mellitus (21). At a county council level, the Swedish national guidelines can be translated to regional guidelines for the PHCCs to follow. Each county council has the responsibility of implementing the recommendations provided by the NBWH. However, PHCCs can also create their own local guidelines (22). Other treatment recommendations for people with T2DM regarding glucose control (23) and for preventing atherosclerosis and heart disease (24) are published by the Swedish Medical Products Agency (*Läkemedelsverket*).

National perspective of knowledge management

The Swedish Association of Local Authorities and Regions (SALAR) is an organization representing local governments of which all of Sweden's municipalities and county councils/regions are members. Its field of responsibility includes advocating the interests of Sweden's 290 municipalities and 21 county councils/regions to achieve improved conditions for local and regional self-government (25).

In 2013, Sweden's health-care regions created knowledge management groups that were tasked with initiating cooperation between the county councils/regions and supporting them with current evidence and indicators of successful care, and with implementing evidence-based clinical practice. In 2018, the county councils/regions implemented a total of 21 different national programs (the number continues to increase), including their own working group. Diabetes mellitus is included in the national program for endocrine disorders. The task of national program areas and their working groups is to increase knowledge about evidence-based care and quality of care (26). Thus, in 2013, the working group for the national program in endocrinology (i.e., a previous knowledge management group) conducted a benchmarking study for successful management of T2DM that identified seven factors relating to different aspects of the organization of primary diabetes care. Success factors 1–3 concern the work of PHCCs:

1. *A focus on the patient's targets*
2. *Using targeted initiatives for persons with poor metabolic control*
3. *Ensuring that PHCC results are always on the agenda*

Success factors 4–6 concern the supervisors' structures, processes and methods at the PHCC:

4. *Ensuring available knowledge and clear expectations*
5. *Enabling follow-up and feedback of results*
6. *Ensuring that the diabetes care area is prioritized with long-term improvement initiatives*

The last success factor describes the overall work of the organization:

7. *Ensuring ownership of results and focusing on prevention*

Results from the benchmarking study suggested that PHCCs operating in accord with these seven success factors performed well (as reported to the Swedish NDR) and to a high degree achieved the Swedish national treatment targets for HbA1c levels (27).

Type 2 diabetes mellitus: a heterogeneous disease

The prevalence of diabetes mellitus in adults in the total population is expected to increase from 8.4% in 2017 to 9.9% by 2045, with T2DM accounting for 85–90% of all cases (1). In Europe, the prevalence varies from 2.4% to 15% between countries (28) with Sweden in 2013 having a prevalence of 4.8% of the total population including both T2DM and type 1 diabetes mellitus (T1DM) (29).

Several risk factors for the development of T2DM are known, which include a combination of a family history of T2DM (30), older age and sedentary lifestyle (31, 32). T2DM is a chronic disease that occurs when the pancreas produces an insufficient amount of the hormone insulin or when the body responds ineffectively to the insulin it produces. Insulin regulates the blood glucose level and controls the transformation of glucose into energy. Lack of insulin or unresponsiveness to insulin leads to a high blood glucose level (33). Treatment for T2DM includes adopting a healthy diet in combination with increased physical activity. People with T2DM are usually treated with oral hypoglycaemic agents (OHAs) if dietary changes and physical activity have failed. Insulin deficiency with worsening blood-glucose levels over time requires continuous blood glucose-lowering treatment (34). Metformin is the first-line drug prescribed to people with diabetes mellitus. However, if normal glycaemic levels are not reached with metformin, insulin and other glucose lowering drugs should be prescribed (21). The heterogeneity of T2DM was reported in a recent cluster analysis (35) which identified four subgroups of people with T2DM, based on different patient characteristics and risks of complications. This new sub-stratification can identify people at elevated risk of complications and thereby help GPs tailor early preventative actions and treatment.

HbA1c and modifiable risk factors

The HbA1c level reflects the blood glucose level during the past 6 to 8 weeks. Monitoring of HbA1c in treatment is the gold standard because of the body of evidence showing that HbA1c as a predictor of micro- and macrovascular complications (36) and all-cause mortality (37). International (38) as well as national guidelines (21) promote individualized targets for HbA1c to maximize the benefits while reducing the risks. The Swedish Medical Products Agency describes the importance of adjusting the treatment target based on age, disease duration and comorbidities (23).

In Sweden, the general treatment goal is an HbA1c level ≤ 52 mmol/mol (otherwise called controlled HbA1c) for people with T2DM. An additional treatment goal is that not more than 10% of people with T2DM should have an HbA1c level of ≥ 70 mmol/mol (uncontrolled HbA1c or hyperglycaemia) (39). In 2017, about 10% of people with T2DM living in Sweden were reported to have an HbA1c level of ≥ 70 mmol/mol. However, the proportion of people with T2DM who have uncontrolled HbA1c varies depending on county council/region, ranging from 7% to 14%. On a positive note, the trend of people with HbA1c ≥ 70 mmol/mol has decreased during recent years. Therefore, high-risk people with elevated HbA1c levels are common, but they are a minority of patients. More than half the people with T2DM are > 60 years old with an HbA1c level of ≤ 52 mmol/mol, and are therefore likely to be relatively healthy (18).

The importance of multifactorial risk-factor control

People with T2DM with hyperglycaemia are at increased risk of developing microvascular (i.e., nephropathy, neuropathy and retinopathy) and macrovascular (i.e., coronary artery disease and stroke) (36, 40) complications and increased risk of early death (41, 42) compared with the general population.

Micro- and macrovascular complications and all-cause mortality

The UK Prospective Diabetes Study conducted a randomized follow-up study with 3642 persons newly diagnosed with T2DM. The study found that each percentage point of decrease in the HbA_{1c} level was associated with a risk reduction of 37% for microvascular complications (36). Major randomized controlled trials (RCTs) have extensively evaluated the effects of uncontrolled glycaemia on microvascular, macrovascular and death endpoints; the Action to Control Cardiovascular Risk in Diabetes (ACCORD) (43, 44), Action in Diabetes and Vascular Disease-Preterax and Diamicron Modified Release Controlled Evaluation (ADVANCE) (45) and, Veterans Affairs Diabetes Trial (VADT) (46). The body of evidence from observational studies and RCTs on

the effects of HbA1c levels ≤ 52 mmol/mol is inconsistent with regarding cardiovascular (CVD) complications and death (47, 48). However, the Steno-2 study found short and long-term effects of intensified multifactorial risk factor intervention compared with usual care, including a reduced risk of (CVD) and death from CVD causes (49-51). In addition, a recent Swedish cohort study of 271,174 people with T2DM found a step-wise decreased risk of CVD complications and mortality compared with the general population in participants who met the targets for five risk-factor variables (HbA1c level, systolic and diastolic blood pressure, presence of micro- and macro albuminuria, smoking and low-density lipoprotein cholesterol levels) (37).

People with T2DM have a two- to four-times higher risk of early death compared with the general population (52, 53). Globally, diabetes mellitus is the eighth leading cause of death and it was estimated in 2012 that 3.5 million deaths were directly caused by diabetes melliuts or other related complications (3). The risk of early death from any cause may be increased with younger age, impaired glycaemic control and severe renal complications (41). Swedish registry data show that the incidence of death from CVD decreased from 1998 to 2014 (53). Similar trends have been identified in North America and Europe (54-56).

Health expenditure, socio-economic status and ethnicity

T2DM is also a large economic burden because of the costs of health services and reduced productivity or inability to work. Expenditure related to diabetes mellitus is estimated to exceed 12% of the global health budget (57) and most of the costs are related to treatment of complications (58). In Sweden, the total health-care costs for glucose-lowering drug treatment of people with T2DM in the PHC increased from 228€ in 2006 to 405€ million in 2014 (59).

Although social welfare overall has improved, people of lower socio-economic status have been negatively affected compared with people of high socio-economic status (60). This can be explained by socio-economic disadvantages such as unemployment or financial hardship. Poor education may also impact on the adaptation of a healthy lifestyle (61). Socio-economic status includes several dimensions such as income, education, occupation, marital status and ethnicity. These dimensions act both independently and jointly (62). Socio-economic status has been found to be a strong predictor of diabetes-related complications and all-cause mortality. A registry-based Swedish observational study of 217,364 people with T2DM showed that people who were married/cohabiting, had high education and had high income were at lower risk of CVD complications and early death (63). Over recent decades global migration to Western societies has increased, leading to a more ethnically diverse population (64). Ethnic differences in T2DM are recognized as

a predictor of glycaemic control and all-cause mortality: non-Western populations display poorer glycaemic control compared with native Swedes (65).

Care for people with type 2 diabetes mellitus

The care for people with T2DM in Western countries is mainly addressed within the PHC system (4). Even though most countries have national guidelines for diabetes mellitus, the organization of diabetes care differs between (66) and within (22, 67, 68) countries. Today, caring for people with T2DM has expanded from including only GPs to involving RNs in the main workforce (69). In Sweden, PHCCs have diabetes-responsible GPs and RNs available in-house who have the overall responsibility for the care and treatment of people with T2DM. In general, people with T2DM visit the RNs and GPs once a year for medical check-ups (such as annual screening for albuminuria; measurements of HbA1c and systolic blood pressure are performed more frequently) and individual counselling. The PHCCs can also include other health-care professionals such as chiropodists, social workers, physiotherapists, psychologists and dietitians (22).

Quality of care – an explanation of the model

Continuous quality improvement is today a central part of the PHC system. It is no longer enthusiastic volunteers who co-ordinate quality improvement work, but instead it is an integrated part of the daily routine. The meaning of improving the quality of care is to support accountability of the health-care professionals and managers, assure that resources are used efficiently, diminish medical errors, maximize effective care and improve patient outcomes (70).

Identification of quality indicators is important for providing high quality and safe diabetes care. Thus, the Donabedian model (71) is often used as a theoretical framework to explain relationships between quality of care and patient outcomes. This model is divided into three dimensions: structure, process and outcomes, which may be seen as either independent or interrelated. Structural indicators are related to conditions in the organizational aspects of care, equipment and personnel resources for delivering the care required. Process indicators relate to actions of health-care professionals or the organization, such as number of consultations, medical check-ups, and laboratory tests. In general, the required actions by health-care professionals are usually described in the guidelines. The last dimension is patient outcomes, which contains all the effects of health care on patients and can be measured as changes in health status, knowledge or patient satisfaction. Structure and process indicators are often used to measure the impact on patient outcomes. Consequently, good

structure/process indicators increase the likelihood of good patient outcomes (Figure 2).

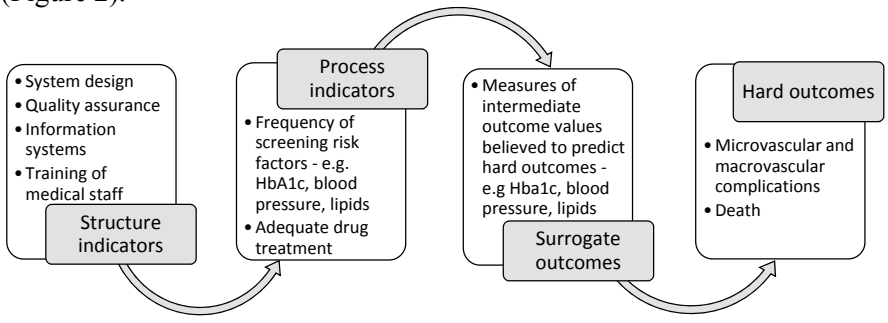


Figure 2. Relationships between structure indicators, process indicators, surrogate outcomes and hard outcomes (Based on Siderenkov et al. 72).

Features of successful organization of primary diabetes care

Recent work by the Health Consumer Powerhouse (73) has established some key features of successful diabetes care. This body stated that the fundamental characteristics are a transparent health-care system and using a national standard diabetes care plan. These are followed by key features of personnel resources and organizational features, including having diabetes specialist RNs and dietitians, well-educated health-care professionals, multidisciplinary teams, patient-centered health care, access to individual counselling, regular check-ups, and a national registry. According to the top performer's index produced by the Health Consumer Powerhouse, Sweden is the leading country in Europe for primary diabetes care. Although the Health Consumer Powerhouse compiled these so-called key features for provision of successful diabetes care, the evidence is scarce that the key features regarding personnel resources and organizational features are beneficial for people with T2DM and improve national treatment targets, particularly glycaemic control.

Although RNs are one of the main health-care professionals in the diabetes workforce and are involved in areas such as patient education, individualized care and promotion of self-care (74), little attention has been paid to the role of RNs in Swedish PHC in allowing people with T2DM to achieve treatment target of HbA1c level. The impact of RNs staffing (75) and their postgraduate education (76), is understudied, particularly the effect of additional diabetes-specific postgraduate education and pedagogical education on improving patients' glycaemic control.

The Swedish national guidelines for diabetes care state that treatment of people with T2DM requires a multidisciplinary approach. This approach requires team-building to ensure that the treatment of CVD, hyperglycaemia and complications is individualized for each patient (21). However, there is limited research about the associations between the existence of diabetes teams and improved glycaemic control for people with T2DM who are treated in the

PHC system (77). In addition, T2DM requires daily self-management by the person to handle their own health. The task of self-management can be complicated, and necessitates confidence by the patient and support from health-care professionals (78). Therefore, the participation of the person in setting and negotiating their treatment targets is essential to achieve these (79). Group education programs might also be made available in an attempt to provide support to people with T2DM. Existing research (80, 81) recognizes the critical role of group education programs in improving the participant's overall knowledge about the disease and glycaemic control. Other recognized facilitators of the organization of diabetes care are call–recall systems (82) and using national registries to promote individualized appointments (83).

Organization of diabetes care – a complicated matter

The past thirty years since the St. Vincent declaration have seen increasingly rapid advances in the field of quality improvement programs that aim to improve care for people with T2DM in a primary care setting. In most cases these programs are referred to as multifaceted interventions because they include quality improvement work that targets both health-care professionals and the organizational context. These multifaceted interventions often include aspects of providing individualized treatment, including patient education and professional development of health-care professionals by means of additional postgraduate education or training, as well as organizational features such as using a call–recall system.

The past decade has seen a rapid growth in the number of systematic reviews assessing the impact of the organization of diabetes care on patient outcomes. At the beginning of the 21st century, a Cochrane review by Renders et al. (84) evaluated the effects on HbA1c levels of diverse interventions in the work of health-care professionals or the structure of care. The review included 19 studies assessing HbA1c as patient outcome in PHC, outpatient and community settings, and found that interventions including postgraduate education for health-care professionals in combination with computerized reminders and feedback can improve process outcomes. However, it remained unclear whether these interventions improved HbA1c levels. In 2012, Tricco et al. (85) published a systematic review and meta-analysis assessing the effectiveness of quality improvement strategies for improving HbA1c levels in people treated in the outpatient setting, which included 48 cluster RCTs and 38,664 people with either T1DM or T2DM. The authors reported a mean difference of 0.37% (95% confidence interval [CI] (–0.45;–0.28) reduction in HbA1c after a median follow-up of twelve months. The most effective quality improvement strategies included team changes, case management, patient education and self-management, with the largest impact being on those with an HbA1c level > 73 mmol/mol.

A previous systematic review by Seidu et al. (86) evaluated the effect on patients' glycaemic control of interventions targeting PHC- or community-based professionals; the review included 39,439 people with T1DM or T2DM from 30 studies. The authors found that multifaceted interventions with multiple professionals were more effective for improving glycaemic control than interventions targeting single professionals. Similar results were found in a review by Seitz et al. (87) in which the majority of included studies were based on multifaceted interventions. However, these interventions included changes involving both the health-care professional (education, reminder system and feedback) and the organization (shared care, case management, patient-oriented care, changes in medical record system), sometimes in combination with patient-centred care. However, regardless of the type of intervention, multifaceted interventions had more impact than single interventions on reducing HbA1c levels. Finally, an overview of systematic reviews by Worswick et al. (88) showed that most of the focus has been on patient education, followed by telemedicine, then broad-based reviews (multifaceted interventions), health-care professional changes, and lastly, organizational changes.

Although extensive research has assessed associations between the organization of diabetes care and HbA1c levels, the PHC system differs between countries, making it difficult to draw any firm conclusions. Therefore, in an attempt to provide a consensus of the available evidence, a summary of the RCTs involving multifaceted interventions for people with T2DM treated in the PHC setting in Europe 2008–2018 is presented in Table 1, as a complement to these reviews (84-88). The interventions have comprised multifaceted interventions including changes in both professionals and the organization. In four of the studies, no significant differences were found between the intervention and control groups. One study, by Goderis et al. (89) showed significant within-group reductions in HbA1c level of 0.4% (95% CI, –0.4 to –0.3) and, although no significant differences were found between groups. An RCT by Griffin et al. (90) conducted in Denmark, the Netherlands and in the UK in the PHC setting screened patients without known T2DM and randomly assigned them to routine diabetes care or a multifactorial approach. It showed a slightly decreased HbA1c level in the intervention group after five years. In addition, Janssen et al. (91) reported significant effects of an intervention on HbA1c level, however, their RCT was involved in the same cohort as that reported by Griffin et al. The nature of the intervention differs considerably between studies, which make it difficult to draw firm conclusions, but this is consistent with the findings from previous reviews by Tricco et al. (85) and Seidu et al. (86).

