Diabetes mellitus in Greenland

Prevalence, organisation and quality in the management of type 2 diabetes mellitus. Effect of a Diabetes Health Care Project

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3. Pedersen ML, Jacobsen JL. Improvement of diabetes care in a small but geographically widely spread population in Greenland. Effects of a national diabetes care programme. Diabetic Medicine. 2011 In Press.

ABBREVIATIONS

ADA	: American Diabetes Association
BMI	: Body mass index
BP	: Blood pressure
DM	: Diabetes
EMR	: Electronically medical record
FDDB	: Fyns Diabetes Data Base
HbA1c	: Glycosylated heamoglobine
HDL	: High density lipoprotein
LDL	: Low density lipoprotein
T1DM	: Type 1 Diabetes Mellitus
T2DM	: Type 2 Diabetes Mellitus
TG	: Triglycerides
U-ACR	: Urine albumin creatinine ratio
WHO	: World Health Organisation

1. INTRODUCTION

The population of Greenland is approximately 56.000 and the population is widely spread geographically along the coast in 18 towns and a number of minor settlements in a country with a total area of more than 2 million km2 [1]. Approximately 16 % live in settlements and 10 percent of the population are immigrants (predominantly from Denmark) [1]. The population has almost three fold doubled since the mid 1940s [1].

Greenland has undergone a rapid transition during the last half century from a traditional Inuit society dominated by small communities, villages and settlements to a modern society with more than 60% living in towns with at least 2500 inhabitants [1].

During the 1950s and 1970s the infrastructural changes were colossal [2]. Within a few decades, Greenland was transformed from a traditional hunting society to a modern society where most people rely on wage earning [2]. The profound social and cultural change has been followed by a health transition with increasing prevalence of lifestyle related diseases like overweight, obesity, diabetes and ischemic heart diseases [3-10] similar to what has happened among Inuit in Alaska and Canada [11-14].

Fifty years ago type 2 diabetes mellitus was very rare in Greenland [15-17]. However, epidemiological studies have indicated a high prevalence of diabetes among Greenlanders [9] comparable to levels among Inuit and Native Indian populations in Canada and Alaska [18-23]. Two out of three cases in these epidemiological surveys were previously undiagnosed [9]. It was concluded that increased awareness of diabetes in Greenland was needed [9].

The national health care system in Greenland provides service free of charge to everyone. In 2008, a national diabetes programme was implemented aiming to improve the diabetes care for patients with T2DM in Greenland based on an unconditioned donation from Novo Nordisk A/S to the national health care service.

The overall aim of this thesis was to evaluate if implementation of a diabetes programme in Greenland would have a measurable effect on quality in diabetes care including diagnostic activity and screening for diabetic complications. A baseline study of prevalence of diagnosed type 2 diabetes mellitus in Greenland and quality of diabetes care in Greenland anno 2008 was the basis for the strategy in the diabetes programme.

2. BACKGROUND

2.1 DIABETES IN GREENLAND

Until 50 years ago, Type 2 Diabetes Mellitus (T2DM) was almost non-existent in Greenland [15-17]. Only sporadic cases were observed in the beginning of the 19th century. One case from southern Greenland was described as early as 1910 [15]. No cases

of obesity were observed among the Inuit whereas few cases among immigrants were recorded [15]. The first study to evaluate the prevalence of diabetes among Greenlanders living in east Greenland was performed as a cross sectional population survey in 1962 including 4249 individuals (1187 above 30 years old) corresponding to 14 % of the entire population of Greenland and 7 % of all Inuit in the world at that time [16]. Urinary glucose two hours after a meal was used as the primary screening test, followed by an oral glucose tolerance test in case of positive urine screen test. Positive urine was found in 24 cases. Of those three cases were defined with possible diabetes corresponding to a prevalence of 0.06 % [16]. Based on surveys of medial record from all 18 hospitals in Greenland ten cases of clinically diagnosed diabetes mellitus in Greenland was reported. This corresponds to a crude prevalence of diagnosed cases for all age groups at 0.03 % (32.249 inhabitants) in 1962 [16]. Three of the ten cases were siblings of mixed Danish-Greenlandic origin. In 12 out of 17 medical districts diabetes mellitus had never been diagnosed [16]. In another study of clinically diagnosed cases in the district of Upernavik (1.800 inhabitants) over a 25 year period (1950-1974) only one case with diabetes mellitus was observed [17]. The expected number according to European incidence rates was nine [17]. Several limitations must be taken into consideration including the low sensitivity of urinary glucose as screening tool for diabetes mellitus, changed diagnostic criteria and methods [24-25], a young age distribution and limited access to diagnostic facilities. However, it seems reasonable that diabetes mellitus used to be a rare condition among Greenlanders.

A more recent epidemiological study performed in 1999-2002 including 917 individuals reported a high prevalence of T2DM among Greenlanders suggesting an age standardized prevalence of diabetes among men and women of 10.8% and 9.4% respectively [9]. Furthermore, 70% of those with diabetes were undiagnosed [9]. In addition, a high prevalence of impaired glucose tolerance (IGT) was demonstrated with age standardized prevalence at 9.4 % and 14.1 % for men and women [9]. A screening survey among Greenlandic migrants living in Denmark demonstrated a similar high prevalence of diabetes at 10.2 % [25]. Only 36 % of those where diagnosed with diabetes [25]. In both studies the diagnosis was based on one oral glucose tolerance test using the WHO diagnostic criteria [25]. The prevalence of T2DM and related complications has thus been predicted to increase in Greenland [27].

However, the actual prevalence of diagnosed cases of T2DM in Greenland was unknown as was the quality in the management of patients with T2DM in the health care system in Greenland.

2.2 DIABETES AMONG INUIT

Terminology

Greenlanders are considered to be Inuit (formerly called Eskimoes), a people indigenous to the circumpolar region in northern hemisphere. Inuit share a common past and are related geographically, historically and culturally [2]. The Inuit are thus a genetically distinct people living under extreme physical conditions [28]. Beside Greenland Inuit are living in the United States of America (Alaska), Canada and Russia [2, 29].

Inuit subgroups depending mainly on geographical location are sometimes referred to as Inuvialuit (Mackensie Delta), Inupiat (Northern Alaska) and Yupik (central and south-western Alaska and the Chukotka peninsula in Russia) and Greenlanders in Greenland [2]. Alaska Natives is often used in a common term for Inuit, Aleuts, Athapaskan Indians, Tlingit and Haida living in Alaska [2]. First Nations are used in Canada as a common term for North American Indians, which together with the Métis people and Inuit are considered Aboriginal peoples of Canada.

Prevalence – The first studies

Fifty years ago, diabetes mellitus also used to be a rare condition among Inuits in Alaska [30-33] and Canada [34-35]. Population surveys based on oral glucose tolerance test documented an overall prevalence among adult Alaska Inuit (at or above 35 years old) as low as 0.08-0.16 % in the 1950'ties [30]. A young age distribution among the Inuit with a median age of 17.7 years (only 23 percent of the population above 35 years old) was discussed as one of the explanations, but also lack of diagnostic facilities, or a racial characteristic was considered, while lack of obesity initially was rejected as explanation since 10 % of males and 27 % of females weighed at least 15 kg more than whites of the same age, height and sex [30]. During the following decades a number of screening studies were performed and consistently a low prevalence ranged from 1.1 -1.8 % among adult Alaska Inuit (defined as age at or above 20 years in one case and at or above 40 years old in the other cases) was reported [30-33]. It was noted that male Inuit were much more physically active than white males and that they were generally well-muscled and that the physical activity and fitness was maintained until age at 60 years or older [31].

In 1973 a screening survey based on oral glucose tolerance test was performed among the Aleut residents of the Pribilof Islands after an epidemic with coxackie B4 virus in 1967 in order to analyse the relationship between the virus infection and glucose tolerance [36]. While no association between the virus infection and glucose intolerance was found, surprisingly a very high prevalence of diabetes at 11.5 % of the adults at or above 35 years old was demonstrated [36].

Prevalence – population studies

Population surveys performed in the early 1980s among Inuit in Northern Quebec in Canada based on random glucose measurements and in Chukotka in Russia based on oral glucose tolerance test demonstrated very low prevalence of diabetes at 0.4 % in Canada while no cases at all was identified in Russia [37-38].

In 1987, a population based survey using random glucose followed by an oral glucose tolerance in case of blood glucose at or above 6.7 mmol/l demonstrated a prevalence of diabetes among Inuit aged 40 years or older in Alaska (Yupik) at 4.7 % compared to 10.0% among Athabascan Indians [39]. It was concluded that the prevalence of diabetes among Inuit in Alaska had increased during the past 25 years since the first performed surveys [39].

In the 1990'ties two population surveys including an oral glucose tolerance test took place among Alaska Native [20-22]. The first pilot project was performed in 1992 among adult (at or above 40 years old) Siberian Yupik people. The prevalence of diabetes was 9 % whereas 12 % met the WHO criteria for impaired glucose tolerance [21].

The second population surveys performing in 1994 using oral glucose tolerance test among Alaska Natives confirmed a high prevalence among Siberian Yupik Inuit at 9.6 % aged 25 years or more while the prevalence among Inupiat was 3.7 % and among Central Yupik 2.8 % [22].

In a study published in 2006 among Alaska Inuit (1284 participants) the prevalence of diabetes based on fasting plasma glucose the prevalence of diabetes was estimated to 3.8 % (women 5.0 %, men 2.2 %) [40]. In the same study an oral glucose toler-

ance were performed in 787 of the Inuit. The prevalence of diabetes (WHO criteria [26]) was 6.9% [40]. It was concluded that Alaska Inuit had low prevalence of diabetes mellitus. However, a high prevalence of impaired fasting glucose (15.6 %) could indicate that diabetes may become increasingly problematic in this population. Abdominal obesity in women could explain why diabetes prevalence differed according to sex [40].

Differences between study populations, changes in survey methods and changes in the diagnostic criteria restrict the possibilities for comparison of the studies over time. The increase in prevalence of diabetes is however so large that the population surveys strongly indicate that the prevalence of diabetes mellitus among Inuit populations has truly increased over the last five decades.

Prevalence of diagnosed diabetes mellitus

The prevalence of diabetes mellitus among Inuit has also been estimated through several register studies of diagnosed cases [41-59].

During the 1980'ties it became clear that diabetes was an upcoming problem among the Inuit in Alaska [20]. The prevalence of diagnosed cases was estimated in the mid 1980's based on the electronically medical records [41]. The crude prevalence among Alaska Native was estimated to 0.83 % of the entire population corresponding to an USA age-standardized prevalence at 1.57 % in 1980 [41]. Ethnic differences were demonstrated between the indigenous people in Alaska [41]. The lowest age-standardized prevalence was found among the Inuit at 0.88 %, while it was 2.20 % among Indians and 2.72 % among the Aleuts [41].).

The prevalence among the Alaska Native was lower than in the general population in USA with prevalence at 2.47 % in 1985 [59]. It was also much lower than seen among other Indians in USA, among whom very high prevalence of diabetes was reported [20]. The prevalence of diabetes among Alaska Natives has increased from 1985 to 2006 by 231 % in males and 139 % in females among Alaska Natives [57]. The increase was predominantly in the Inuit regions [57]. The age standardized prevalence of diagnosed cases among Inuit thus rose from 2.0 % in 1985 to 3.4 % in 2006 [57]. The incidence of diabetes has been steadily increasing with the largest increase around 1999-2001 probably reflecting increased diagnostic activity at that time [57].

The age-standardized prevalence of diagnosed cases of diabetes among Indigenous people was compared across the circumpolar area in 1992 [44]. For Inuit of the North West Territories the prevalence was lower (0.36 %) than for the Alaska Inuit (0.79 %) but higher than among the Chukotka Inuit (0.018%) in Russia [44]. The prevalence among the Canadian Inuit was also lower than among Athapakan Indians (0.93 %) in Canada and for the all subgroups still much lower than among the all race USA prevalence (2.35 %) at that time [44].

Also among Canadian Inuit increasing prevalence of diagnosed diabetes has been documented.

The prevalence of diagnosed cases among First Nation population in British Columbia thus more than doubled between 1987 and 1997 from 1.2 % to 2.6 % [54]. A North-south gradient was reported with a higher prevalence in the southern communities [54] which could indicate an association with degree of westernization. It was concluded, that there was a continued epidemic of type 2 diabetes among first nations in Canada with trend toward earlier age at onset [44].