All-cause mortality in relation to organization of diabetes care

A systematic review of diabetes self-management education that included 42 studies and 13,017 people with T2DM showed a decreased risk of early death when self-management education was implemented (92). A multicentre RCT by Krag et al. (93) assessed gender differences in all-cause mortality after 6 years of people with T2DM receiving structured personal care, including 970 patients. The structured personal care included regular follow-up, individualized goal setting and postgraduate education for GPs. A reduced risk of early death was found for women who received personal structured care compared with those who received routine care, however, no significant differences were found for men. Other RCTs comprising multifaceted interventions have shown no associations with all-cause mortality (90, 94). However, no previous study has explored how an optimal PHC should be organized to reduce the risk of early death in people with T2DM in a Swedish context.

Table 1. Randomized controlled trials in multifaceted interventions for people with type 2 diabetes mellitus treated in primary health care in Europe 2008–2018.

Study	Number of participants		Intervention description	Timepoints	HbA1c (%) mean or median at baseline		Difference between I and C, *P*-value or β [95%CI]
	I	C			I	C	
Cleveringa et al. (95) The Netherlands	26 PHCCs, 1,699 patients	29 PHCCs, 1,692 patients	**Intervention**: patient consultation with RN, use of computerized decision-support system, guideline-based care, GP support by RN, interdisciplinary care by a specialist team, individualized treatment advice, patient education, GP feedback, recall system, regular patient consultations by RN + GP feedback. **Control group**: usual care	Baseline 1 year	7.1 6.9	7.0 6.9	- N/S
Sönnischen et al. (96) Austria	43 GPs, 654 patients	47 GPs, 840 patients	**Intervention:** Physician education, guideline-based care, patient education, use of a clinical information system tool, interdisciplinary care by specialist team, patient reminders, goal setting, shared decision-making by patient and physician, regular consultations. **Control group**: usual care	Baseline ~1 year	7.5 7.1	7.3 7.0	*P* = 0.026 N/S
Frei et al. (97) Switzerland	15 GPs, 147 patients	15 GPs, 156 patients	**Intervention:** Specialist team involving an RN, GP and RN education, independent patient consultations with RN, GP support by RN, clinical information system, guideline-based decision support, self-management support for patient. **Control group**: usual care.	Baseline 1 year	7.8 7.6	7.6 7.3	N/S N/S
Janssen et al. (91) Netherlands	37 PHCCs, 250 patients	42 PHCCs, 241 patients	**Intervention:** Guideline-driven management, GP education in treatment protocol, RN education in lifestyle, frequent patient consultations with RNs, feedback sessions with GP. **Control group**: usual care.	Baseline 1 year	7.4 6.2	7.3 6.5	- *P* = 0.03
Griffin et al. (90)	161 PHCCs, 1678 patients	157 PHCCs, 1678 patients	**Intervention**: Guideline-driven management of hyperglycaemia, RNs promotion of healthy lifestyle, GP and RN education, audit and feedback in group meetings. **Control group**: usual care.	Baseline 5 years	7.0 6.6	7.0 6.7	N/S –0.08 (–0.14; –0.02).
Goderis et al (89). Belgium	67 GPs, 1577 patients	53 GPs, 918 patients	**Two intervention groups:** (1) Advanced (AQIP): UQIP + interventions of intensified follow-up, shared care and patient behavioural changes. (2) Usual (UQIP): evidence-based treatment protocol, annual benchmarking, postgraduate education, case-coaching for GPs, and patient education (control group)	Baseline 18 months	7.2 6.8	7.1 6.7	N/S N/S

Note: C, control group; GP, general practitioner; I, intervention group; RCT, randomized controlled trial; PHCCs, primary health-care centres; RN, registered nurse.

Rationale

The gap between ideal and actual care is not surprising, given the complex nature of T2DM. Continuous evaluation of the care of people with T2DM is essential. Very little is currently known about the hallmarks of successful diabetes care in the Swedish PHC, particularly because no recent studies have been published in this field. Most people with T2DM are treated within the PHC system, and given the increasing prevalence of T2DM, the PHC system is facing serious challenges in providing high-quality and equitable care to all people with T2DM.

In 2006, a nationwide survey was conducted in the Swedish PHC system, aiming to address personnel resources and organizational features. The survey included more than 70% of Swedish PHCCs. Further, in 2010, new national guidelines were published for Swedish diabetes care. However, no national survey has been conducted to identify whether any changes have been made in Swedish diabetes care since these guidelines were introduced. The revised version of the national guidelines was published in 2015. Therefore, we considered it important to investigate changes in diabetes care before implementation of these new guidelines. In addition, in 2013 approximately 90% of all people diagnosed with T2DM were registered in the NDR.

It has become clear that identifying the characteristics of successful diabetes care is a daunting task. There is still very little scientific understanding of Swedish primary diabetes care and its associations with improved HbA1c levels or all-cause mortality. Far too little attention has been paid to consideration of important confounding factors at the PHCC and individual level, including socio-economic status and comorbidities. Sweden is one of the leading countries in Europe for primary diabetes care and is therefore of interest. This thesis will provide an addition to published RCTs in the form of information about real-life clinical practice, to better understand the benefits of the organization of diabetes care in the Swedish PHC setting.

Aims

The overall aim of this thesis was to extend the current knowledge about how Swedish primary diabetes care changed between 2006 and 2013 and to investigate the association between the personnel resources, organizational features and quality-of-work conditions of PHCCs and the individual HbA1c levels and all-cause mortality in people with T2DM.

The specific aims were as follows:

Study I	To compare the resource allocation and organizational features for people with T2DM in Swedish primary diabetes care between 2006 and 2013.
Study II	To examine the associations between personnel resources and organizational features of PHCCs and the individual HbA1c level in people with T2DM.
Study III	To describe and examine the associations between PHCCs' quality of work and individual HbA1c levels in people with T2DM.
Study IV	To identify associations between personnel resources and organizational features in real-life clinical practice in Swedish PHC and all-cause mortality in people with T2DM.

Methods

The present thesis is a compilation of four studies presented within a framework. It is based on my licentiate thesis titled "*The organisation of diabetes care for persons with type 2 diabetes mellitus: A nationwide cross-sectional study in Swedish primary health care*", which was published in 2017 (98), and that included two of the studies (I and II) described in this compilation.

The research data in this thesis is drawn from two main sources: the responses of PHCC managers to the Swedish National Survey of the Quality and Organisation of Diabetes Care in Primary Health Care (Swed-QOP) questionnaire concerning personnel resources, organizational features and quality-of-work conditions, and individual-level data on people with T2DM retrieved from the Swedish NDR. Individual clinical data were linked to other registries containing data on individual socio-economic status and comorbidities. An overview of the methods used in the thesis is presented in Table 2.

Table 2. Overview of the methods used in this thesis.

	Study I	Study II	Study III	Study IV
Design	Longitudinal	Cross-sectional		Registry-based cohort
Participants	684 (74.3%) PHCCs in 2006 and 880 (76.4%) in 2013.	People with T2DM (n = 230,958) attending 846 PHCCs.		People with T2DM (n = 187,570) attending 787 PHCCs.
Data collection	Managers of PHCCs responding to the Swed-QOP questionnaire in 2006 and 2013.	PHCC-level data from the Swed-QOP questionnaire. Individual clinical data from the Swedish NDR in 2013, linked to individual-level data on socio-economic status and comorbidities.		PHCC-level data from the Swed-QOP questionnaire. Individual-level data from the Swedish NDR in 2013, linked to individual-level data on socio-economic status and comorbidities. All-cause mortality was retrieved from the Swedish Population Register.
Statistical analysis	Bootstrap procedures for tests of differences utilizing Pearson's $\chi 2$ test for categorical data and the Mann–Whitney test for ordinal, discrete and continuous data.	GEE linear regression models.	Explanatory factor analysis and GEE linear regression models.	Unadjusted and adjusted hierarchical Cox regression models.

Notes: GEE, generalized estimating equations; NDR, National Diabetes Register; PHCC, Primary health-care centres; Swed-QOP, Swedish National Survey of the Quality and Organisation of Diabetes Care in Primary Health Care.

Setting and study design

All studies included in this thesis were conducted in the setting of the Swedish PHC. The longitudinal cross-sectional design of Study I involved all Swedish PHCC that responded to the Swed-QOP questionnaire in 2006 and 2013. Studies II and III were cross-sectional studies using PHCC-level data for 2013 from the Swed-QOP questionnaire and individual-level clinical data from 2013 for people with T2DM reported in the Swedish NDR. The registry-based cohort design of Study IV involved PHCC-level data from 2013 and individual-level clinical data reported in the NDR in 2013 for people with T2DM who were followed until death, emigration or the end of follow-up.

Participants

In Study I, 684 (74.3%) of 921 eligible PHCCs responded to the Swed-QOP questionnaire in 2006. In 2013, 880 (76.4%) of 1152 eligible PHCCs responded. Studies II and III included 846 (74.3%) of the 880 responding PHCCs, because PHCCs that had reported no data to the NDR (n = 11) or had reported less than 30 people with T2DM to NDR (n = 23) (i.e. deemed eligible to perform statistical analyses) were excluded. A total of 290,808 people with T2DM were eligible to participate. People with T2DM were excluded if they were registered at non-responding PHCCs (n = 59,461) or were registered at PHCCs reporting fewer than 30 people with T2DM (n = 389). The final sample in Studies II and III consisted of 846 PHCCs and 230,958 people with T2DM.

Participants in Study IV included 787 PHCCs and 187,570 people with T2DM who med the criterion of having complete cases for all PHCC variables. A flow chart describing the process of inclusion of PHCCs and people with T2DM in the studies comprising this thesis is presented in Figure 3.

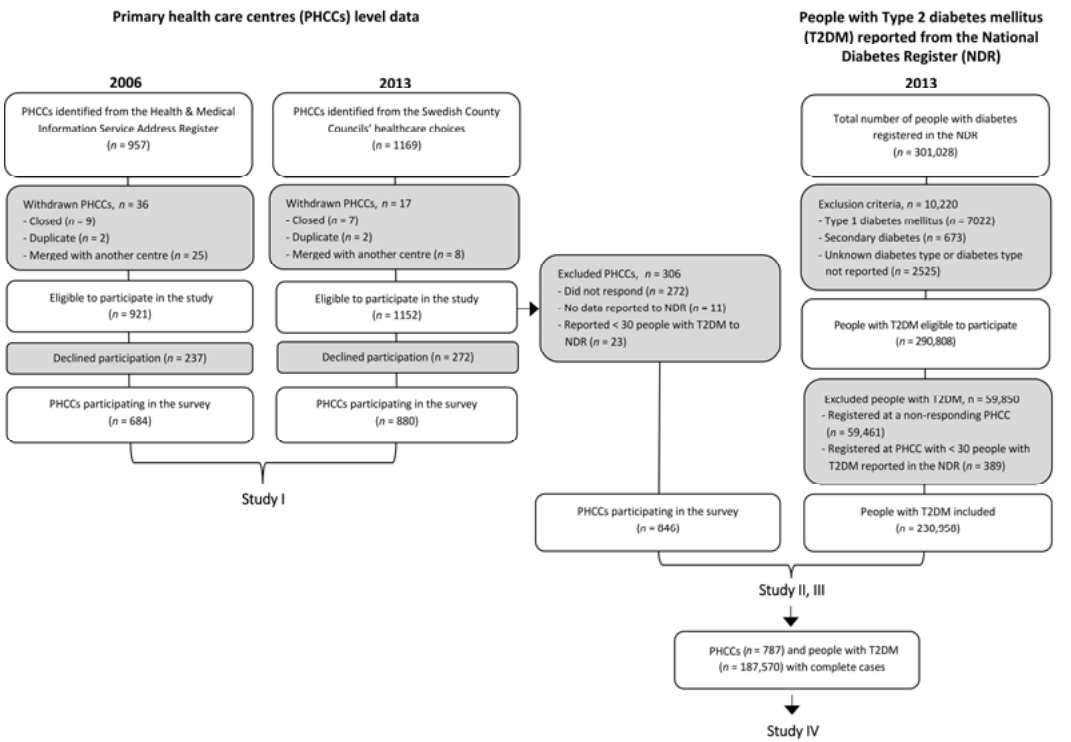


Figure 3. Overview of the inclusion process of the PHCCs and people with type 2 diabetes mellitus from the Swedish National Diabetes Register.

Data collection procedure

In Study I, the data for 2006 were collected during January–August, 2007, and those for 2013 during January–June, 2014, by sending the Swed-QOP questionnaire to PHCC managers. In 2006, the addresses of PHCC managers were identified through the health and medical information service address registry; in 2013, email addresses were obtained from the county councils/regions health-care choices registries. In 2006, paper-based questionnaires were sent to all PHCC managers whereas for the 2013 data collection, a combination of web- and paper-based questionnaires was used. The web-based questionnaire was accessed through the web-based survey program Artologik Software for the Web: Survey and Report (Artisan Global Media, Växjö, Sweden). In total, three reminders were sent in 2006 and four reminders in 2013. All managers were encouraged to answer the questionnaire together with personnel responsible for the people with T2DM. The PHCC-level data collected in 2013 for Study I were also used for Studies II, III and IV.

Demographic and clinical data for people with T2DM were retrieved from the Swedish NDR in 2013 and linked to individual data on socio-economic status and comorbidities from the Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) and National Patient Register (NPR), respectively. People with T2DM identified from the NDR were linked to the PHCCs' Swed-QOP data using the unique health-care address register identity number (HSA-ID) of each PHCC. These HSA-IDs were obtained from SALAR and verified by each of Sweden's county councils/regions. Individual-level data were linked using Swedish personal identification numbers. For Study IV, the participants were followed up through the Swedish population register from each individual's last registration reported in the NDR in 2013 until death, emigration or end of follow-up at 30 January 2018.

Data sources

Swed-QOP questionnaire

All studies in this thesis used the Swed-QOP questionnaire to address questions regarding the personnel resources, organizational features and quality-of-work conditions of the PHCCs. The Swed-QOP questionnaire was created based on a survey of asthma care in Sweden (99) and previous studies conducted in the United Kingdom regarding the organization of diabetes care (100, 101) and, for the 2013 version, a qualitative benchmarking study conducted by SALAR (27). A reliability test of the Swed-QOP questionnaire was conducted in 2006 that included 10 RNs responsible for diabetes care and 10 PHCC managers at 10 PHCCs in the county of Västmanland. The results

showed a correlation between –0.316 and +1.0 and questions with low reliability were subsequently adjusted and instructions made clearer (22).

For Study I, some minor changes were made in the questionnaire between 2006 and 2013. Differences in the questionnaire between the two years involved changes in the questions about patient education, which were open-ended in 2006 but were changed to closed-answer questions in 2013 based on qualitative content analysis of the answers from 2006 (22). The 2006 question about medical check-ups of people with T2DM undergoing dietary/OHA treatment was constructed as one question while in 2013 medical check-ups of people with T2DM having diet/OHA treatment were split into two questions. Answers to the question about medical check-ups of people with T2DM undergoing dietary and OHA treatment in 2013 were merged into single answer in order to make the two years comparable. Study III aimed to examine the associations between the PHCCs' quality-of-work conditions and individual HbA1c levels in people with T2DM. Thus, 21 questions about quality-of-work conditions, addressing SALAR's seven quality-of-work features, were included in the Swed-QOP questionnaire after being face-validated. Details of the variables from the questionnaire used in all studies are listed in Table 3.

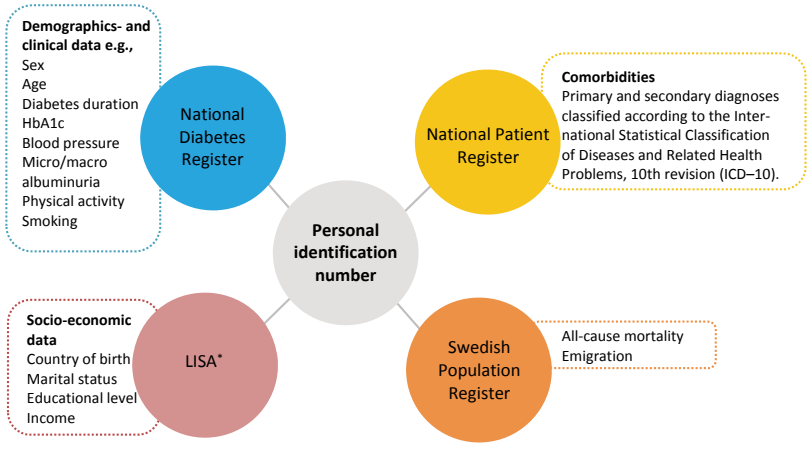
Table 3. Overview of questions included in each study.

Variable	Study			
	I	II	III	IV
List size of the PHCC	X	X	X	X
Number of listed people with T2DM	X	X	X	X
Number of listed patients/WTE GPs	X			
Number of WTE RNs/500 people with T2DM assigned for diabetes care	X	X	X	X
Number of WTE GPs/500 people with T2DM		X	X	X
Diabetes-responsible RN, (yes/no)	X	X	X	X
Diabetes-responsible GP, (yes/no)	X	X	X	X
Other professionals (chiropodists, social workers, physiotherapists, psychologists or dietitians) in-house or outside the PHCC (yes/no)	X			
Lengths of visits to RNs and GPs (minutes)	X	X	X	X
Number of diabetes-educated RNs (0–5)		X	X	X
RNs' mean number of ECTS credits for diabetes-specific and or pedagogic education	X			
RNs' mean number of ECTS credits for diabetes-specific education		X	X	X
RNs' mean number of ECTS credits for pedagogic education		X	X	X
Have and use regional and/or local guidelines (yes/no)	X		X	
Routines for medical check-ups for HbA_{1c}, weight, WC, lipids, blood pressure, albuminuria and foot examinations for persons with dietary/OHAs or insulin treatments (≥ 2 times per year/once a year/every other year or less frequently/never/almost never)	X			
Call–recall system for RNs and GPs (yes/no)	X	X	X	X
Computerized system/manual	X	X		
Based on the persons' needs/standardized system		X	X	
System checking that patients participated in visits to RNs and GPs (yes/no)	X	X	X	X
Diabetes team including RNs and GPs (yes/no)		X	X	X
How individual counselling is provided: checklist driven/based on persons' needs/not specified	X			
Group education program (yes/no)	X	X	X	X
How group education in provided: pre-planned content/based on persons' needs/not specified	X			
Discussing treatment targets with persons with T2DM (yes/no)	X			
RN/GP/person with T2DM participating in setting treatment targets (yes/no)	X	X	X	X
Goal-oriented drug therapy based on clear treatment stages (yes/no/do not know)			X	
Clear strategy with interventions targeted to people with poor outcomes (yes/no/do not know)			X	
Common meetings regarding diabetes guidelines for all healthcare professionals (yes/no/do not know)			X	
Frequent dialogue between PHCC management and health-care professionals about PHCCs results (yes/no/do not know)			X	
The health-care professionals are informed about PHCC results (yes/no/do not know)			X	
County council/region continuously reports results from NDR to PHCC (yes/no/do not know)			X	
County council/region uses NDR-results for quality of dialogue (yes/no/do not know)			X	
County council/region internally reports NDR results concerning all PHCCs (yes/no/do not know)			X	
Culture of following guidelines (yes/no/do not know)			X	
Focusing on prevention of diabetes complications (yes/no/do not know)			X	
Follow–up strategy for people with poor outcome (yes/no)			X	
Responsibility of quality and results for people with diabetes (yes/no)			X	
Political priority of diabetes care (yes/no)			X	
Having conducted quality improvement work during several years (yes/no)			X	

Notes: ECTS, European Credit Transfer Accumulation System; GP, general practitioner; OHA, oral hypoglycaemic agent; PHCC, primary health-care centres; RN, registered nurse; Swed-QOP, Swedish National Survey of the Quality and Organisation of Diabetes Care in Primary Health Care; T2DM, type 2 diabetes mellitus; WC, waist circumference; WTE, whole-time equivalent.

Registries

Four nationwide registries were used in this thesis to obtain individual-level data. For Studies II, III and IV, the NDR provided data on demographics and clinical data, the NPR provided data on comorbidities and the LISA provided data on socio-economic status. In Study IV, data on all-cause mortality and emigration date were retrieved from the Swedish population register. An overview of the included registries and some of the data extracted from each registry is presented in Figure 4.



*Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA)

Figure 4. Overview of registers and some of the data used in this thesis.

National Diabetes Register

The NDR is maintained by the Västra Götaland Centre for Registries and demographics, clinical and lifestyle data for people with T2DM were obtained from the NDR. The definition of T2DM used was the diagnosis based on clinical assessment by a physician that was reported to the NDR.

Demographic data collected were: age (years), sex (male/female) and duration of diabetes (years). Clinical data included HbA1c level (mmol/mol), systolic blood pressure (mmHg), diastolic blood pressure (mmHg), body mass index (BMI; kg/m^2), total cholesterol (mmol/l), triglycerides (mmol/l), low-density lipoprotein (mmol/l), high-density lipoprotein (mmol/l), estimated glomerular filtration rate (eGFR) < 60 ml/min (yes/no), micro-albuminuria (yes/no), macro-albuminuria (yes/no), risk or presence of foot complications (yes/no), diabetes retinopathy (yes/no), use of antihypertensive drugs (yes/no), use of lipid-lowering drugs (yes/no), and glucose-lowering treatment (diet/OHA/insulin/OHA + insulin/other glucose-lowering treatments). Lifestyle data recorded were: smoker (yes/no) and physical activity (never/fewer than or once per week/1–2 times per week/3–5 times per week/daily).

The National Patient Register

The NPR is maintained by the NBHW (*Socialstyrelsen*) and contains individual-level data about comorbidities (i.e., primary and secondary medical diagnoses) from in-patient and out-patient hospital visits. The NPR uses the International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10) to classify primary and secondary diagnoses (102). Comorbidities were retrieved by ICD-10 code at the main diagnostic (Chapter) level (except for the main diagnostic group of E00–E90 for which secondary diagnosis was retrieved) for 2012 and 2013. If an ICD-10 diagnosis was present in either of the two years it was coded as "Yes" and otherwise coded as "No". ICD-10 codes with a prevalence of < 1.0% were excluded.

Longitudinal Integration Database for Health Insurance and Labour Market Studies

LISA is maintained by Statistics Sweden (*Statistiska centralbyrån*) and contains individual-level data on socio-economic variables (103). The variables included from LISA and categorized in the thesis were: born in Sweden (yes/no), marital status (single/married/divorced/widowed), disposable income in Swedish Krona (quintiles; q1–q5), educational level (9 years or less/10–12 years/college or university) and occupational status (not employed aged < 65 years/not employed aged ≥ 65 years/employed).

The Swedish Population Register

For Study IV, follow-up data for all-cause mortality and emigration were obtained for all people with T2DM registered in the NDR in 2013 from the Swedish population registry maintained by the Swedish National Tax Board (*Skatteverket*).

Ethical considerations

The studies were approved by the Regional Ethical Review Board in Uppsala (approval number 2013/376) and three subsequent ethics applications were approved (approval numbers 2013/376/1, 2013/375/2 and 2013/375/3), waiving informed consent. Managers at the PHCCs received a cover letter together with the Swed-QOP questionnaire indicating that their participation in the study was voluntary and that all data were to be kept confidential. We also informed them that published results would not identify PHCCs or individuals and that all data would be presented at a group level. As for the data from the NDR, all people with T2DM had given their informed consent to participate in the registry and were informed that the data could be used for research.

Statistical analysis

For descriptive statistics: categorical variables are presented as percentages and frequencies, *n* (%); ordinal, discrete and continuous variables are given as median and interquartile range (IQR) in Study I and discrete and continuous variables was given as means and standard deviations (SDs) in Study II, III, IV.

Mann-Whitney *U*-test
Used for ordinal, discrete and continuous data to test for univariate differences between the two years (2006 and 2013) (Study I).

Pearson's χ^2- test
Used for categorical data to test for univariate differences between the two years (2006 and 2013) (Study I).

Bootstrap procedure
To test for differences between the two years (2006 and 2013), the dependence between the two studies had to be considered. Therefore, a bootstrap procedure was used to calculate the *P* values for tests of differences between the two years (Study I).

Exploratory factor analysis (EFA)
A principal component analysis factor extraction, retaining all factors with eigenvalues > 1, was used to identify the underlying structure of the questions. The quality-of-work questions with three alternative answers were dichotomized as 0 ("No") and 1 ("Yes") while "Do not know" was coded as missing. Varimax rotation with Kaiser normalization was performed and excluded questions with $\lambda < 0.4$ (i.e. "political priority of diabetes care", $\lambda = 0.327$) and questions with $\lambda < 0.6$ that were seen as not fitting the interpretation of the other questions with $\lambda > 0.6$ for the same factor (e.g., "having diabetes-responsible RNs", $\lambda = 0.430$, and "having conducted quality improvement work during several years", $\lambda = 0.511$). Seven EFA factor analysis scores were calculated for each PHCC, based on factor score coefficients estimated using the Anderson–Rubin method. The re-estimated rotations and extractions led to the retention of 18 questions forming seven quality-of-work features with 2–4 questions for each feature (Study III).

Generalized estimating equations (GEE) linear regression models
GEE was used for analysing associations in Studies II and III to take account of the hierarchical dependence structure of the data, in that several people with T2DM attend the same PHCC, and several PHCCs belong to the same county council/region. Utilizing an independent structure working correlation matrix.

In Study II, the analyses were performed in three steps. In the first step, a base model was constructed by including all PHCC-level variables except those measuring the type of call–recall system. The base model was adjusted for all other variables relating to personnel resources and organizational features, and for all background data measured at the PHCC level. In the second step, the full model included all variables in the base model as well as all demographic factors and clinical, lifestyle, socio-economic and comorbidity variables measured at the individual level. In the third step, a trimmed model was derived, which started by including all variables in the full model and used a backward selection procedure to exclude variables with high *P* values, using a removal probability of 0.2 starting with the highest *P* value in the full model. A subgroup analysis of PHCCs that used a call–recall system to RNs and GPs included the variables measuring the type of system used.

For Study III, two steps were applied. The first step was an unadjusted model, including only the quality-of-work features, while the second step was an adjusted model, which in addition to the quality-of-work features also included individual clinical data, socio-economic data and comorbidities, as well as background characteristics, personnel resources and organizational features of the PHCCs. The regression model was stratified into three levels of HbA1c: controlled (≤ 52 mmol/mol) intermediate (53–69 mmol/mol), and uncontrolled (≥ 70 mmol/mol). Data were presented as the linear slope coefficient β (95% CI), using a normal approximation Z-test procedure to compare strata.

Survival analysis

Survival analysis is performed to identify the time to an event of interest and to examine the nature of the survival distribution. The event of interest in Study IV was all-cause mortality.

Cox regression

The main focus of Study IV was to examine the associations between the personnel resources and organizational features of PHCCs and all-cause mortality during the follow-up period. Survival was measured from the date of last registration in the NDR in 2013 to the date of death or date of censoring because of emigration or end of follow-up (30 January 2018). A total of 160,434 people with T2DM were censored, for whom date of emigration (n = 498) and end of follow-up (n = 159,936) were used as censoring dates.

Two hierarchal Cox regression models were used to analyse the association between PHCC personnel resources and organizational features and all-cause mortality. The hierarchal approach was used because of the interdependence between people with T2DM nested in PHCCs and PHCCs nested in county council/regions. The unadjusted models included only the personnel resources

and organizational features whereas the adjusted model also included individual-level confounding variables concerning clinical, socio-economic and comorbidity characteristics. In addition, subgroup analyses by age (≤ 55 years, 56–74 years, ≥ 75 years), sex (female/male) and HbA1c level category (≤ 52 mmol/mol, 53–69 mmol/mol, ≥ 70 mmol/mol) were constructed.

Handling of missing data

The NDR is a longitudinal database that contains repeated measurements and has missing data. People with diabetes mellitus enrolled in the NDR are examined repeatedly at different times and intervals. Several statistical techniques have been developed to handle longitudinal and complex data. The present thesis used simple imputation, which involves replacing missing values using the last observation carried forward (LOCF) method, because that is the default method used by the NDR.

Role of bias

In epidemiological studies such as those included in this thesis, bias is unavoidable. Random biases can be reduced by having a large sample, however, systematic biases remain even in a large sample. There are three phenomena that may occur in observational studies: selection bias (study population), information bias (data collection procedure, analysis and interpretation) and confounding. *Selection bias* arises from the procedure used to select participants and factors that can influence study participation. The presence of selection bias is prevalent when, for example, the associations between exposure and disease differ between participants and non-participants. *Information bias* in a study can be prevalent if the information obtained is erroneous, introducing systematic errors. This can manifest as misclassification and occurs when a variable is measured on categorical scale and participants are placed in an incorrect category. There is also a risk of recall bias in cross-sectional studies that require participants to provide information and to remember something after it has occurred. *Confounding:* every epidemiological study faces problems with confounding. Confounding can be explained as confusion of effects, which implies that the effects of the exposure are influenced by effects from other variables (104). There is a risk of confounding by indication in epidemiological studies. This term refers to the baseline outcome being the reason for the intervention so that effects from the phenomena investigated might not be a step in a causal pathway (105).

Results

Study I

Personnel resources

The median list size for a PHCC decreased between 2006 and 2013 but the median number of people with T2DM listed at PHCCs increased (all $P < 0.001$). The whole-time equivalent (WTE) RNs per 500 people with T2DM increased from 0.64 in 2006 to 0.79 in 2013 ($P < 0.001$) with a variation in 2013 of (SD) (0.52; 1.12). From 2006 to 2013, 30 percentages points more PHCCs (from 17.0% in 2006 to 47.5% in 2013) had an RN with 16 or more European Credit Transfer Accumulation System (ECTS) credits for postgraduate education in diabetes ($P < 0.001$). Moreover, access to a psychologist in-house increased from 25.9% of PHCCs in 2006 to 47.1% in 2013 ($P < 0.001$). No change was found in terms of in-house access to dietitians, chiropodists, social workers or physiotherapists.

Organizational features

The use of a call–recall system in 2013 increased for GPs (62.3% in 2006 to 79.2% in 2013; $P = 0.002$) and for RNs (88.4% in 2006 to 95.2%; $P = 0.020$), as did their use of a system for checking that people made annual visits to GPs (68.8% in 2006 and 80.3%; $P = 0.017$) and to RNs (77.8% in 2006 to 88.8% in 2013; $P = 0.008$). No difference was found between 2006 and 2013 for the number of PHCCs providing group education, with almost one-quarter providing it in both years. The proportion of PHCCs reporting people with T2DM participating in goal setting of treatment targets remained low, and in 2013 ranged from 30.3% to 54.0% depending whether the target was HbA1c, systolic blood pressure, lipids or lifestyle changes. There was a significant change between 2006 and 2013 in the proportion of people with T2DM being included in goal setting for lifestyle changes (34.1% in 2006 to 54.0% in 2013: $P < 0.001$).

Medical check-ups of risk factors

Descriptive statistics for screening “at least twice a year” and “once a year” between the two years for people receiving diet/OHA treatment (A) and for people receiving insulin treatment (B) are presented in Figure 5. Between 2006 and 2013 there were no significant differences in screening of HbA1c levels, weight, blood pressure, or feet, irrespective of the type of treatment.

However, compared with 2006, in 2013 more PHCCs reported performing medical check-ups at least twice a year to assess waist circumference (27.7% in 2006 and 40.9% in 2013; $P = 0.004$), lipids (8.9% in 2006 and 14.7% in 2013; $P = 0.027$) and albuminuria (18% in 2006 and 26.3% in 2013; $P = 0.026$) for people receiving dietary treatment or using OHAs as glucose-lowering treatment. Further, more PHCCs in 2013 than in 2006 reported screening waist circumference at least twice a year in insulin-treated patients (34.7% in 2006 and 47.7% in 2013; $P = 0.010$).