Population studies versus register studies

The register based studies thus demonstrated a significant increase in the prevalence of diagnosed cases of diabetes. The prevalence in the population surveys however demonstrated a much higher prevalence than in the register studies [20]. Several explanations contribute to the observed difference. First of all undiagnosed cases obviously were not included in the register studies and the true prevalence in the population therefore underestimated. Secondly the clinical diagnose of diabetes has to be confirmed independently on a second test [25], which were not performed in the population surveys. This may tend to overestimate the true prevalence in the population surveys. Thirdly, since only 50-60 % of the population participates in the surveys a selection bias cannot be excluded. If those participating were those at highest risk the prevalence would be overestimated [20]. Thus register studies tend to underestimate the prevalence while surveys may overestimate the prevalence [20].

Lifestyle changes and diabetes

T2DM and IGT prevalence rates vary widely amongst the world's aboriginal populations. Despite very different histories and cultures, the consequences of rapid changes in nutrition and exercise appear to have very similar metabolic consequences on aboriginal populations [60].

The increase in prevalence and incidence among the Alaska Native has thus been linked to the changes in diet and lifestyle and increasing body mass index [57, 61-62]. The risk of diabetes has thus been demonstrated to be lower among the physically active Alaskan Native and those who consumed seal oil or salmon [63-64]. Furthermore, several studies has documented that the association between abnormal glucose tolerance and overweight was also present among Alaska Native [65-70].

The very low prevalence among Inuit in Russia may reflect a lesser degree of western influence on life style in northern Russia. The diets consumed by the Siberian Chukotka Natives were thus less "westernized" than those of the Alaska Natives in the 1980 ties [71].

Diabetes Care

Initiatives to improve diabetes care have been taken both in Alaska and Canada [72].

A national diabetes register (The Alaska Native Diabetes registry) was started in 1985 [41] and has provided information on diabetes prevalence, incidence, mortality and complications among Native Alaska including three major subgroups namely Indians, Inuit and Aluets [41, 49, 56-57, 73].

While diabetes care for Alaska Native was initially provided by the Indian Health Service a Special Diabetes Programme for Indians was initiated in 1994 and fully implemented in 1999 [56-57]. This program was based on an enhanced health care infrastructure, a national diabetes registry, standardized guidelines for care and annual evaluation and feedback to the clinics [56]. Intermediate outcomes were improved during the first observation period1994-2004 [56]. Both mortality and complications rates have decreased [57]. The increasing prevalence of diagnosed cases could have contributed to the lower mortality and decreasing rates of complication [57]. It was however concluded, that a health care system with a unified electronic medical record, no personal bills for health care and medications could improve diabetes care in a remote rural area of Alaska [57].

Also in Canada, initiatives to optimize the treatment of hypertension among patients with diabetes have been taken with proven

effect [74-76]. A randomized controlled study of the effect of blood pressure monitoring by home care nurses has demonstrated significantly lower blood pressure levels after one year of intervention. The reduction was demonstrated both in a group were the antihypertensive treatment was adjusted by the home care nurse using a treatment algorithm and in a group with only home care blood pressure monitoring by nurses including follow-up treatment by a family physician [74]. The positive effect on the blood pressure was sustained two years after the end of the intervention [76].

Complications

The prevalence of complications to diabetes has showed ethnical and gender related differences [20]. Initially (1986-1998) amputation rate among all Alaska Native people with diabetes was 6.1/1000 person years [73]. The highest incidence was found among male Aluets and the lowest prevalence among the Inuit (3/1000 person year) [73]. A recent study have demonstrated decreasing amputation rates among Alaska Native people to 2.6/ 1000 person year [57] still with a lower prevalence among Inuit while the Indians had comparable levels as the Aleuts [57]. Male had higher rates than females [20, 57]. Renal replacement or dialyses rates had decreased between the periods (1986-1990) and (2002-2006) from 3.3 to 1.2/ 1000 person year [57]. No interaction between ethnicity and gender was found [57]. Mortally rates was reduced in the same period from 41.7 to 33.2/1000 person year [57]. While Indian and Aleuts has the highest prevalence of death due to ischemic heart disease with prevalence at 4.2 and 3.73/1000 person years compared with Inuit (2.6/1000 person year). The Inuit has the highest prevalence of death to cerebrovascular accidents (2.2/1000 person year) followed by Aluet people and Indians at 1.75 and 1.45/ 1000 person years [57]. Inuit thus seem to have a higher risk of cerebrovascular complication to diabetes than the other Alaska Natives which was also found in the early observation and even more pronounced for females where the incidence of stroke was as high as 19.6/ 1000 person years [49].

Summary

In summary, diabetes was almost not exiting 40-50 years ago among Inuit in Alaska, Canada and Greenland. The prevalence of diagnosed cases has however increased through the last few decades in both Alaska and Canada. The prevalence was highest in Alaska Inuit followed by Canada while the prevalence among the Chukotka Inuit in Russia was the lowest but with no recent data available. The prevalence among Inuit was lower than among Indians in both Alaska and Canada and lower than in the USA. The prevalence of diabetes documented in population surveys was not surprisingly much higher than those found in the registry studies. Inuit had fewer complications to diabetes than Indians with the exception of cerebrovascular events.
Initiatives to improve the quality in the diabetes care among Inuit in Alaska and Canada has been documented to reduce blood pressure level, complication and mortality rates while the incidence of diabetes steadily is increasing and the epidemic thus still running.

2.3 THE HEALTH CARE SYSTEM IN GREENLAND

A geographically wide spread small population, arctic climate and shortage of health care professionals all contribute to the major challenges for the health care system in Greenland. Expensive transportation and evacuation of patients also represents an economic burden.