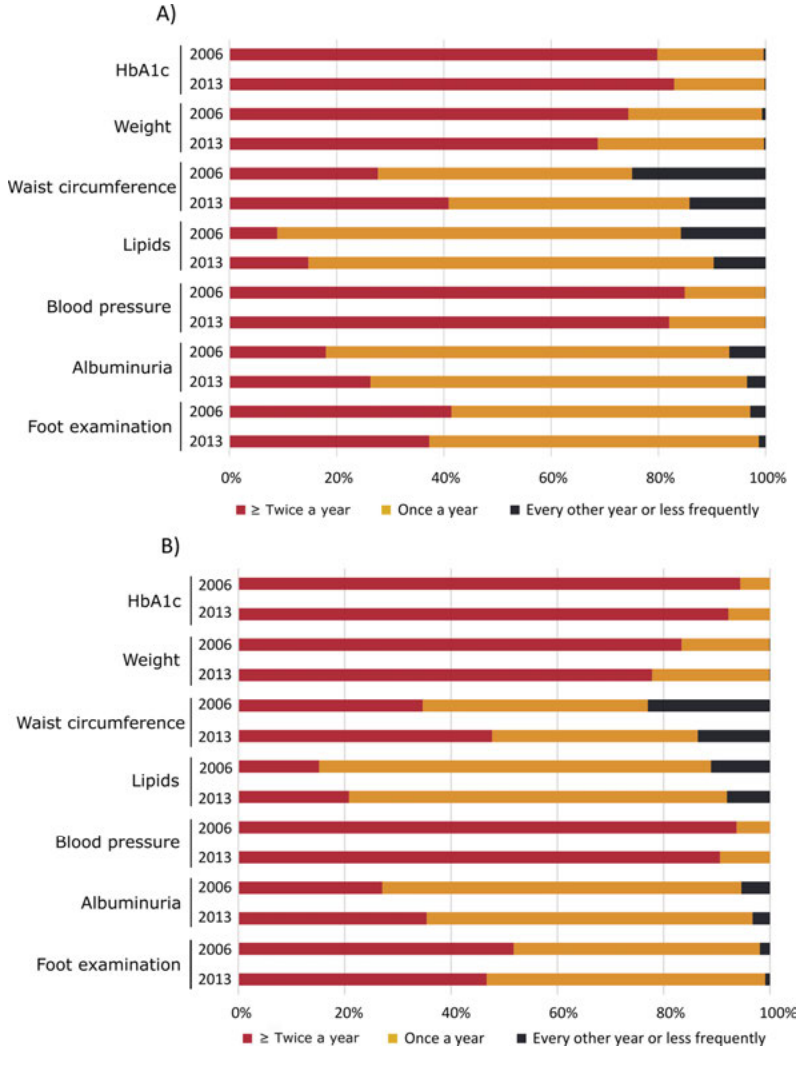


Figure 5. Differences between 2006 ($n = 684$) and 2013 ($n = 880$) in the proportion of primary health-care centres reporting medical check-ups "≥ Twice a year", "Once a year" and "Every other year or less frequently" for people treated with diet/oral hypoglycaemic agents (A) and for people treated with insulin (B).

Study II and III

Characteristics of people with type 2 diabetes mellitus

Table 4 shows the characteristics for the total participant population (Study II) and stratified for those with uncontrolled, intermediate and uncontrolled HbA1c levels (Study III). In Study II, a total of 230,958 people with T2DM attending 846 PHCCs were included. The study population had a mean (SD) age of 68 (11.8) years, 56.6% were male, and the mean (SD) duration of diabetes was 9 (7.6) years. The mean (SD) HbA1c level was 54 (13.7) mmol/mol. Most of the participants were born in Sweden (80.7%) and were married (51.8%). Common comorbidities were diseases of the circulatory system (33.3%), diseases of the eye and adnexa (23.5%) and diseases of the musculoskeletal system and connective tissue (19.0%).

In Study III, a total of 56.0% of the participants had a controlled HbA1c level (≤ 52 mmol/mol), 31.9% had an intermediate level (53–69 mmol/mol) and 12.1% had uncontrolled (≥ 70 mmol/mol) HbA1c. There were differences in the characteristics of people with uncontrolled HbA1c compared with the controlled and intermediate HbA1c groups: they were slightly younger (mean [SD] age 66 [12.9]), more often male (58.8%) and had longer diabetes duration (mean [SD] 12.4 [8.5] years). Most of the people with uncontrolled HbA1c were being treated with OHA + insulin as glucose lowering treatment (37.1%) while most people with controlled or intermediate HbA1c (52.7% and 48.9%, respectively) were treated with OHA alone. Smoking (17.4%) and undertaking physical activity never or less than once per week (40.9%) were also more common in the group with uncontrolled HbA1c.

Characteristics of primary healthcare centres

For Study II and III, the mean (SD) total number of people listed per PHCC was 8561 (4196) and the mean number of listed people who had T2DM was 354 (199). The mean (SD) number of WTE RNs per 500 people with T2DM assigned to diabetes care was 0.8 (0.4). More than half (59.4%) of the people with T2DM attended PHCCs that had a diabetes team and about a third (30.3%) attended PHCCs that had group education programs. Call-recall systems to RNs and GPs were used for the majority of people with T2DM, 96.0% and 80.0% respectively. About half (53.2%) of the participants attended PHCCs with call-recall systems to RNs based on the patient's needs and two fifths (39.4%) to GPs. Most of the RN (70.0%) and GP (52.5%) call–recall systems were computerized.

Table 4. Descriptive statistics for the total population of participants (n = 230,958), stratified according to HbA1c level: controlled (n = 124,671), intermediate (n = 70,928) and uncontrolled (n = 26,947).

Variable	Total population	Controlled HbA1c (≤ 52 mmol/mol)	Intermediate HbA1c (53–69 mmol/mol)	Uncontrolled HbA1c (≥ 70 mmol/mol)
Age (years), mean (SD)	68.1 (11.8)	68.1 (11.5)	68.8 (11.6)	66.1 (12.9)
Men, *n* (%)	130,714 (56.6)	69 430 (55.7)	40,699 (57.4)	15,844 (58.8)
Duration of diabetes (years), mean (SD)	9.0 (7.6)	7.1 (6.6)	10.9 (8.0)	12.4 (8.5)
HbA1c (mmol/mol), mean (SD)	54.0 (13.9)	N/A	N/A	N/A
Systolic blood pressure (mmHg), mean (SD)	135 (15.7)	134.2 (15.4)	135.5 (15.7)	136.0 (16.5)
Diastolic blood pressure (mmHg), mean (SD)	76 (9.7)	76.1 (9.6)	76.0 (9.7)	76.9 (10.3)
Body mass index (kg/m2), mean (SD)	29.8 (5.4)	29.4 (5.2)	30.1 (5.3)	31.2 (5.8)
Total cholesterol (mmol/l), mean (SD)	4.7 (1.1)	4.7 (1.1)	4.6 (1.1)	4.8 (1.2)
Triglycerides (mmol/l), mean (SD)	1.8 (1.2)	1.7 (1.0)	1.9 (1.2)	2.3 (1.9)
High-density lipoprotein (mmol/l), mean (SD)	1.3 (0.4)	1.3 (0.4)	1.2 (0.4)	1.2 (0.4)
Low-density lipoprotein (mmol/l), mean (SD)[a]	2.6 (0.9)	2.6 (0.9)	2.5 (0.9)	2.6 (1.0)
Estimated glomerular filtration rate (eGFR) <60 (ml/min), *n* (%)[b]	33,151 (17.0)	16,240 (15.0)	11,740 (19.1)	4569 (19.8)
Risk/presence of foot complications, *n* (%)	41,754 (22.9)	19,619 (19.7)	14,303 (25.0)	6159 (29.8)
Diabetes retinopathy, *n* (%)	47,676 (27.9)	18,772 (20.5)	18,697 (33.8)	8809 (43.9)
Microalbuminuria, *n* (%)[c]	30,020 (19.9)	13,660 (16.1)	10,678 (22.6)	5247 (31.3)
Macroalbuminuria, *n* (%)[d]	11,187 (7.8)	4593 (5.6)	4119 (9.1)	2305 (14.5)
Antihypertensive drugs, *n* (%)	174,345 (79.0)	94,409 (79.0)	54,951 (80.7)	19,848 (76.9)
Lipid-lowering drugs, *n* (%)	137,412 (62.5)	72,921 (61.2)	44,697 (65.8)	16,247 (63.2)
Glucose-lowering treatment, *n* (%)				
Diet	51,091 (22.3)	40,439 (32.6)	6460 (9.2)	1490 (5.6)
OHA	111,571 (48.6)	65,370 (52.7)	34,531 (48.9)	8294 (30.9)
Insulin	25,378 (11.1)	7264 (5.9)	10,977 (15.6)	6190 (23.1)
OHA + insulin	37,817 (16.5)	9716 (7.8)	17,057 (24.2)	9952 (37.1)
Other medications	3644 (1.6)	1184 (1.0)	1527 (2.2)	880 (3.3)
Smoker, *n* (%)	28,091 (14.2)	14,946 (13.7)	8432 (13.7)	3925 (17.4)
Physical activity, *n* (%)				
Never or less than once per week	50,928 (28.2)	23,960 (23.9)	17,596 (30.8)	8492 (40.9)

1–2 times/week	36,211 (20.0)	19,507 (19.5)	11,864 (20.7)	4406 (21.2)
3–5 times/week	40,624 (22.5)	24,319 (24.3)	12,279 (21.5)	3515 (16.9)
Daily	52,843 (29.3)	32,306 (32.3)	15,450 (27.0)	4357 (21.0)
Born in Sweden, *n* (%)	186,400 (80.7)	102,293 (82.1)	56,963 (80.4)	20,419 (75.9)
Marital status, *n* (%)				
Single	35,098 (15.2)	18,120 (14.5)	10,412 (14.7)	5223 (19.4)
Married/registered partner	119,541 (51.8)	66,798 (53.6)	36,527 (51.5)	12,245 (45.5)
Divorced	40,691 (17.6)	21,389 (17.2)	12,316 (17.4)	5419 (20.1)
Widowed	35,400 (15.3)	18,279 (14.7)	11,607 (16.4)	4031 (15.0)
Income, *n* (%)				
<120 000 SEK	46,314 (20.1)	23,598 (18.9)	14,484 (20.4)	6264 (23.3)
120 000 ≤ SEK < 145 000	45,259 (19.6)	23,219 (18.6)	14,439 (20.4)	5812 (21.6)
145 000 ≤ SEK < 175 000	45,055 (19.5)	24,254 (19.5)	14,210 (20.0)	5042 (18.7)
175 000 ≤ SEK < 250 000	48,691 (21.1)	27,223 (21.8)	14,577 (20.6)	5332 (19.8)
≥250 000	45,538 (19.7)	26,348 (21.1)	13,193 (18.6)	4482 (16.6)
Educational level, *n* (%)				
≤9 years	90,622 (40.0)	46,891 (38.2)	29,190 (42.0)	11,088 (42.3)
10–12 years	108,560 (47.9)	52,865 (43.1)	29,455 (42.4)	11,442 (43.6)
College/university	27,379 (12.1)	22,954 (18.7)	10,834 (15.6)	3691 (14.1)
Occupational status, *n* (%)				
Working	61,340 (26.6)	33,508 (26.9)	18,302 (25.8)	7441 (27.6)
Not working aged < 65 years	31,316 (13.6)	15,466 (12.4)	9131 (12.9)	5518 (20.5)
Not working aged ≥ 65 years	138,072 (59.8)	75,612 (60.7)	43,429 (61.3)	13,959 (51.9)
Neoplasms (ICD 10; C00–D48), *n* (%)	29 808 (12.9)	16,415 (13.2)	9224 (13.0)	3033 (11.3)
Eye and adnexa, (ICD 10; H00–H59), *n* (%)	54 351 (23.5)	27,427 (22.0)	17,796 (25.1)	7223 (26.8)
Circulatory system (ICD 10; I00–I99), *n* (%)	76 929 (33.3)	39,113 (31.4)	24,379 (34.4)	10,085 (37.4)

Notes: ICD-10, International Statistical Classification of Diseases and Related Health Problems, 10th Revision; OHA, oral hypoglycaemic agents; SEK, Swedish krona.

[a] Primarily based on low-density lipoprotein level reported to the NDR and secondary if missing; the low-density lipoprotein was calculated based on the Friedewald formula (106).

[b] Calculated based on the Modification of Diet in Renal Disease form (107).

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

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

Personnel resources and organisational features in relation to HbA1c levels (Study II)

As can be seen from the results of the trimmed model shown in Table 5, after adjusting for several important confounders at the PHCC and individual levels, personnel resources such as the mean number of ECTS credits in diabetes-specific education among RNs ($P < 0.001$) and each additional 15 minutes duration of regular visits to RNs ($P < 0.001$) were associated with decreased individual HbA1c level. The opposite effect (i.e., increased HbA1c levels) was found to be associated with each additional 15 minutes duration of regular visits to GPs ($P < 0.001$). Organizational features of PHCCs associated with decreased individual HbA1c levels were having a diabetes team ($P < 0.009$) and providing group education ($P < 0.001$). The opposite effect (i.e., increased HbA1c levels) was found for PHCCs using a call–recall system for GPs ($P < 0.001$). In the subgroup analysis, attendance at PHCCs using an RN call–recall system based on individual needs ($P < 0.010$) and being computerized ($P < 0.001$) were associated with decreased individual HbA1c levels. However, having a computerized call–recall system for GPs was associated with increased HbA1c levels ($P < 0.001$).

Table 5. Adjusted results (trimmed model) from the main and subgroup analyses of the generalized estimating equations' linear regression models. Significant differences are shown in **bold**.

Main analysis (n = 188,094 people at 787 PHCCs)		
Variable	**β (95%CI)**	***P* Value**
Mean number of ECTS credits of diabetes-specific education for RNs	–0.02 (–0.02; –0.01)	**< 0.001**
Duration of regular visits to RNs (per 15 minutes)	–0.19 (–0.29; –0.10)	**< 0.001**
Duration of regular visits to GPs (per 15 minutes)	0.28 (0.18; 0.39)	**< 0.001**
Diabetes team including RN and GP	–0.18 (–0.31; –0.04)	**0.009**
Group education program	–0.20 (–0.33; –0.08)	**0.001**
Call–recall system to RNs	0.31 (–0.02; 0.65)	0.070
Call–recall system to GPs	0.42 (0.26; 0.59)	**< 0.001**
Subgroup analysis (n = 146,084 people at 594 PHCCs)		
Call–recall system to RNs based on persons' needs	–0.22 (–0.39; –0.05)	**0.010**
Computerized call–recall system to RNs	–1.10 (–1.54; –0.66)	**< 0.001**
Call–recall system to GPs based on persons' needs	0.01 (–0.16; 0.18)	0.911
Computerized call–recall system to GPs	1.20 (0.76; 1.63)	**< 0.001**

Notes: CI, confidence interval; ECTS, European Credits Transfer Accumulation System; GP, general practitioner; RN, registered nurse.

[a] Adjusted for all other personnel resources and organizational features and for all background variables measured at the PHCC level as well as for all demographic and clinical factors, lifestyle, socio-economic level, and comorbidities measured at the individual level except for the following variables: diseases of the ear and mastoid process (ICD-10: H60–H95), lipid-lowering drugs, mental and behavioural disorders (ICD-10: F00–F99), eGFR, and injury, poisoning and certain other consequences of external causes (ICD-10: S00–T98).

Quality-of-work conditions at primary health-care centres (Study III)

Figure 6 presents an overview of the PHCCs' quality-of-work conditions. Overall, 73.5% had a goal-oriented drug therapy treatment plan and 71.3% had a clear strategy for people with poor outcomes. Surprisingly, fewer of the respondents reported having common meetings about guidelines (41.0%), or accommodating a dialogue between the PHCC management and the health-care professionals (57.7%), and only 60.2% informed the health-care professionals about PHCC results. In contrast, the highest reported values were found with PHCCs taking responsibility for quality and results (96.6%) and having a culture of following guidelines (98.5%).