The public Health Care system was organised into 16 districts. Each district comprised one town and a varying number of small settlements coupled to a Primary Health Care Centre which also functioned as a local hospital (except from the Primary Health Care Center in Nuuk (the capital) where the central hospital for Greenland, Queen Ingrid Hospital, served as a local hospital as well). All 16 clinics used the same electronically medical record (EMR) system (Æskulap®), which was fully implemented September 2007 [77-78]. Diabetes Care was organised locally within each district.
From January 2009 the 18 counties in Greenland has been reduced to four counties [78]. From January 2011 the number of health care districts was reduced to five regions.
The national health care system provides service free of charge to everyone including free prescribed drugs. X-Ray was digitalized (Chilli web) from 2005 and fully implemented 2007 [77-78]. During 2007 a uniform electronical medical record (Æskulap® – Greenlandic version) has been implemented in all primary health care districts. Æskulap® is based on the internet which facilitates the communication among the districts when patients move to or are on vacations in other districts. In September 2007 an electronically lab system (BBC) was introduced which also eased the use of bio analytic results [78]. Telemedicine has been used in different forms during the last decade. Further efforts to improve telemedicine have been initiated as a three year project starting in 2008.
Plenty of initiatives have been done to improve the health care in Greenland including screening for tuberculosis among school children, screening among pregnant woman for some genetic diseases like cholestasis familiaris groenlandica, propionic academia, and several others [79].
The diabetes programme presented later in this thesis represents another initiative that has not yet been evaluated.

2.4 FYNS DIABETES DATA BASE (FDDB)

The management of patients with T2DM was done locally in each district. In addition, a minor group of patients was followed in the out-patients' clinic, Department of Internal Medicine, Queen Ingrid's Hospital in Nuuk.
In two districts, Nuuk and Aasiaat, the Primary Health Care Clinics have focused on the management of the patients with T2DM and in these two towns an electronic database, Fyns Diabetes Database [80] was implemented in November 2006 to improve the quality in management. The database contained information about patients with diabetes mellitus affiliated to each clinic. The information comprised year of diagnose, medical treatment, lifestyle factors like smoking and exercising habits and results from examinations of blood pressure, blood lipids, HbA1c, microalbuminuria, eyes and feet. All data had to be recorded manually in the database. The database included a statistical software modus that could identify patients who fulfilled different criteria. For example, patients who did not have their blood pressure recorded within the previous year could easily be identified allowing the clinicians to evaluate some aspects of the diabetes care performance in the clinic.
However, no evaluation of the quality in the diabetes care in districts with and without database has been done so far.

2.5 REORGANISATION OF DIABETES CARE

Initiatives to develop and improve the diabetes care in Greenland were made in 2007 and 2008 as a result of an unconditioned donation from Novo Nordisk A/S to the national health care system.

The diabetes program was established as a three year project with the aim to improve the diabetes care for patients with diabetes, to improve detection of new cases and promote prevention of diabetes in Greenland. Evaluation of the diabetes care prior to new initiatives was part of the project. This was done in order to identify weaknesses and strengths in the diabetes care, to benefit from prior experiences, and to get baseline information about the quality in the diabetes care in Greenland 2008.

3. HYPOTHESIS

Based on the literature and clinical experience for the health care system in Greenland we hypothesised that:

1. The quality in the diabetes care differs between districts with and without an electronically quality database Greenland 2008.
2. The quality in the diabetes care differs between districts in Greenland 2008.
3. The quality in the diabetes care can be improved by implementation of a diabetes programme.
4. The prevalence of diagnosed type 2 diabetes mellitus in Greenland is increasing.

4. AIM

The overall aim of this study was to evaluate if implementation of a diabetes programme in Greenland would have a measurable effect on quality of care in diabetes including diagnostic activity and screening for diabetic complications. A baseline study on prevalence of diagnosed type 2 diabetes mellitus in Greenland and quality of diabetes care in Greenland anno 2008 was the basis for the strategy in the diabetes programme.

The specific objective was therefore:

1. To estimate and compare the quality in the diabetes care between districts with and without an electronically quality database Greenland 2008 (Publication 1).
2. To estimate and compare the quality in the diabetes care between districts Greenland 2008 (Publication 2).
3. To estimate and compare the quality in the diabetes care before and after the implementation of the diabetes programme (Publication 3).
4. To estimate the prevalence of type 2 diabetes mellitus in Greenland before and after the implementation of the diabetes programme (Publication 3).

5. MATERIALS AND METHODS

5.1 THE DIABETES PROGRAMME

The diabetes programme was established to improve care for patients with diabetes, to improve detection of undiscovered cases and to promote prevention of diabetes in Greenland. A group, comprising a physician, a nurse, a dietician and a state registered chiropodist, was employed to plan and organize the diabetes program. During the end of 2008, a new diabetes care concept was implemented.

It was based on three components:

- National guidelines
- Electronically medical recording
- Performance feedback
- National guidelines

The national guidelines were developed and adapted to a Greenlandic context with inspiration from the guidelines used in Denmark based on international scientific evidence and published by The Danish College of General Practitioners [81]. The guidelines were then reviewed and accepted by the medical chief of the department of internal medicine at Queen Ingrid Hospital in Nuuk, Greenland, and the medical director of Steno Diabetes Center in Copenhagen, an expert in diabetes. Finally, the guidelines for handling T2DM were distributed in paper form, electronically via an intranet system for health care professionals in Greenland and through course based education of local health care professionals.

Electronically medical recording (EMR)

Systematic recordings of so-called diabetes profiles in the EMR—including coding with a D for diabetes—was introduced thus taking advantage of the benefits of database organization [82-84]. The diabetes profile database contains information about patients with diabetes mellitus affiliated to each clinic. The information comprised year of diagnose, smoking habits and results from examinations of blood pressure, blood lipids, HbA1c, microalbuminuria, eyes and feet. The EMR included a statistical software modus that could identify patients who fulfilled different criteria similar to the prior used database (FDDB).

Performance feedback

Performance feedback reports were sent to the clinics to establish a benchmark on health care based on process-of-care indicators [85-86],allowing the clinicians to compare the performance of their own clinic with that of the other clinics. This method has a positive effect on improving the quality in the health care management as documented in other studies [86].

Other initiative

Among other initiatives the diagnostic criteria of diabetes mellitus in Greenland had been clarified in July 2008. The former diagnostic cut off value for ascertaining diabetes with fasting whole blood glucose concentration at 6.6mmol/l was corrected in the laboratory reference card to 6.1mmol/l thereby brought into accordance with the most recent (1999) WHO definitions [26]. Diagnosis was based on confirmed WHO defined pathological whole blood glucose values [26]. An oral glucose tolerance tests was recommended when whole blood glucose concentrations were in the range of 5.6 to 6.0mmol/l. All districts were equipped with a DCA vantage analyser® [87] in order to facilitate the analysis of HbA1c, and urine albumin-to-creatinine ratio (U-ACR).

Awareness and prevention

It was further intended to increase the information of diabetes in the general population, in the health care system, among health care professionals, among patients with diabetes and to promote and initiate primarily and secondarily preventive initiatives. Aspects of these efforts are described in section 10.

5.2 DATA COLLECTION

Data were collected during 2 months, February and March, in 2008 and in 2010 respectively.

The samples

In 2008 all health care districts were asked to make a list of patients with T2DM including information about age, gender, last blood pressure, HbA1c, blood lipids and information about last screening for retinopathy, neuropathy and microalbuminuria by reviewing the medical records two years back in time. In the two districts with a database (FDDB), Nuuk and Aasiaat, the data could be drawn electronically.

In 2010 the data was collected by reviewing the EMR of all patients coded with D for diabetes. Only adults aged 20 years or above with T2DM defined as all patients with diagnosed diabetes mellitus excluding patients with T1DM. Patients were classified as having T1DM if they were diagnosed below the age of 30 and treated with insulin within the first half year after diagnosis. Patients born in Greenland were considered Greenlanders while patients born outside Greenland were considered non-Greenlanders (publication 3). The age and gender specific prevalence of T2DM among Greenlanders was estimated using the population in Greenland January 2007 (Publication 1) and Greenland January 2009 as background population (Publication 3). Districts with more than 3000 inhabitants (2009) or more were considered large whereas the other districts were considered small.

5.3 QUALITY INDICATORS

The quality in the management of diabetes mellitus was described by six process-of-care indicators inspired by the Danish National Indicator Project [88-93], ten biological indicators and three treatment indicators. All indicators included are directly related to patient outcome as documented in the "documentalist report" provided by the Danish National Indicator Programme (Diabetes) http://www.nip.dk/files/Subsites/NIP/Diabetes/01072010_Diabetes_Dokumentalistrapport.pdf [88]. The indicators are defined in table 1. No information about prescribed drugs was obtained in 2008 where the use of electronically prescription was not fully implemented.

5.4 MEASURE METHODS

Measurement of whole blood glucose concentration was performed using Hemoecue® calibrated weekly. Analysis of venous blood for cholesterol and HbA1c and U-ACR was performed at the Central Laboratory, Queen Ingrid Hospital in Nuuk, using Architecht ® 8000T from Abbott. The Central Laboratory is member of the Danish quality control system for laboratories, DEKS. Some of the analysis of HbA1c and U-ACR have been performed locally using DCA vantage ® or Nycocard Reader ®.
Blood pressures are recommended to be measured using an automated device (UA-787 from A&D Medical ®) with appropriate cuff on a sitting patient after approximately five minutes of rest in the office or done home by the patient using the average of 12 blood pressures measurements performed during three days using the same device as in the office.
Dilated eye examination was included if performed by an ophthalmologist or if photography of the retina was read by an ophthalmologist. Foot examination was included in 2008 if the feet where described in medical record whereas only foot examinations recorded in the diabetes profile was included in 2010. Foot examination performed by a state registered chiropodist includes examination of pulses in foot (dorsalis pedis and tibilalis posterior arteries) and sensation including pressure (10 g monofilament), thermal (Tip Therm ®) and vibration threshold (biothesiometer, Rova Company ®) modalities.

5.5 STATISTICS

Statistical analyses were performed using SPSS 17.0 and STATA 10.0. Normally distributed parameters were described with means and standard divisions. Means were compared with t-test. Normality was checked by Q-Q plots. Proportions were compared by Chi-square tests using significance level at 0.05. Estimates were calculated with 95 % confidence intervals.

6. ETHICS

This thesis was based on two observational cross-sectional stud-

Table 1

Proces, biological and treatment indicators in diabetes care used in present study

Process indicators
The percentage of patients in whom HbA1c was measured within the previous year.
The percentage of patients in whom BP was measured within the previous year.
The percentage of patients in whom blood lipids were measured within the previous two years.
The percentage of patients in whom urine was tested for microalbuminuria within the previous two years.
The percentage of patients who had their eyes examined within the previous two years.
The percentage of patients who had their feet examined within the previous two years.
Biological indicators
The percentage of patients in whom HbA1c was measured within the previous year and with a value below 7 % within the previous years.
The percentage of patients in whom HbA1c was measured within the previous year and with a value above 9 % within the previous years.
The percentage of patients in whom systolic BP was measured within the previous year and with a value below 130 mmHg within the previous years.
The percentage of patients in whom systolic BP was measured within the previous year and with a value above 150 within the previous years.
The percentage of patients in whom diastolic BP was measured within the previous year and with a value below 80 mmHg within the previous years.
The percentage of patients in whom diastolic BP was measured within the previous year and with a value above 90 within the previous years.
The percentage of patients in whom total cholesterol was measured within the previous year and with a value below 4.5 mmol/l within the previous two years.
The percentage of patients in whom total cholesterol was measured within the previous year and with a value above 5.5 mmol/l within the previous two years.
The percentage of patients in whom LDL cholesterol was measured within the previous year and with a value lower than 2.5 mmol/l within the previous two years.
The percentage of patients in whom LDL cholesterol was measured within the previous year and with a value above 3.5 mmol/l within the previous two years.
Treatment indicators
The percentage of patients in whom ACE inhibitors or ArB* has been prescribed within the previous two years.
The percentage of patients in whom blood lipid lowering agents has been prescribed within the previous two years.
The percentage of patients in whom aspirine 75 mg agents has been prescribed within the previous two years.

*ArB: Angiotensin II receptor blocker

ies including review of medical records. No risk or inconveniency for any patients has been applied. Data has been handled within the computers belonging to the health care system and secured so no personal information would be identifiable. The districts could perceive the feedback on performance as control, which could be potentially unpleasant. However, all results were given anonymously so no clinic could be identified by others than themselves. The use of benchmarking is an evidence based method to improve heath care quality. The samples were obtained to provide information to identify and quantity of the diabetes care related problems in Greenland in order to firstly direct and secondly evaluate the diabetes programme.

7. MAIN RESULTS

The main results from the three publications are presented separately in this section.