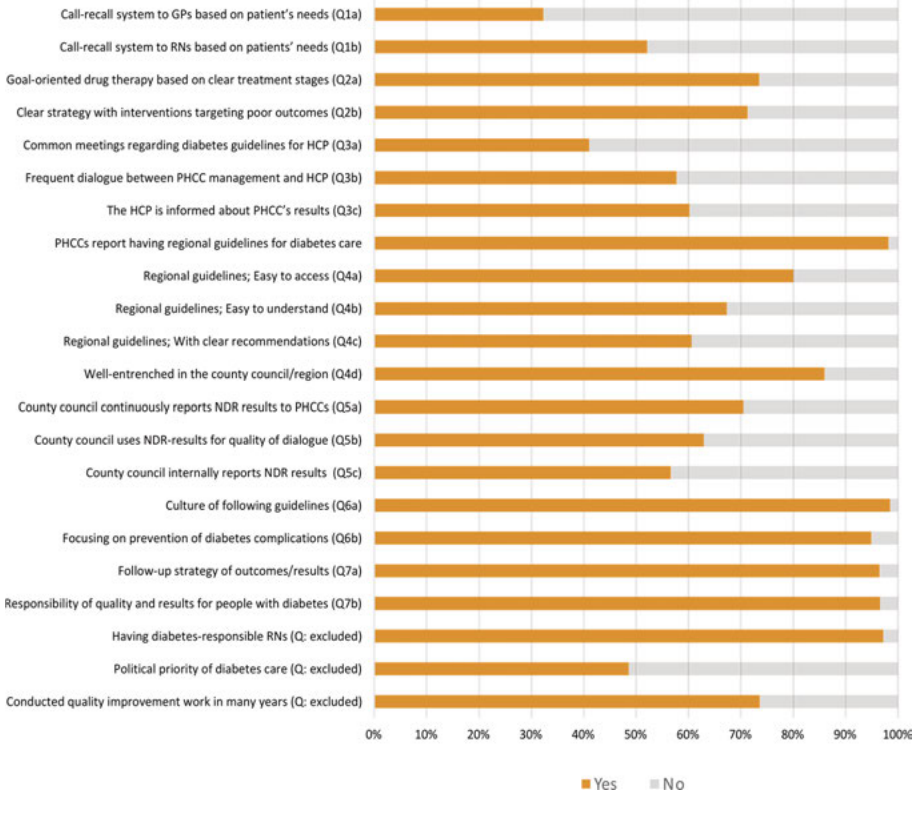


Figure 6. Descriptive statistics of primary health-care centres' quality-of-work conditions. The figure also describes which questions (Q:x) belong to which quality-of-work feature. GP, general practitioner; HCP, health-care professionals; NDR, National Diabetes Registry; PHCC, primary health-care centre; RN, registered nurse.

Results from the explorative factor analysis and its association with HbA1c levels (Study III)

An EFA was conducted, which identified seven quality-of-work features:

1. Call–recall systems
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

The results obtained from the adjusted GEE regression models are summarized in Table 6. Interestingly, four of seven quality-of-work features were associated with decreased HbA1c level among people in the controlled group. These associations expressed as the effect on HbA1c of increased presence of the relevant quality-of-work feature (i.e. change in HbA1c per one SD higher degree of presence of the quality-of-work feature at a PHCC). Significant associations were observed for for Call–recall systems ($P \leq 0.001$), Individualized treatment ($P \leq 0.001$), PHCC results always on the agenda ($P \leq 0.001$) and Strategies and responsibility ($P < 0.01$). The most surprising association was between the observed increase in HbA1c levels and the quality-of-work feature Culture and prevention ($P < 0.01$).Further analysis showed that attendance at PHCCs with Individualized treatment was significantly associated with lower levels of HbA1c in the intermediate ($P < 0.01$) and uncontrolled group ($P < 0.01$). The top 2.5% PHCCs (i.e. having ≥ 2 SDs on all quality of work features) had a decreased HbA1c level of 1.136 mmol/mol in the controlled group, 0.212 mmol/mol in the intermediate group and 0.788 mmol/mol in the uncontrolled group, compared to those PHCCs at the bottom 2.5% (i.e. having ≤ 2 SDs on all quality-of-work features).

Table 6. Adjusted results from the generalized estimating equations regression models of the associations between quality-of-work features and HbA1c level, reported for groups with uncontrolled, intermediate and uncontrolled HbA1c level.

	Controlled (*n* = 104,647 people at 788 PHCCs)	**Intermediate (*n* = 61,078 people at 788 PHCCs)**	**Uncontrolled (*n* = 22,849 people at 783 PHCCs)**
Quality-of-work feature	**Adjusted β (95% CI)**	**Adjusted β (95% CI)**	**Adjusted β (95% CI)**
1. Call–recall system	–0.054 (–0.083; –0.025)***	–0.009 (–0.046; 0.028)	–0.004 (–0.160; 0.152)
2. Individualized treatment	–0.053 (–0.083; –0.023)***	–0.053 (–0.091; –0.014)**	–0.197 (–0.355; –0.040)**
3. Results always on the agenda	–0.088 (–0.119; –0.057)***	–0.017 (–0.057; 0.022)	0.085 (–0.080; 0.249)
4. Regional guidelines	–0.015 (–0.044; 0.014)	–0.009 (–0.046; 0.028)	–0.091 (–0.251; 0.068)
5. Follow-up and feedback	–0.014 (–0.042; 0.014)	0.036 (0.000; 0.073)	–0.056 (–0.206; 0.095)
6. Culture and prevention	0.043 (0.013; 0.073)**	0.003 (–0.035; 0.041)	–0.098 (–0.258; 0.062)
7. Strategies and responsibility	–0.046 (–0.077; –0.015)**	0.007 (–0.032; 0.046)	0.109 (–0.054; 0.272)

Notes: PHCC, primary health-care centre; HbA1c levels: controlled, ≤ 52 mmol/mol; intermediate, 53–69 mmol/mol; uncontrolled, ≥ 70 mmol/mol.

*$P < 0.05$; **$P < 0.01$; ***$P \leq 0.001$.

Study IV

A total of 27,136 people with T2DM of the 187,570 originally included in the study (14.5%) were deceased. The people who were deceased were older (mean [SD] age 77 [9.4]), and had longer diabetes duration (11.9 [8.9] years) and slightly increased mean HbA1c level (58.2 [14.9] mmol/mol). Of note, the presence of complications was more prevalent among the deceased people compared with the censored participants, with almost twice as many having foot complications (40.2%), more than one third (36.5%) having retinopathy and three times as many having microalbuminuria (18.2%).

Results from the adjusted Cox regression models including the total population (n = 187,570) showed that WTE GPs/500 people with T2DM was associated with decreased risk of early death (hazard ratio [HR] 0.989, 95% CI 0.982–0.996; $P < 0.01$). However, attendance at a PHCC with a call–recall system for GPs was associated with increased risk of early death (HR 1.074, 95% CI 1.022–1.129; $P < 0.01$). We constructed Cox regression models including subgroups stratified by age, sex and HbA1c level to assess whether differences occurred between different subgroups. Attendance at a PHCC with WTE GPs/500 people with T2DM was associated with lower risk of early death in people aged ≥ 75 years (HR 0.986, 95% CI 0.977–0.996; $P < 0.01$), women (HR 0.990, 95% CI 0.981–0.9996; $P < 0.05$), men (HR 0.989, 95% CI 0.981–0.997; $P < 0.01$) and with HbA1c ≤ 52 mmol/mol (HR 0.988, 95% CI 0.981–0.996; $P < 0.01$).

We observed significant associations between RNs mean number of ECTS credits in diabetes-specific education and a lower risk of early death for people ≤ 55 years of age (HR 0.983, 95% CI 0.972–0.995; $P < 0.01$) (Figure 7). Being male with T2DM and attending a PHCC having RNs with pedagogical education was also associated with a lower risk of early death (HR 0.995, 95% CI 0.992–0.999; $P < 0.01$) (Figure 8). Another finding of Study IV was that attendance at PHCCs having GP call–recall systems and providing group education increased the risk of early death. Surprisingly, the risk of early death for people with uncontrolled HbA1c (≥ 70 mmol/mol) were not associated with any personnel resources or organizational features.

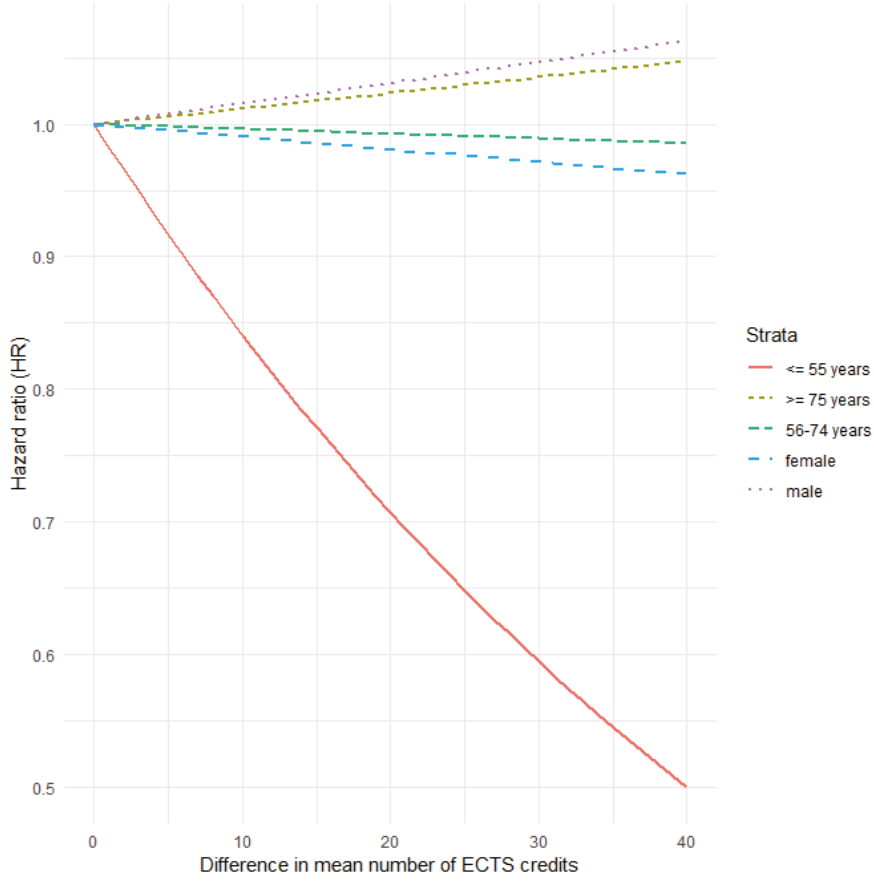


Figure 7. Illustration of the cumulative effect of the mean number of ECTS credits in diabetes-specific education obtained by registered nurses in relation to all-cause mortality. ECTS, European Credits Transfer Accumulation System.

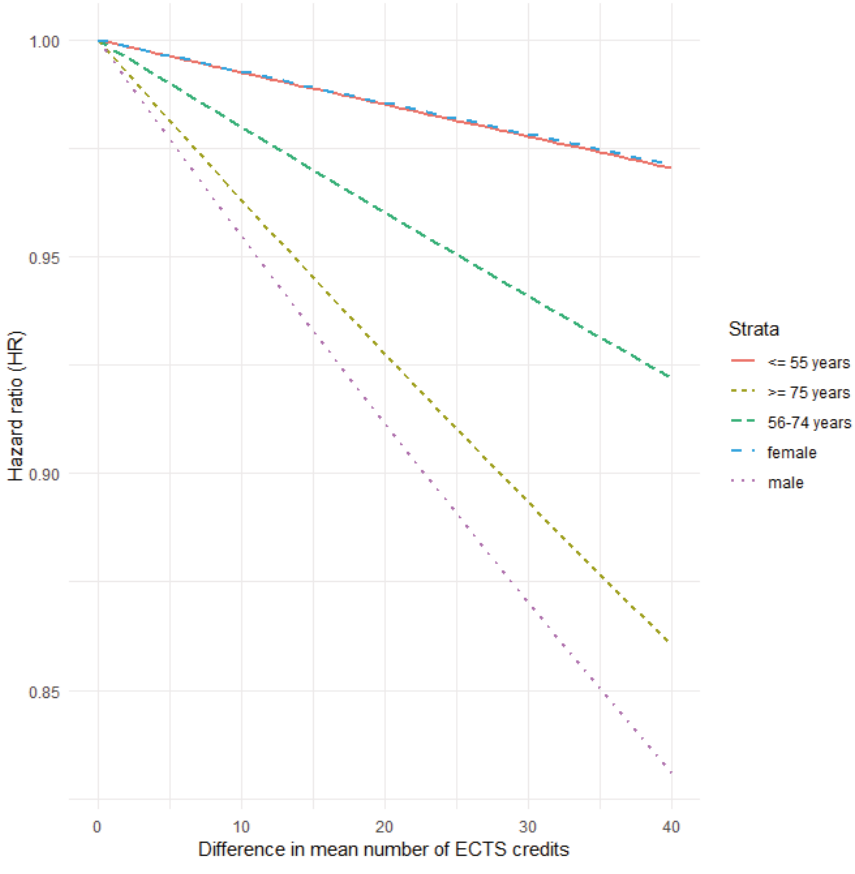


Figure 8. Illustration of cumulative effect of the mean number of ECTS credits in pedagogic education obtained by registered nurses in relation to all-cause mortality. ECTS, European Credits Transfer Accumulation System.

Discussion

The studies in this thesis examined changes in Swedish primary diabetes care between 2006 and 2013 and associations between the organization of diabetes care, HbA1c levels and all-cause mortality among people with T2DM. Different aspects of the organization of diabetes care involving personnel resources, organizational features and quality of work in the PHC setting were evaluated.

Key findings

The longitudinal follow-up demonstrated that RNs mean number of diabetes-specific education credits and the time devoted by RNs to care for people with T2DM had increased. However, there is still scope for further improvement by PHCCs to provide group education programs and for health-care professionals to include the patients in the goal setting of treatment targets.

The findings also indicate that personnel resources (e.g., having well-educated RNs and additional time for patient visits with RNs as well as sufficient access to GPs) was associated with decreased HbA1c level and/or decreased risk of early death. Providing group education and having diabetes teams were associated with decreased HbA1c level, however, group education programs were also associated with an increased risk of early death. The opposite effect was observed for PHCCs using GP call–recall systems, which were associated with increased level of HbA1c and increased risk of early death.

An overall high level of quality-of-work conditions at Swedish PHCCs was identified, and our EFA identified seven important quality-of-work features. However, most of these quality-of-work features were associated with decreased HbA1c level in the controlled group (≤ 52 mmol/mol). Only the quality-of-work feature "Individualized treatment" was associated with decreased HbA1c level among people in the intermediate (53–69 mmol/mol) and uncontrolled (≥ 70 mmol/mol) groups. However, all findings included in this dissertation must be interpreted with caution because the small effect sizes may not be clinically relevant.

Personnel resources

The present thesis reveals changes in Swedish primary diabetes care between 2006 and 2013, with increases in the education level of RNs and higher levels of RNs staffing in terms of WTE RNs/500 people with T2DM. The level of diabetes-specific education of RNs was associated with both a decreased HbA1c level in the total population and a decreased risk of early death among people aged < 55 years, while their level of pedagogical education was associated with a previously unidentified decreased risk of early death in men. It has been identified that a central cornerstone to the provision of high-quality care is the possibilities for RNs and GPs to undertake further postgraduate education and training in diabetes mellitus (108). However, evaluating the effects of the RNs' educational level on patient outcomes was viewed as problematic in a Cochrane review by Loveman et al. (76) because of insufficient information about the definition of a diabetes-educated RN. Several RCTs that included multifaceted interventions (91, 96, 97) also included additional education for RNs and GPs, however, these studies reported no associated improvement in patients' HbA1c levels, and distinguishing an independent effect of postgraduate education was impossible.

Because the questionnaire used in the present thesis asked RNs to report the number of ECTS credits that they had obtained, the findings are unique. Further, they might be applicable to other European countries. Interestingly, sex differences between an association of RN pedagogical education with the risk of early death were found, with a decreased risk of early death observed only in men. One possible explanation for this is that men may are less willing than women to discuss issues concerning the disease, a situation that the RN's pedagogical expertise can help resolve (109). However, a systematic and meta-analysis by Galdas et al. (110), identified no support for sex differences in the requirements for self-management support for people with chronic conditions, and explicitly stated the need for more evidence.

Staffing levels of RNs (WTE RNs/500 people with T2DM) increased during the seven years of follow-up, however no associations of staffing levels of RNs with HbA1c level or risk of early death were found. However, the length of regular visits to RNs was associated with a decrease in HbA1c level (–0.19 mmol/mol for each additional 15 minutes), although this effect was marginal. A qualitative study conducted in Sweden including people with T1DM and T2DM reported that support from the diabetes care team is crucial and that this care should address the patient's individual needs regarding access, content, treatment and the emotional aspects of living with the disease (111). It is possible that those PHCCs with more time for patient visits with RNs can accommodate these needs to a greater extent, which may facilitate improvement in glycaemic control. However, the present thesis did not consider these needs.

Access to GPs (i.e., each additional WTE GP/500 people with T2DM) were not significantly associated with decreased HbA1c levels, although they were

associated with a decreased risk of early death in people with T2DM. This should be interpreted in relation to the substantial variation between GPs staffing of the PHCCs included in this study: an SD of 4.1 for a mean of 7.1, which is a major concern. The International Health Policy Survey in 2015 of about 2,900 GPs reported that one third could not arrange for patients' to choose their caregiver and always see the same caregiver (112), which is seen as a prerequisite for people with T2DM (111). An aggregated analysis of the responses of GPs found that those who stated that the organization of their PHCC was well-prepared to handle people with chronic conditions were also more likely to have more patients reporting an overall better impression, good reputation and increased patient participation (112).

Organizational features

The follow-up revealed that although the RNs diabetes-specific education level increased, the level of provision of group education programs by PHCCs remained low. Attendance at those PHCCs that provided group education programs was associated with decreased HbA1c levels but increased risk of early death. The low level of provision of group education programs in Swedish primary diabetes care may be explained by the perceived high workload of the RNs (113). Comparison of the present findings with those of other studies confirms that group education is associated with reduced HbA1c levels for people with T2DM (80, 81). However, the association of group education programs with an increased risk of early death is probably due to confounding by indication. Thus, in those PHCCs that provided group education programs, only a minority of people with T2DM attended these sessions. However, issues concerning barriers to implementation of group education programs in Swedish PHCCs need to be further investigated.

Another finding in the present thesis was that attendance at PHCCs reporting that they had diabetes teams including a GP and RN was associated with decreased HbA1c level, although this effect was marginal. RNs and GPs are often the main care providers in the diabetes team, which can be supported by other health-care professionals; however, the most important individual in the diabetes team is the person who lives with T2DM (21). A systematic review and meta-analysis demonstrated that quality improvement strategies including the use of multidisciplinary teams or including changes in the structure of diabetes teams were associated with 0.57% lower HbA1c levels (95% CI 0.42–0.71; 48 trials) (85).

However, a cross-sectional study including 83 health-care professionals at 30 PHCCs and 752 people with T2DM showed no associations between teamwork and glycaemic control (114). In view of the marginal effects we observed, we did not investigate other mediating factors such as team communication and team climate (115) which could have helped us understand this

complex construct. It has been reported that a successful diabetes team is characterized by active participation of both the health-care professionals and the people with T2DM (116).

The follow-up also identified that the use of a review system had increased over recent years and that the use of call–recall systems remained high, with almost all PHCCs using a call–recall system for RNs and four-fifths using one for GPs. However, the present thesis produced confusing results regarding the use of call–recall systems for GPs, indicating that they were associated with increased HbA1c levels and increased risk of early death. The arguments for using call–recall systems are mainly that they can reduce the risk of worse patient outcomes and can provide structured care that ensures that people visit the GPs or RNs (82, 85). A possible explanation of our finding of the reverse effects of GP call–recall systems is that it is the result of confounding by indication. In this case, this implies that PHCCs that use call–recall systems better identify those people who are at increased risk (elevated HbA1c levels or risk of early death). Therefore, a call–recall system could be an organizational feature implemented to provide more structured primary diabetes care rather than as a risk factor. Another perspective is that the use of a call–recall system might, rather than being beneficial for people with T2DM, increase the workload for health-care professionals by requiring more administration. Although we did not find an association of outcomes with having a system that checked whether patients visited the RNs or GPs, it should be considered which of these systems would be more effective to limit the amount of time spent on administration. However, the main concern that should be addressed is how organizational features can be designed to help the number of people with T2DM who have uncontrolled HbA1c levels to achieve optimal glyceamic control.

Even though the consensus from both international (38) and Swedish national guidelines for diabetes care (21) promotes the inclusion of the patient in setting treatment goals, only 30%–54% (depending on treatment targets) of health-care professionals at the Swedish PHCCs reported that they did so. A possible explanation of the low level of patient participation may be related to a qualitative study (117) including 10 Swedish diabetes specialist nurses and 44 people with T2DM, which showed that nurses perceive a struggle to deal with authority, which increases the risk of diminishing people with T2DM autonomy. Also, Swedish nurses may require additional skills to support patients' self-management (118, 119). The importance of including the patient in individualized goal setting could also be interpreted in relation to an RCT study (94) that showed that structured personal care including individualized goal setting combined with patient education and surveillance support for people with T2DM was associated with a significant reduction in HbA1c to a median level of 78 mmol/mol (IQR 70–89) compared with the 83 mmol/mol (IQR 73–98) achieved with routine care ($P \leq 0.001$).

Quality of work

Although the majority of PHCCs were reported to provide an overall high quality of work, only one feature, individualized treatment, was associated with decreased HbA1c level among people in the uncontrolled group. This quality-of-work feature was assessed by two questions concerning goal-oriented drug therapy and intervention strategies targeted to people with poor outcomes. A major concern that should be addressed is that the people with uncontrolled glycaemic control seem not to be influenced by either personnel resources, organizational features, or quality of work. These findings are consistent with those of a systematic review (120) including data from 42 studies across four continents, which showed that people with uncontrolled HbA1c level (i.e., defined in the review as ≥ 59 mmol/mol) had modest to no improvement from interventions conducted in a PHC setting. The meta-regression analysis also showed that people with an HbA1c level of 9.5% (89 mmol/mol) benefited most from the interventions. In our study, we did not explore the multifactorial treatment approach for each patient, which might have shed more light on the mechanisms underlying our findings. We can only speculate that perhaps for people with uncontrolled HbA1c level the organization of diabetes care is much less important than multifactorial treatment (37).

General discussion

The rationale of the work described in the present thesis was to add to knowledge about the aspects of real-life clinical practice in the Swedish PHC, particularly the personnel resources, organizational features and quality of work of PHCCs, which influence the ability of people with T2DM to achieve their treatment goals for HbA1c and decrease their risk of early death. The findings reported in the present thesis suggest that the organization of diabetes care is associated with only marginal effects on HbA1c levels and the risk of early death.

During recent years there has been substantial focus on the organization of diabetes care, especially because the prevalence of T2DM is increasing dramatically (1). It is well-known that the nature of primary diabetes care differs between and within countries (4); however, disparities in care might lead to poorer health outcomes (121). Even though primary diabetes care is struggling to provide care for all people with T2DM, there is an endeavour to provide good and equal first-line care to all. Key barriers to the provision of a high quality of care may include the demands of waiting time, availability, state cooperation and financial incentives. At the same time, the PHCCs may need to adjust the care they offer based on national guidelines, the national perspective on knowledge management and results from the NDR, as well as reports published by SALAR. Thus, the gap between the ideal world and real life is

not new (122, 123). Although, the Swedish national guidelines (21) and other guidelines for management of T2DM (124-126) should be used as guidance and the foundation of scientific priorities in primary diabetes care, only a limited proportion of patients are aware of this at their actual visit (127). It has been reported that the recommendations of the National guidelines do not adequately reach health-care professionals or patients. Therefore, to eliminate this problem, SALAR implemented a new organizational model in 2017 that is based on three levels: micro (health-care professional teams), meso (county councils/regions) and macro (national), with the aim of reducing the gap between the ideal and actual world.

Although a new organizational model has been implemented that aims to reduce this gap, more research is required on how an optimal diabetes care organization should be designed to allow full understanding of its relationship with patient outcomes (85). The generalizability of much published research on this issue is problematic, because all previous reviews (84-88) report the existence of heterogeneous studies based on different multifaceted interventions, in mixed settings, and including both T1DM and T2DM patients in the same study. In addition, these reviews include studies from diverse continents. The complexity of multifaceted interventions is described in Table 1, which indicates that only two studies, that of Janssen et al. (91) and Griffin et al. (90), found decreases in the HbA1c levels after one year and after 5 years of follow-up, respectively. However, these findings must be interpreted in terms of their aims to examine the effects of early multifactorial treatment, rather than the effects of changes in the organization of diabetes care, on patients' achievement of reduced HbA1c levels. In addition, the results of Janssen et al. (91) were derived from the same research project as those of Griffin et al. (90). Multifaceted interventions targeting aspects of both personnel resources and organization may make it difficult to distinguish separate effects that the work described in the present thesis might be able to detect. In addition, an observational study conducted in the United Kingdom showed that organizational factors (i.e., clinical recording, education and training of nursing personnel) rather than staffing levels were the strongest predictors of quality of care (75).

The main insight from this thesis is that the organization of diabetes care in the Swedish PHC setting is variable, although it must be noted that each county council/region is free to decide the organization of their diabetes care, and priorities are affected by difficulties in implementation, cost-effectiveness and their effect. A possible way forward in providing more tailored diabetes care could be to establish certified diabetes clinics. An argument for this is the combination of the complexity of heterogeneous diabetes disease and the rapid development of technological and medical treatments, which places great demands on GPs and other personnel. In 2016, certified clinics were established in the Skåne region based on specific criteria; e.g., having RNs with a minimum of 15 ECTS credits in diabetes-specific education who work in diabetes teams (128). However, the results indicate that this initiative resulted in no

improvement in HbA1c after one year and that PHCCs including more people with controlled T2DM were more likely to be certified than PHCCs including more people with uncontrolled T2DM (129). Thus, the "one size fits all" concept might not be right pathway to caring for people with T2DM (130).

Time to go beyond glycaemic control

Two of the four studies included in this thesis (Studies II and III) addressed only glycaemic control as the main outcome. However, it is time to go beyond glycaemic control. Although HbA1c level is the gold-standard patient outcome, it is time to change the focus to include other factors of major interest. The pathways to high quality of diabetes care are complex and multidimensional (131) and, to understand fully how optimal diabetes care could be achieved, measures such as the quality of life of people with T2DM and their experiences of the organization of diabetes care should be taken into consideration. According to the Donabedian model (72), the structure of health care influences the actual care provided (process indicators) and resulting in consequences of care (surrogate and hard outcomes). However, what is not mentioned in this explanatory model is inter-personal care; e.g., interactions between health-care professionals and people with T2DM. Socio-demographic characteristics (121), health need (119) and health beliefs (132) are other factors that influence the possibility of achieving the desired patient outcomes. The present thesis used a research design in which these factors were not considered. Performing such a study requires a different research design and it is questionable whether it is even possible to carry out such a study on a total population. However, the lack of consideration of these attributes is a possible cause of the weakness of the effects found in the present thesis. A previous population-based cohort study showed that people with self-rated poor health were at higher risk of mortality (133). Therefore, it is important to highlight other aspects to allow people to achieve their treatment targets or decrease their risk of early death.

Because people with T2DM visit the GP and RN only once a year each, and it is the people with T2DM who have the daily responsibility of managing their disease, it may be insufficient to address only the impact of diabetes care and not consider the perspective of self-management by the person with T2DM. In addition, even if there is a well-organized primary diabetes care system with diabetes-educated health-care professionals who promote healthy behaviour for people with T2DM, there is a need for both engagement and motivation by the people with T2DM to achieve change. However, the overall goal of the health system is to provide a high quality of diabetes care that is accessible and distributed equitably to everyone who needs it. Thus, the answer to the question about whether key features of successful Swedish primary diabetes care are a reality or fiction is that yes, although fiction might occur,

from now on the person with T2DM should be the main decision maker about whether successful key features are a reality.

Methodological considerations

Strengths

The major strength of all the studies included in this thesis is the large sample size of included PHCCs and people with T2DM. This increases the possibilities of identifying associations that are clinically relevant for people with T2DM. There is a minimal risk of selection bias with such a large sample size, and about 90% of all people with T2DM in Sweden are included in the NDR, which minimizes both selection and sampling bias. The present thesis adds important knowledge about associations between the organization of diabetes care in a real-life clinical practice and HbA1c levels in people with T2DM. The use of the Swed-QOP questionnaire made it possible to compile an overall picture of the management of primary diabetes care. Utilization of the web-based survey program facilitated both monitoring the response rate and sending out reminders. In addition, the web-based survey program allowed us to define the proportion of non-responding PHCCs based on whether the PHCC managers opened the questionnaire.

Study I was the first longitudinal cross-sectional study to be conducted in Swedish primary diabetes care. A major strength with this follow-up was the inclusion of more than 70% of all PHCCs in both years, which increased the generalizability of the results for Swedish primary diabetes care. For Studies II, III and IV, we only included PHCCs with at least 30 people registered in the NDR to provide a representative sample and to diminish the risk of selection bias. Study II provided information about both the independent and simultaneous effects of the variables included. In Study III, the utilization of EFA made it possible to identify seven quality-of-work features, which should be seen as complimentary information about success factors in primary diabetes care and not a replication. In Study IV, we stratified the findings by age, sex and HbA1c level, because these have been reported to be risk factors for the outcome of all-cause mortality. This stratification allowed us to identify more interesting findings. Results from the GEE (Study II and III) and Cox regression (Study IV) analyses provided information on both *P* values and 95% CIs to allow a more detailed description. It must be mentioned that even though there is a significant difference between exposure and outcome, caution must be used in interpreting both estimated β and 95% CIs.

Limitations

The major limitation of the present studies is the validity of the Swed-QOP questionnaire, which increases the risk of a discrepancy between the theoretical and operational definitions. The quality of a questionnaire should be based on its validity and reliability. However, the questions in the Swed-QOP questionnaire regarding quality of work were face-validity tested, during which we obtained expert opinions about their usefulness and relevance. *Reliability* concerns the precision of measurement and if high reliability occurs there is low risk of random errors. In 2006, the Swed-QOP questionnaire was reliability tested and corrections were made. Another limitation with the questionnaire is the lack of questions concerning RNs further training other than their educational level and GPs postgraduate education or experience. In addition, the questionnaire only assessed whether personnel resources, organizational features and quality of work were prevalent but not how these resources or features were used in actual clinical practice. This might contribute to reducing understanding and misclassification with participants placed in an incorrect category. The Swed-QOP questionnaire is based on self-reported data from PHCC managers. A possible limitation in these studies is the risk of *selection bias* because of the risk of including only those PHCCs having the greatest interest in providing an overall high-quality primary diabetes care. Therefore, there is a risk of a skewed picture of reality. However, 19 of 21 county councils/regions had a response rate of ≥ 70%. Being limited to self-reported data increases the risk for *information bias*, which can be described as reporting false or inaccurate answers and the misinterpretation of questions, and is a major concern. The Swed-QOP questionnaire did not include definitions of terms for e.g., call–recall system, individual counselling or group education, which increased the risk of misinterpretation. To reduce the risk of misinterpretation, we encouraged PHCC managers to answer the questionnaire together with other personnel who had the most contact with people with T2DM.

In Study III, an EFA was used to identify underlying clusters of variables. One source of weakness in the applied EFA was the retention of those factors that were represented by two questions. It can be argued that a factor with fewer than three items is weak. However, by using a large sample size, the item number can be reduced and the item be retained as a strong factor. In Study IV, a limitation is that we only had baseline data on baseline and could not account for any changes at follow-up. We also assumed that the patient attended the same PHCC during the follow-up period. This may have introduced confounding; however, given our short follow-up time these effects should have a low impact on the outcome.

A limitation is the use of simple imputation method such as LOCF to impute individual clinical level data for missing values. The limitation of LOCF is that simple imputation does not take into consideration the uncertainty of imputations, which may result in inaccurate results. However, because the

NDR used LOCF as a standard method and because of practical constraints, multiple imputation was not applied. All studies included in this thesis are observational studies and conclusions about causal relationships cannot be drawn. It became evident that *confounding by indication* is probably prevalent, especially in the two cross-sectional Studies, II and III. Confounding by indication most likely the explanation of the observed associations between personnel resources, organizational features and quality-of-work features and increased HbA1c levels and increased risk of early death.

Moreover, some of the studies involve the testing of many separate null hypotheses, which may entail problems with inflated Type I error rates. This should be taken into consideration when interpreting the results, and the reader may wish to apply a more stringent criterion for statistical significance level than the conventional $P < 0.05$ (e.g., apply a Bonferroni correction). However, it should be noted that Bonferroni correction concerns the universal null hypothesis that all the tested null hypotheses are simultaneously true, which was not of interest in any of the studies. Thus, the *P* values are always valid, conditional on the restriction that each hypothesis test is considered separately.

Conclusions

This thesis describes the extent of changes in Swedish primary diabetes care between 2006 and 2013, and identifies associations of personnel resources, organizational features and quality-of-work features with HbA1c levels and all-cause mortality. To summarize the results of the studies reported in this thesis, personnel resources that could be valuable in caring for people with T2DM include the RNs' educational level, longer patient visits to RNs and the access to sufficient GPs. Organizational features such as PHCCs offering group education programs and having diabetes teams were associated with decreased HbA1c levels. Although there have been some changes in the organization of Swedish primary diabetes care, there is still scope for further improvement, including the provision of group education programs and involving the people with T2DM in the goal setting of their treatment targets. PHCCs reported an overall high level of quality-of-work conditions, although the only quality-of-work feature found to be associated with decreased HbA1c levels in all groups was individualized treatment. However, most of the quality-of-work features were associated with decreased HbA1c level in the group with controlled HbA1c. Thus, more strategies are needed to support people with uncontrolled HbA1c.

Overall, this thesis adds to previous work on significant but less pronounced key features for successful organization of primary diabetes care. The results reported in this dissertation indicate that the care of people with T2DM is complex, which makes it difficult to identify specific success factors for all people living with T2DM. The results of the studies included in this dissertation do not support a need for certified diabetes clinics for people with T2DM to achieve patient outcomes. This suggests that there is still scope for further evidence to fully understand the real-life clinical associations between the organization of primary diabetes care and glycaemic control and risk of early death in people with T2DM.