7.1 QUALITY IN THE MANAGEMENT OF T2DM IN CLINICS WITH AND WITHOUT DATABASE IN 2008

Data were received from 14 of the16 districts in Greenland (Publication 1). Two districts were not able to deliver the results before the deadline. Two districts were excluded because of a small number (totalled seven) of patients with T2DM. One district delivered only demographics on patients with T2DM but with no other parameters like last blood pressure etc. leaving 11 clinics as the basis for further analysis.

The number of patients registered in the districts (two) with a database totalled 140 and in the districts (nine) without a database 245. There were no differences between the two groups regarding distribution of gender (p=0.686) or age (p=0.415).

The indicators of the quality of the management in Greenland of T2DM 2008 in districts with and without a database are shown in table 2.

The two districts with a database performed significantly better (p<0.001) than the clinics without a database concerning all process indicators except from screening for retinopathy.

However, results from the screening for retinopathy were not fully updated neither in districts with or without a database due to a shortage of eye doctors (delayed response). In one of the districts with a database the results from the screening for microalbuminuria and examinations of the feet were not updated in the database leading to an underestimation of the percentage of patients screened.

7.2 QUALITY IN THE MANAGEMENT OF T2DM IN 12 PRIMARY HEALTH CARE DISTRICTS 2008

Data received from 14 of the16 districts in Greenland (Publication 2). Two districts were not able to deliver the results before the deadline. The two smallest districts were excluded because of the small number of patients (seven), leaving 12 clinics as the basis for further analysis, representing approximately 90 % of population in Greenland (Publication 2). The number of patients registered in the 12 districts totalled 440. The number of patients in each clinic varied from 10 to 94. No difference in the distribution of males and females between the 12 clinics was observed (p=0.43).

The process-of-care indicators in each of the 12 districts and all districts together are shown in table 3. Furthermore, a standard monitoring level [88-89] was suggested (Table 3). Table 3 shows that between 2 and 4 districts meet the standard, of which 2 districts have no more than 10 and 11 patients listed. Thus most districts did not meet the standard.

However, the screening rates within 2 years for microalbuminuria, eye and foot examinations were much lower than the suggested standard. However, great variation among the districts was demonstrated. Thus, the percentage of patients with T2DM in whom HbA1c was measured within the previous year varied from 39% to 100%. The percentage of patients with T2DM in whom hypertension was measured within the previous year varied from 20% to100%, while the percentage of patients in whom blood lipids was measured within the previous 2 years varied from 36% to 100%. The examination of feet and the screening for microalbuminuria were done very sporadically in many of the districts. It was observed that 8 out of the 12 districts performed these examinations on less than 50% of their patients. In one of the districts that maintained a database, the results of screening for microalbuminuria and foot examinations were not updated, resulting in an underestimation of the actual percentage of patients screened. The percentage of patients who had an eye examination within the last 2 years was only 45 %. However, results from the screening for retinopathy were not fully updated in all districts. There were significant differences between all indicators, and thus the health care management seemed to vary considerably between the districts. Most attention seemed to have been placed on measuring blood lipids, HbA1c and casual blood pressure. No districts achieved all the standards suggested in table 3.

Table 2

The quality of the management of type 2 diabetes mellitus in the districts with and without en electronic database

Indicator	The percentage of patients with T2DM who had	Districts with database N=140	Districts without database N=245	Standard	Type	P (χ 2)
Metabolic	Glycosylated haemoglobin measured within the previous year	95	69	95 %	Process	<0.001
Blood pressure	Blood pressure measured within the previous year	96	69	95 %	Process	<0.001
Blood lipids	Blood lipids measured within the previous two years	94	66	90 %	Process	<0.001
Microalbuminuria	Urine tested for microalbuminuria within the previous two years	76*	24	95 %	Process	<0.001
Eye examination	Eyes examined within the previous two years	32*	48*	90 %	Process	<0.001
Foot examination	Feet examined within the previous two years	64*	25	95 %	Process	<0.001

*The examinations were in some cases done but the results were not received from the ophthalmologist, and in some instances were not updated in the database.

Table 3

The quality of the management of type 2 diabetes mellitus among the 12 districts (1-12) in Greenland 2008

Indicator (Number of patients)	The % of patients with T2DM who had:	1 (94)	2 (46)	3 (42)	4 (51)	5 (17)	6 (11)	7 (46)	8 (23)	9 (24)	10 (10)	11 (22)	12 (54)	All 440	Stan-dard	P (χ 2)
Metabolic	Glycosylated haemoglobin measured within the last year	98	91	98	39	88	91	70	57	83	100	82	63	79	95 %	<0.001
Blood pressure	blood pressure measured within the last year	98	91	83	20	100	73	83	83	88	90	82	63	79	95 %	<0.001
Blood lipids	blood lipids measured within the last two years	96	89	95	63	76	100	91	72	96	100	36	69	83	90 %	<0.001
Microal-buminuria	urine tested for microalbuminuria within the last two years	83	60	80	31	24	0	0	30	54	0	0	50	47	95 %	<0.001
Eye exami-nation	eyes examined within the last two years	30	37	74	43	41	0	85	22	79	0	23	50	45	90 %	<0.001
Foot exa-mination	feet examined within the last two year	89	13	4	1	29	22	48	4	17	0	0	0	29	95 %	<0.001

Small and large districts performed differently as illustrated in table 4a and 4b. While no difference in monitoring HbA1c was seen (p=0.614) blood pressure was controlled more often in the small districts (p=0.018) whereas monitoring cholesterol level and screening for retinopathy (eye examination), neuropathy (foot examination), and microalbuminuria was done more often in the large districts. Both districts with a database were large districts. These two districts with documented higher quality of care (publication 1) thus contributed to some of the difference observed. After exclusion of the two districts with a database the small districts performed better than the large districts concerning monitoring of both HbA1c and systolic blood pressure whereas no difference was observed in monitoring cholesterol. In contrast, the large districts performed better concerning screening for retinopathy and microalbuminuria than the small districts whereas screening for neuropathy was hardly done in either small or

Table 4a

The quality of the management of type 2 diabetes mellitus in small and large districts in Greenland 2008.