Future studies

Results reported in the current thesis suggest new aspects for future studies. The concept of providing optimal primary diabetes care is mainly addressed from the perspective of the health-care professionals and not from that of the people with T2DM. A government proposition in (2017/18:83) concluded that the future requires new tools within the PHC systems to support the growing population of people with chronic diseases (134). Thus, increased investment in strengthening information about the patients' perspectives is a necessary investment. A report by the Swedish Agency for Health and Care Services shows that there are challenges in involving people's experiences and to make them participate in their own care (135). Therefore, in the future new tools will be needed to accommodate the needs of people with T2DM. Consequently, the NDR has developed PROM and PREM that include topics concerning how to live a good life with diabetes and feelings about the diabetes disease (PROM) and support from the diabetes care team (PREM) (19). These tools of PROM and PREM provide additional support for GPs or RNs at patient visits to allow them to address peoples' needs to increase the possibility that more people achieve national treatment targets.

Svensk sammanfattning (Summary in Swedish)

Sverige erbjuder den främsta diabetesvården i Europa vilket till stor del beror på ett omfattande användande av det svenska Nationella diabetesregistret (NDR), Socialstyrelsens Nationella riktlinjer för diabetesvård och mycket subventionerade priser på läkemedel och sjukvårdsbesök. Detta till trots visar resultaten från NDR att endast hälften av personer med typ 2-diabetes i primärvården uppnådde en tillfredställande måluppfyllelse för HbA1c (52,9 %) år 2013. Idag finns bristande evidens om vilka faktorer inom svensk diabetesvård i primärvården som kan få personer med typ 2-diabetes att uppnå en god glykemisk kontroll. Majoriteten av personer med typ 2-diabetes får sin vård i primärvården och givet en ökad prevalens av typ 2-diabetes blir behovet av primärvården ännu större. Organiseringen av vården är en komplex process och det finns inte någon motsvarande totalundersökning genomförd i Sverige. Resultaten från avhandlingen kan därför komma att kunna utgöra ett underlag för bättre prioriteringar i diabetesvården. Det är av betydelse att utvärdera hur vården ser ut i förhållande till den evidens som finns angående dess optimala organisation och arbetssätt, för att patienterna skall få en vård som hjälper dem att nå optimala behandlingsmål samt undvika komplikationer och en för tidig död.

Det övergripande syftet med detta forskningsprojekt är att bidra med evidens angående förändringar av Sveriges diabetesvård i primärvården mellan 2006 och 2013, samt att undersöka om det finns samband mellan arbetssätt och personella resurser inom primärvården och nivå av HbA1c och totalmortalitet, samt undersöka sambandet mellan kvalitetsarbete och nivå av HbA1c för personer med typ 2-diabetes.

Syftet med Studie I var att beskriva hur diabetesvårdens organisation 2013 avseende personella resurser och arbetssätt skiljer sig från förhållandena 2006. Studien genomfördes som en kartläggning av diabetesvårdens organisation för personer med typ 2-diabetes. Denna longitudinella tvärsnittsstudie inkluderade alla landets vårdcentraler vid den aktuella tidpunkten för datainsamling d.v.s. 2006 och 2013. År 2006 besvarade totalt 684 (74,3 %) av landets 921 vårdcentraler år 2006 ett formulär om diabetesvårdens organisation och år 2013 besvarade 880 (76,4 %) av 1152 vårdcentraler i landet formuläret. Studien visade att vårdcentralerna i Sverige har blivit fler medan antalet personer

listade på vårdcentralen har minskat. Antalet heltidssjuksköterskeårsjänster per 500 personer med typ 2-diabetes varierade stort i landet (från 0.52 till 1.12). Samtidigt visar studien att ingen förändring skett vad gäller hur vanligt det är att bedriva grupputbildningsprogram (en fjärdedel vid båda tidpunkterna) eller att inkludera personer med typ 2-diabetes när behandlingsmål ska sättas.

Syftet med Studie II var att undersöka sambandet mellan vårdcentralers organisering av diabetesvården avseende personella resurser, arbetssätt och HbA1c nivån för personer med typ 2-diabetes. Studien inkluderade 846 (73 %) vårdcentraler som besvarat formuläret 2013 och 230 958 personer med typ 2-diabetes som hade kliniska data registrerade på dessa vårdcentraler i NDR. Individdata kompletterades med socioekonomisk status och samsjuklighet. Studien visade att det fanns ett samband mellan ett högre medelantal högskolepoäng i diabetesspecifik utbildning för sjuksköterskor på en vårdcentral samt mer avsatt tid för återbesök till sjuksköterska och minskat långtidsblodsocker (HbA1c). Ett oväntat resultat var att mer tid avsatt för återbesök till läkare kopplat till ökat långtidsblodsocker. De organisatoriska variabler som visade sig ha samband med minskat långtidsblodsocker var om vårdcentraler bedrev grupputbildningsprogram eller hade diabetesteam.

Syftet med Studie III var att undersöka sambandet mellan vårdcentralers kvalitetsarbete och HbA1c nivån för personer med typ 2-diabetes. Totalt inkluderades 846 (73 %) vårdcentraler och 230 958 personer med typ 2-diabetes. En explorativ faktoranalys identifierade totalt sju faktorer för kvalitetsarbete. Dessa faktorer var:

1. Kallelsesystem baserat på patientens behov,
2. Individualiserad behandlingsplan,
3. Vårdcentralens resultat alltid på agendan,
4. Regionala riktlinjer,
5. Uppföljning och återkoppling,
6. Kultur och prevention,
7. Strategier och ansvar.

Mer än hälften (56 %) av de inkluderade personerna med typ 2-diabetes tillhörde gruppen med kontrollerat låntidsblodsocker (≤ 52 mmol/mol), en minoritet (12 %) hade dåligt kontrollerat långtidsblodsocker (≥ 70 mmol/mol) och resterande (32 %) av gruppen hade acceptabel långtidsblodsockernivå (53-69 mmol/mol). Fler faktorer (Kallelsesystem baserat på patientens behov, Individualiserad behandlingsplan, Vårdcentralens resultat alltid på agendan samt Strategier och ansvar) var kopplat till ett lägre långtidsblodsocker för personer med kontrollerat långtidsblodsocker jämfört med de med som låg på 53-69 mmol/mol och för de med okontrollerat långtidsblodsocker var det endast Individualiserad behandlingsplan som var kopplat till ett lägre långtidsblodsocker.

Syftet med Studie IV var att identifiera samband mellan vårdcentralers organisering av diabetesvård avseende personella resurser, arbetssätt och ris-

ken för en för tidig död för personer med typ 2-diabetes. I denna studie inkluderades 787 vårdcentraler med 187 570 personer med typ 2-diabetes. Från det svenska folkbokföringsregistret hämtades information angående datum för död och emigration. Personerna följdes från det senaste besöket på vårdcentraler under 2013 till uppföljningens slutdatum den 30 januari 2018. Totalt hade 27 136 personer med typ 2-diabetes avlidit under denna tid. Resultaten visade att personer med typ 2-diabetes som besökte vårdcentraler med god tillgång till heltidsallmänläkare hade en lägre risk för en för tidig död. Samtidigt visade subgruppsanalyser att ett högre medelantal högskolepoäng i diabetesspecifik utbildning bland sjuksköterskor på en vårdcentral var kopplat till en minskad risk för en för tidig död bland personer som var 55 år och yngre. Även hittades ett samband mellan vårdcentraler som hade sjuksköterskor med ett högre medelantal högskolepoäng i pedagogisk utbildning och minskad risk för en för tidig död. Motsatta samband, d.v.s. en ökad risk för en för tidig död hittades för vårdcentraler som erbjöd grupputbildningsprogram och de vårdcentraler som hade kallelsesystem till läkare.

Sammanfattningsvis är organiseringen av diabetesvården i primärvården i förhållande till möjligheten för personer med typ 2-diabetes att uppnå uppsatta behandlingsmål för långtidsblodsocker och risken för en förtidig död ett fenomen som är svårt att studera. Även om studierna i denna avhandling belyser faktorer inom diabetesvården i primärvården som kan vara av betydelse för HbA1c nivån bland personer med typ 2-diabetes behövs mer kunskap om på vilket sätt dessa faktorer kan användas för att skapa en optimal diabetesvård för de som behandlas i primärvården.

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Appendix 1: The 2006 questionnaire in Swedish

Uppgiftslämnare

Profession

Telefonnummer

Nedanstående frågor berör förhållandet för omhändertagande av era patienter med typ 2 diabetes på er vårdcentral/mottagning år 2006.

Besvara gärna enkäten tillsammans med den/de medarbetare som har den direkta patientkontakten. Det är viktigt att svara på samtliga frågor i enkäten. Sätt ett kryss på varje fråga som är avsedd för detta och besvara öppna frågor i löpande text. För vissa av frågorna kan flera alternativ stämma överens, ange då samtliga alternativ som överensstämmer med de förhållanden som råder på vårdcentralen/mottagningen.

Allmänna frågor – Patienter

1. Hur många patienter totalt är listade/tillhör er vårdcentral/mottagnings geografiska upptagningsområde?

   Antal patienter:

2. Hur många personer med diabetes ansvarar er vårdcentral/mottagning för?

☐ < 50	☐ 151-200	☐ 301-350	☐ 501-600
☐ 50-100	☐ 201-250	☐ 351-400	☐ 601-700
☐ 101-150	☐ 251-300	☐ 401-500	☐ >700

Allmänna frågor- Personal

3. Ange totala antalet personer som var i tjänst under november månad 2006 omräknat till heltidstjänster för följande professioner:

	Antal heltidstjänster
Allmänläkarspecialist	
Vikarierande läkare	
ST-läkare	
AT-läkare	
Sjuksköterska/distriktssköterska	

4. Har ni diabetesansvarig läkare (DAL)?

   ☐ Ja ☐ Nej

5. Har ni diabetesutbildad sjuksköterska/sjuksköterskor som ansvarar för patienter med typ 2 diabetes?

   ☐ Ja, antal: ☐ Nej

6.	Vilka övriga resurser **inom** er vårdcentral/mottagning har ni **tillgång till** för era diabetespatienter? ☐ Fotvårdsterapeut ☐ Kurator ☐ Sjukgymnast ☐ Psykolog ☐ Dietist Kommentar:
7.	Till vilka övriga resurser **utanför** er vårdcentral/mottagning brukar ni **remittera** era diabetespatienter? ☐ Fotvårdsterapeut ☐ Kurator ☐ Sjukgymnast ☐ Psykolog ☐ Dietist Kommentar:
8.	Hur många timmar avsätter sjuksköterskan/sjuksköterskorna totalt per vecka för diabetespatienter? timmar/vecka Kommentar:
9.	Hur många universitetspoäng inom diabetes har nuvarande ansvarig sjuksköterska/sjuksköterskor. 0 1-5 6-10 11-15 16-20 >20 Sjuksköterska I ☐ ☐ ☐ ☐ ☐ ☐ Sjuksköterska II ☐ ☐ ☐ ☐ ☐ ☐ Sjuksköterska III ☐ ☐ ☐ ☐ ☐ ☐
Vårdprogram och rutiner	
10.	Finns vårdprogram/handlingsprogram för diabetes utarbetat i ert landsting/region? ☐ Ja ☐ Nej
11.	Finns vårdprogram/handlingsprogram för diabetes som ni själva har utarbetat på er vårdcentral/mottagning? ☐ Ja ☐ Nej
12.	I vilken omfattning anser ni att vårdprogram/handlingsprogram efterföljs? ☐ I stor utsträckning ☐ I liten utsträckning ☐ Inte alls Kommentar:

13. Ange hur ofta följande kontroller genomförs för patienter med **kost/tablettbehandlad diabetes** på er vårdcentral/mottagning? *Markera det vanligast förekommande för varje parameter.*

	≥ 2 ggr/år	1 g/år	Vartannat år eller mindre	Aldrig/Nästan aldrig
HbA1c	☐	☐	☐	☐
Vikt	☐	☐	☐	☐
Midjemått	☐	☐	☐	☐
Lipidstatus	☐	☐	☐	☐
Blodtryck	☐	☐	☐	☐
Mikroalbuminuri	☐	☐	☐	☐
Fotstatus	☐	☐	☐	☐

14. Ange hur ofta följande kontroller genomförs för patienter med typ 2 diabetes som har **insulinbehandling eller kombinationsbehandling tablett- och insulinbehandling** på er vårdcentral/mottagning? *Markera det vanligast förekommande för varje parameter.*

	≥ 2 ggr/år	1 g/år	Vartannat år eller mindre	Aldrig/Nästan aldrig
HbA1c	☐	☐	☐	☐
Vikt	☐	☐	☐	☐
Midjemått	☐	☐	☐	☐
Lipidstatus	☐	☐	☐	☐
Blodtryck	☐	☐	☐	☐
Mikroalbuminuri	☐	☐	☐	☐
Fotstatus	☐	☐	☐	☐

15. Ange hur lång tid som avsätts per patient för de återkommande kontrollerna (inklusive dokumentation). *Välj det alternativ som är vanligast förekommande.*

	1-15 min	16-30 min	31-45 min	46-60 min
Hos läkare (allmänläkarspecialist, AT-/ST-läkare, vikarie)	☐	☐	☐	☐
Hos sjuksköterska/diabetesansvarig sjuksköterska	☐	☐	☐	☐

16. Vilken är den vanligaste rutinen för insulininställning av patienter med typ 2 diabetes som sviktar på tablettbehandling?

☐ Patienterna remitteras till specialistklinik

☐ Läkaren startar insulinbehandling

☐ Läkaren startar insulinbehandling i samarbete med sjuksköterskan

☐ Annat, vad:

	Uppföljning/utvärdering
17.	Vilket system har ni för uppföljning av era patienter till läkare respektive sjuksköterska? Läkare: ☐ Patienterna kallas ☐ Patienterna bokar själva tid Sjuksköterska: ☐ Patienterna kallas ☐ Patienterna bokar själva tid
18.	***Om*** patienterna kallas, vilket system använder ni till läkare respektive sjuksköterska? Läkare: ☐ Datoriserat ☐ Manuellt Sjuksköterska: ☐ Datoriserat ☐ Manuellt
19.	Har ni något system för att följa upp att patienterna har deltagit i regelbundna kontroller hos läkare respektive sjuksköterska? Läkare: ☐ Ja, datoriserat ☐ Ja, manuellt ☐ Nej Sjuksköterska: ☐ Ja, datoriserat ☐ Ja, manuellt ☐ Nej
	Patientutbildning och behandlingsmål
20.	Bedriver ni patientutbildning? ☐ Ja ☐ Nej Kommentar:
21a.	***Om*** ni bedriver patientutbildning, använder ni er av checklista för innehållet i utbildningen? ☐ Ja ☐ Nej
21b.	Vilka områden omfattar i så fall checklistan?
21c.	Om ni **inte** använder er av checklista, hur gör ni i stället?
22.	Anordnar ni speciella utbildningstillfällen för era patienter? ☐ Ja ☐ Nej Beskriv hur ni gör och hur ofta:
23.	Ange hur vanligt förekommande det är att ni diskuterar **mål för behandlingen** med era patienter avseende HbA_{1c}, blodtryck, lipider och livsstilsförändringar? HbA1c: ☐ Nästan med alla ☐ Med många ☐ Ett fåtal ☐ Diskuterar ej mål Blodtryck: ☐ Nästan med alla ☐ Med många ☐ Ett fåtal ☐ Diskuterar ej mål Lipider: ☐ Nästan med alla ☐ Med många ☐ Ett fåtal ☐ Diskuterar ej mål Livsstilsförändringar: ☐ Nästan med alla ☐ Med många ☐ Ett fåtal ☐ Diskuterar ej mål

24.	Vem/vilka fattar i regel beslut om **mål för behandlingen** avseende HbA1c, blodtryck, lipider och livsstilsförändringar? HbA_{1c} Blodtryck Lipider Livsstilsförändringar
	Nationella Diabetesregistret
25.	Registrerar ni era patienter i Nationella Diabetesregistret (NDR)? ☐ Ja ☐ Nej ☐ Planerar att starta registrering
26.	Hur använder ni er av resultaten i NDR? ☐ För egen del ☐ För patientens del ☐ Verksamhetsutveckling ☐ Sätta mål för vårdcentralen/mottagningen ☐ Vi använder inte resultaten ☐ Annat, vad
27.	Om ni **inte** registrerar i NDR. Vad är den viktigaste anledningen till att ni inte gör det? ☐ Tar för mycket tid ☐ Har inte kommit igång ☐ Tror inte på kvalitetsregister ☐ Annat, vad
28.	Ge exempel på kvalitetssäkringsarbete som ni bedriver på er vårdcentral:
29.	Övriga synpunkter som ni vill förmedla:

Appendix 2: The 2013 questionnaire in Swedish

Vårdcentral:

Profession:

HSA- id (alt. vårdcentralens namn):

Telefonnummer:

Län/region:

Nedanstående frågor berör förhållandet för omhändertagande av era patienter med typ 2 diabetes på er vårdcentral/mottagning år 2013.
Besvara gärna formuläret tillsammans med den/de medarbetare som har den direkta patientkontakten. Det är viktigt att svara på samtliga frågor i formuläret. Beroende på hur ni svarar kan det finnas underfrågor. Efter att ni besvarat formuläret kan ni skicka det i medföljande svarskuvert.