Indicator (Number of patients)	The % of patients with T2DM in who had:	Small Districts (107)	Large Districts (333)	Standard	P (χ 2)
Metabolic	glycosylated haemoglobin measured within the last year	80	78	95 %	0.614
Blood pressure	blood pressure measured within the last year	86	75	95 %	0.018
Blood lipids	blood lipids measured within the last two years	76	85	90 %	0.027
Microalbuminuria	urine tested for microalbuminuria within the last two years	22	55	95 %	<0.001
Eye examination	eyes examined within the last two years	34	49	90 %	0.007
Foot examination	feet examined within the last two year	12	34	95 %	<0.001

Table 4b

The quality of the management of type 2 diabetes mellitus in small and large districts in Greenland 2008.

Indicator (Number of patients)	The % of patients with T2DM who had:	Small Districts (107)	Large Districts (193)	Standard	P (χ 2)
Metabolic	glycosylated haemoglobin measured within the last year	80	66	95 %	0.008
Blood pressure	blood pressure measured within the last year	86	61	95 %	<0.001
Blood lipids	blood lipids measured within the last two years	76	78	90 %	0.615
Microalbuminuria	urine tested for microalbuminuria within the last two years	22	40	95 %	0.002
Eye examination	eyes examined within the last two years	34	61	90 %	<0.001
Foot examination	feet examined within the last two year	12	13	95 %	0.841

large districts.

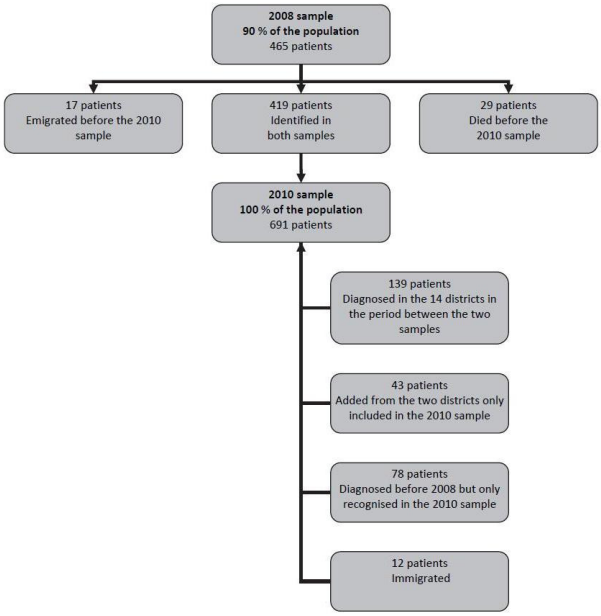
7.3 QUALITY IN THE MANAGEMENT OF DIABETES GREENLAND 2008-2010

Data were received from 14 districts representing 90 % of the whole population in Greenland in 2008. In 2010 the data was collected from the electronic medical record used in all districts and the sample thus represents the entire population of Greenland.

Four hundred and sixty-five patients with T2DM - 367 Greenlanders (207 females, 160 males) and 98 non-Greenlanders (13 females, 85 males) - were included in the 2008-sample after the exclusion of twenty-two patients with T1DM (Publication 3). Six hundred and ninety one patients — 571 Greenlanders (320 females, 251 males) and 120 non-Greenlanders (18 females, 102 males)—were included in the 2010-sample after the exclusion of thirty patients with T1DM (Publication 3).

The composition of the two samples studies are illustrated in Fig. 1.

Figure 1
The composition of the two samples.



Among the 465 patients in the 2008-sample, 29 had died and had 17 emigrated. The remaining 419 were included in the 2010-sample. The 2010-sample consists of these 419 patients plus 43 patients from the two districts not included in the 2008-sample, 12 immigrants, 139 incident cases diagnosed 2008-2010 and 78 patients that were only identified in 2010 despite have being diagnosed prior to 2008. These 78 "forgotten" patients have been enrolled in the control system in the period between the two sampling periods. Review of their medical records showed that these patients had not been included in the 2008 sample because they had not been seen regularly in the clinics (process indicators varied from 0 % concerning eye foot and urine examination to 13 % for lipids, 14 % for HbA1c and 22 % for blood pressure).

These 78 patients were included in the estimation of prevalence of diagnosed T2DM but excluded from estimation of quality indicators concerning 2008. The 2008 prevalence of diagnosed T2DM calculated in 2010 (Publication 3) was thus higher than the prevalence calculated in 2008 (Publication 1) where the "forgotten patients" obviously were not included.

Process and treatment indicators

As shown in table 6 all process indicators showed improvement from 2008 to 2010.

The process indicators were very high in both large and small districts and also in the settlements in the 2010-sample (table 7). The most striking difference observed was that patients in the settlements where less likely to have been screened for microalbuminuria (81 % vs. 63 %, p<0.001). Patients in the settlements were more likely to be treated with aspirin than in the towns (63 % vs. 49 %, p=0.017). Otherwise no difference was observed concerning the treatment indicators

Biological indicators

The biological indicators are illustrated in table 8 and 9. The proportion of patients with HbA1c below 7 % and systolic blood pressure below 130 mmHg increased from 2008 to 2010 whereas the proportion of patients with total cholesterol below 4.5 mmol/l and LDL cholesterol below 2.5 mmol/l had decreased.

The proportion of patients with systolic blood pressure below 130 mmHg was higher in the large districts than in small districts and higher in the towns than in settlements. This could indicate a better treatment in larger districts. No difference in use of ACE-inhibitors or ArB was however observed (table 7). On the other hand, the proportion of patients with LDL cholesterol below 2.5 mmol/l was higher in large towns than in small towns (table 9).

Table 6

Process and treatment indicators in the management of T2DM in Greenland 2008 and 2010 (n.d.=No data).

Process indicator	The % of patients with T2DM who had	2008 sample N=465	2010 sample N=691	P
Metabolic	Glycosylated haemoglobin measured within one year	81	93	<0.001
Blood pressure	Blood pressure measured within one year	82	93	<0.001
Blood lipids	Blood lipids measured within two years	79	91	<0.001
Micro-albuminuria	Urine tested for microalbuminuria within two years	44	80	<0.001
Eye examination	Eyes examined within two years	45	80	<0.001
Foot examination	Feet examined within two year	32	84	<0.001
Treatment indicator	**Agent prescribed within the last two years**			
Thrombo-prophylaxis	Aspirin 75 mg	n.d.	51	
Blood lipids	Lipid lowering agent	n.d.	74	
Hypertension	ACE-inhibitors or ARB*	n.d.	66	

*ArB: Angiotensin II receptor blocker

Table 7

Process and treatment indicators in the management of T2DM in large and small districts and in towns and settlements Greenland 2010.