Allmänna frågor – Patienter

1. Hur många patienter är totalt listade/tillhör er vårdcentral/mottagning?
   Antal patienter:

2. Hur många personer med diabetes ansvarar er vårdcentral/mottagning för?
   Antal patienter:

Allmänna frågor- Personal

3. Ange totala antalet personer som är/var i tjänst under november månad 2013 omräknat till heltidstjänster för följande professioner:

	Antal heltidstjänster
Allmänläkarspecialist	
Vikarierande läkare	
ST-läkare	
AT-läkare	
Sjuksköterska/distriktssköterska	

4. Har ni diabetesansvarig läkare (DAL)?
   ☐ Ja
   ☐ Nej

5. Har ni diabetesutbildad sjuksköterska/sjuksköterskor som ansvarar för patienter med diabetes?
   ☐ Ja,
   ☐ Nej

5a.	***Om ja***, hur många diabetesutbildade sjuksköterskor har ni? ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
5b.	**Utifrån antal diabetesutbildade sjuksköterskor**, hur många högskolepoäng (hp) (exempelvis 10 gamla poäng= 15 nya hp) i ämneskompetens och pedagogisk kompetens inom diabetes har nuvarande ansvarig sjuksköterska/sjuksköterskor? Ämneskompetens Antal nya högskolepoäng (hp) / Pedagogisk kompetens Antal nya högskolepoäng (hp) Sjuksköterska 1 _____ _____ Sjuksköterska 2 _____ _____ Sjuksköterska 3 _____ _____ Sjuksköterska 4 _____ _____ Sjuksköterska 5 _____ _____
6.	Hur många timmar avsätter sjuksköterskan/sjuksköterskorna totalt per vecka för diabetespatienter? *Ange under **kommentar** om ni har uppehåll för exempelvis sommar och jul.* Antal timmar/vecka _____ Kommentar:
7.	Vilka övriga resurser **inom** er vårdcentral/mottagning har ni **tillgång till** för era diabetespatienter? *Kryssa för **alla** alternativ som stämmer.* ☐ Fotvårdsterapeut ☐ Sjukgymnast ☐ Dietist ☐ Kurator ☐ Psykolog Annan, vem/vilka?
8.	Till vilka övriga resurser **utanför** er vårdcentral/mottagning brukar ni **remittera** era diabetespatienter? *Kryssa för **alla** alternativ som stämmer.* ☐ Fotvårdsterapeut ☐ Sjukgymnast ☐ Dietist ☐ Kurator ☐ Psykolog Annan, vem/vilka

9.	Har ni ett diabetesteam på er vårdcentral/mottagning? ☐ Ja ☐ Nej ☐ Vet ej
9b.	***Om ja,*** vilka ingår i ert team? *Kryssa för **alla** alternativ som stämmer.* ☐ Läkare ☐ Sjuksköterska ☐ Dietist Annan, vem/vilka:
	Vårdprogram och rutiner
10.	Finns vårdprogram/handlingsplan för diabetes utarbetat i ert landsting/region? ☐ Ja ☐ Nej
10a.	**Om ja,** ni har utarbetat vårdprogram/handlingsplan i ert landsting/region, är de medicinska riktlinjerna: Kryssa för **alla** alternativ som stämmer. ☐ Lättillgängliga ☐ Lättförståeliga ☐ Med tydliga rekommendationer Annat, vad:
10b.	**Om ja,** är riktlinjerna i vårdprogrammet/handlingsplanen välförankrade i ert landsting/region? ☐ Ja ☐ Nej ☐ Vet ej Kommentar:
11	Finns vårdprogram/handlingsplan för diabetes som ni själva har utarbetat på er vårdcentral/mottagning? ☐ Ja ☐ Nej
11a.	**Om ja,** ni har utarbetat vårdprogram/handlingsplan på er vårdcentral/mottagning, är de medicinska riktlinjerna: Kryssa för **alla** alternativ som stämmer. ☐ Lättillgängliga ☐ Lättförståeliga ☐ Med tydliga rekommendationer Annat, vad:

11b. I vilken omfattning anser ni att vårdprogram/handlingsplan efterföljs?
*Sätt **ett kryss** för det som stämmer in på er vårdcentral/mottagning.*

☐ I stor utsträckning
☐ I liten utsträckning
☐ Inte alls

Kommentar:

12. Ange hur ofta följande kontroller genomförs för patienter med **kostbehandling** på er vårdcentral/mottagning? *Markera det **vanligast** förekommande för varje parameter.*

	≥ 2 ggr/år	1 g/år	Vartannat år eller mindre	Aldrig/Nästan aldrig
HbA1c	☐	☐	☐	☐
Vikt	☐	☐	☐	☐
Midjemått	☐	☐	☐	☐
Lipidstatus	☐	☐	☐	☐
Blodtryck	☐	☐	☐	☐
Mikroalbuminuri	☐	☐	☐	☐
Fotstatus	☐	☐	☐	☐

13. Ange hur ofta följande kontroller genomförs för patienter med **tablettbehandlad** diabetes på er vårdcentral/mottagning? *Markera det **vanligast** förekommande för varje parameter.*

	≥ 2 ggr/år	1 g/år	Vartannat år eller mindre	Aldrig/nästan aldrig
HbA1c	☐	☐	☐	☐
Vikt	☐	☐	☐	☐
Midjemått	☐	☐	☐	☐
Lipidstatus	☐	☐	☐	☐
Blodtryck	☐	☐	☐	☐
Mikroalbuminuri	☐	☐	☐	☐
Fotstatus	☐	☐	☐	☐

14. Ange hur ofta följande kontroller genomförs för patienter med typ 2 diabetes som har **insulinbehandling eller kombinationsbehandling tablett- och insulinbehandling** på er vårdcentral/mottagning? *Markera det **vanligast** förekommande för varje parameter.*

	≥ 2 ggr/år	1 g/år	Vartannat år eller mindre	Aldrig/nästan aldrig
HbA1c	☐	☐	☐	☐
Vikt	☐	☐	☐	☐
Midjemått	☐	☐	☐	☐
Lipidstatus	☐	☐	☐	☐
Blodtryck	☐	☐	☐	☐
Mikroalbuminuri	☐	☐	☐	☐
Fotstatus	☐	☐	☐	☐

15. Erbjuder er vårdcentral/mottagning systematiskt egenmätning av blodglukos till insulinbehandlade personer med typ 2 diabetes?
Mätning av blodglukos före och efter måltid under en dag (6-7 stickor), två dagar per vecka.

☐ Ja
☐ Nej

16. Erbjuder er vårdcentral/mottagning riktad egenmätning av blodglukos till personer med typ 2 diabetes, som inte behandlas med insulin?
Riktad egenmätning av blodglukos vid speciella situationer som vid byte av läkemedel eller akut svängande blodglukos vid exempelvis infektioner och kortisonbehandling eller i pedagogiskt syfte.

☐ Ja
☐ Nej

17. Ange hur lång tid som avsätts per patient för de återkommande kontrollerna (inklusive dokumentation). *Välj det alternativ som är **vanligast** förekommande hos respektive profession.*

	1-15 min	16-30 min	31-45 min	46-60 min
Hos läkare (allmänläkarspecialist, AT-/ST-läkare, vikarie	☐	☐	☐	☐
Hos sjuksköterska/diabetesansvarig sjuksköterska	☐	☐	☐	☐

18. Vilken är den vanligaste rutinen för insulininsättning av patienter med typ 2 diabetes som sviktar på tablettbehandling?
*OBS! Sätt **ett kryss** som berör majoriteten av era diabetespatienter.*

☐ Patienterna remitteras till specialistklinik
☐ Läkaren startar insulinbehandling
☐ Sjuksköterskan startar insulinbehandling efter läkarordination
☐ Läkaren startar insulinbehandling i samarbete med sjuksköterskan
☐ Annat, vad:

	Uppföljning/Utvärdering
19.	Vilket system har ni för uppföljning av era patienter till läkare? *Sätt **ett kryss** som berör majoriteten av era diabetespatienter.* ☐ Patienter kallas ☐ Patienter bokar själva tid
19a.	***Om patienterna kallas*** till läkare, vilket system använder ni? *Sätt **ett kryss** som berör majoriteten av era diabetespatienter.* ☐ Datoriserat ☐ Manuellt
19b.	***Om patienterna kallas*** till läkare, sker kallelsen utifrån: *Sätt **ett kryss** som berör majoriteten av era diabetespatienter.* ☐ Standardiserad uppföljning ☐ Uppföljning efter patientens behov ☐ Vet ej
20.	Vilket system har ni för uppföljning av era patienter till sjuksköterska? *Sätt **ett kryss** som berör majoriteten av era diabetespatienter.* ☐ Patienter kallas ☐ Patienter bokar själva tid
20a.	***Om patienterna kallas*** till sjuksköterska, vilket system använder ni? *Sätt **ett kryss** som berör majoriteten av era diabetespatienter.* ☐ Datoriserat ☐ Manuellt
20b.	***Om patienterna kallas*** till sjuksköterska, sker kallelsen utifrån: *Sätt **ett kryss** som berör majoriteten av era diabetespatienter.* ☐ Standardiserad uppföljning ☐ Uppföljning efter patientens behov ☐ Vet ej
21.	Har ni något system för att följa upp att patienterna har deltagit i regelbundna kontroller hos läkare respektive sjuksköterska? *Sätt **ett kryss** som berör majoriteten av era diabetespatienter.* Ja, datoriserat ☐ Ja, manuellt ☐ Nej ☐ Läkare ☐ ☐ ☐ Sjuksköterska ☐ ☐ ☐
22.	Vid återkommande besök träffar patienten samma vårdgivare? *Sätt **ett kryss** som berör majoriteten av era diabetespatienter.* Ja ☐ Nej ☐ Vet ej ☐ Läkare ☐ ☐ ☐ Sjuksköterska ☐ ☐ ☐ Dietist ☐ ☐ ☐

Patientutbildning och behandlingsmål	
23.	Hur bedriver ni patientutbildning? ☐ Individuellt ☐ Grupp ☐ Individuellt och grupp
24.	***Om*** ni bedriver **individuell patientutbildning**. Hur gör ni i mötet med patienten? *OBS! Sätt **ett kryss** som berör majoriteten av era diabetespatienter* ☐ Använder checklista som utgångspunkt för mötet ☐ Utgår från patientens behov ☐ Annat Vad:
24a.	***Om*** ni använder er av **checklista i individuell patientutbildning**, vilka områden omfattas? *Kryssa för **alla** alternativ som stämmer.* ☐ Livsstil (kost, motion, alkohol, BMI, rökning) ☐ Egenvård (egenkontroller, munhälsa, leva med diabetes, livskvalitet) ☐ Komplikationer (blodtryck, njurar, fötter, ögon, hjärta-och kärl, sexuella problem) ☐ Medicinsk behandling och fysiologi (behandling, injektionsteknik, hypo- och hyperglykemi, ärftlighet, sjukdomslära) ☐ Sjukdomsrelaterade problem (stress, kris, socialt, psykologiskt) ☐ Övrigt (Nationella diabetesregistret, vårdprogram, patientens rättigheter, Diabetesförbundet)
25.	***Om*** ni bedriver **grupputbildning**. Vilken utbildning erbjuder ni? *OBS! Sätt **ett kryss** som berör majoriteten av era diabetespatienter.* ☐ Planerad utbildning med förutbestämt innehåll ☐ Utbildning som helt utgår från patientens behov ☐ Utbildning med en fast ram (tid, tidpunkt och handledare förplanerade, men innehållet i utbildningen utgår från patientens behov) ☐ Annat Vad:
25a.	***Om*** ni använder er av **förutbestämt innehåll i grupputbildningen**, vilka områden omfattas? *Kryssa för **alla** alternativ som stämmer.* ☐ Livsstil (kost, motion, alkohol, BMI, rökning) ☐ Egenvård (egenkontroller, munhälsa, leva med diabetes, livskvalitet) ☐ Komplikationer (blodtryck, njurar, fötter, ögon, hjärta-och kärl, sexuella problem) ☐ Medicinsk behandling och fysiologi (behandling, injektionsteknik, hypo- och hyperglykemi, ärftlighet, sjukdomslära) ☐ Sjukdomsrelaterade problem (stress, kris, socialt, psykologiskt) ☐ Övrigt (Nationella diabetesregistret, vårdprogram, patientens rättigheter, Diabetesförbundet)

25b. ***Om*** ni bedriver **grupputbildning**, erbjuder er vårdcentral/mottagning gruppbaserad utbildning till personer med diabetes typ 2, som leds av vårdpersonal med ämneskompetens och pedagogisk kompetens?
Med ämneskompetens i diabetesvård menas minst 15 högskolepoäng (hp) och med pedagogisk kompetens menas minst 7,5 (hp).

☐ Ja
☐ Nej
☐ Vet ej

25c. ***Om*** ni bedriver **grupputbildning**, erbjuder er vårdcentral/mottagning kulturanpassad grupputbildning?
Med kulturanpassning menas anpassad utbildning till personer med olika kulturell bakgrund. Anpassningen gäller språk och utbildning om kost- och andra livsstilsfaktorer.

☐ Ja
☐ Nej
☐ Vet ej

26. Ange hur vanligt förekommande det är att ni diskuterar mål för behandlingen med era patienter avseende HbA1c, blodtryck, lipider och livsstilsförändringar?
*Välj det alternativ som är **vanligast** förekommande för respektive parameter.*

	Nästan med alla	Med många	Ett fåtal	Diskuterar ej mål
HbA1c	☐	☐	☐	☐
Blodtryck	☐	☐	☐	☐
Lipider	☐	☐	☐	☐
Livsstilsförändringar	☐	☐	☐	☐

27. Vem/vilka fattar i regel beslut om mål för behandlingen avseende HbA1c, blodtryck, lipider och livsstilsförändringar? *Kryssa för **alla** alternativ som stämmer.*

	Läkare	Sjuksköterska	Dietist	Patient
HbA1c	☐	☐	☐	☐
Blodtryck	☐	☐	☐	☐
Lipider	☐	☐	☐	☐
Livsstilsförändringar	☐	☐	☐	☐

Kvalitetsarbete

28.

	Ja	Nej	Vet ej
Har ni målinriktad läkemedelsbehandling baserad i tydliga behandlings-trappor (riktlinjer för när man ska byta läkemedelsbehandling)?	☐	☐	☐
Har ni en tydlig strategi med riktade insatser för personer med diabetes med sämre värden?	☐	☐	☐
Följer ni upp utfall/resultat för personer med diabetes?	☐	☐	☐
Har ni gemensamma möten om diabetesriktlinjer för alla inom er vårdcentral/mottagning?	☐	☐	☐
Vårdcentralen/mottagningens ledning för ofta dialog med medarbetarna kring enhetens resultat?	☐	☐	☐
Känner medarbetarna väl till vårdcentralen/mottagningens resultat?	☐	☐	☐
Har ni bedrivit ett förbättringsarbete under många år?	☐	☐	☐

	Har er vårdcentral/mottagning ansvar för kvalitet och resultat för personer med diabetes?	☐	☐	☐
	Finns det en kultur på er vårdcentral/mottagning att följa riktlinjer?	☐	☐	☐
	Finns det på er vårdcentral/mottagning ett fokus på prevention av följdsjukdomar vid diabetes?	☐	☐	☐
Kvalitetsuppföljning och återkoppling i organisationen				
29.			Ja	Nej
	Huvudmannen återkopplar regelbundet resultat från NDR till vårdcentralerna/mottagningarna?		☐	☐
	Huvudmannen använder återkoppling av resultat från NDR som en möjlighet till kvalitetsdialog?		☐	☐
	Huvudmannen redovisar internt alla vårdcentraler/mottagningars NDR-resultat?		☐	☐
	En satsning sker och/eller har skett på diabetes med en politiskprioritering i ert landsting/region?		☐	☐

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