Process indicator	The % of patients with T2DM who had	Large Districts 2010 N=490	Small Districts 2010 N=201	P	Towns 2010 N=612	Settle-ments 2010 N=79	P
Metabolic	Glycosylated haemoglobin measured within one year	91	96	0.029	92	97	0.080
Blood pressure	Blood pressure measured within one year	93	93	0.835	93	99	0.041
Blood lipids	Blood lipids measured within two years	90	94	0.077	93	90	0.703
Micro-albuminuria	Urine tested for microalbuminuria within two years	83	73	0.001	81	63	0.000
Eye examination	Eyes examined within two years	78	86	0.023	85	72	0.057
Foot examination	Feet examined within two year	86	81	0.109	86	75	0.015
Treatment indicator	Agent prescribed within the last two years						
Thrombo-prophylaxis	Aspirin 75 mg	52	47	0.254	49	63	0.017
Blood lipids	Lipid lowering agent	75	71	0.698	73	78	0.223
Hypertension	ACE-inhibitors or ARB*	66	66	0.737	65	73	0.055

*ArB: Angiotensin II receptor blocker

No difference in use of lipid lowering agents was observed (table 7). No information about dietary habits was available.

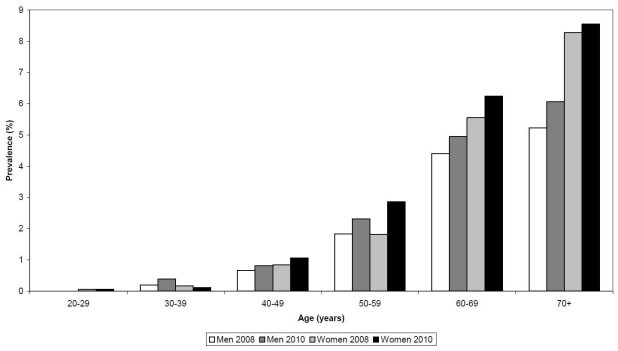
7.4 PREVALENCE OF DIAGNOSED TYPE 2 DIABETES MELLITUS 2008-2010

Four hundred and sixty five patients with T2DM was included in the 2008-sample and 691 patients was included in the 2010-sample, see table 6 (Publication 3).

The age and gender specific prevalence in 2008 and 2010 are shown in Fig.2.

Figure 2

Age and gender specific prevalence af T2DM amog Greenlanders in 2008 and 2010.



The prevalence increased in almost every age group for both genders. The total prevalence increased from 2.3 (95%CI: 2.1; 2.5) % in 2008 to 2.7 (95%CI: 2.5; 3.0) among Greenlanders aged 40 years old or above (p=0.006) corresponding to an increase of 19 % or almost an annual increase in prevalence at 10 %.

8. DISCUSSION

The prevalence of diagnosed cases T2DM among Greenlanders has increased over a period of two years. In the same period a significant increase in the quality of care in diabetes in Greenland has been documented concerning all process-of-care indicators. Significantly regional variation in the diabetes care was demonstrated in 2008. The quality in the diabetes care was best in districts with a database. In 2010 a more homogenate quality among the districts in the diabetes care was demonstrated. These effects could be a result of the diabetes programme implanted in between the two observations. Aspects of the sub analysis are discussed in detail below.

8.1 QUALITY IN THE MANAGEMENT OF T2DM IN DISTRICTS WITH AND WITHOUT DATABASE IN 2008

The quality in the management of T2DM based on process-of-care indicators was significantly higher in districts with an electronic database than those without. This suggests that a database was a valuable tool for use in the districts to improve the quality of diabetes care. However, the existence of a database or its lack was probably not the only difference between the districts. Most likely the use of a diabetes database was also accomplished of increased awareness of diabetes care which may have influenced the results positively in districts with a database. The results, however, also demonstrated the limits of a database when it was not properly updated; in which case the quality reported was lower than the factual quality.

The quality of diabetes care have also been affected by the of electronic diabetes registers in other studies. The use of a diabetes registry was one of the tools in the Special Diabetes Program in Alaska that was associated with improvements in process-of-care and biological indicators [56, 57, 72]. Recently the mortality and complication rates have also been reported to decline among Alaska Natives as a result of the Special Diabetes Program in Alaska [57].The use of planned diabetes care and a diabetes electronic management system in primary health care sites in the USA was also associated with improvements of process-of-care indicators [94]. Even in rural areas benefits from electronic registers seem realistic. Thus, the use of a basic electronically register has also recently been demonstrated to improve diabetes care in rural areas in West Virgina, USA [95].

A report from the Danish National Register has demonstrated a 40 % decrease in mortality among patients in the three year after inclusion in the registry [84] which may reflect benefits from initial diabetes treatment [84].

In conclusion, the quality of the management of T2DM could be improved by the use of an electronic database when it was properly updated. Implementation of a database was desirable in all the districts in Greenland but idealistically as an integrated part of the electronically medical record to avoid double registration of results and consequently risk of a not updated database.

Table 8

Biological indicators in the management of T2DM in Greenland 2008 and 2010.

Biological indicator	The % of patients with T2DM and available data in whom/ who had		2008 sample	2010 sample	N (2008+2010)	P
Metabolic	Glycosylated haemoglobin	< 7%	44	57	1018 (378+640)	<0.001
		> 9%	20	13		0.004
Blood pressure	Systolic mmHg	< 130	33	39	1029 (384+645)	0.032
		> 150	21	18		0.336
Blood pressure	Diastolic mmHg	< 80	48	48	1029 (384+645)	0.976
		> 90	12	10		0.352
Cholesterol	Total mmol/l	< 4.5	44	29	995 (366+629)	<0.001
		> 6.0	17	29		<0.001
Cholesterol	LDL mmol/l	< 2.5	47	29	877 (336+541)	<0.001
		>3.5	21	40		<0.001

8.2 QUALITY IN THE MANAGEMENT OF T2DM IN 12 PRIMARY HEALTH CARE DISTRICTS 2008

The quality of the management of T2DM in Greenland 2008 could be described based on process-of-care indicators. Great variation in the quality of the management was observed. Monitoring the patient's HbA1c, blood pressure and blood cholesterol was done routinely in most districts. Screening for diabetic retinopathy seems to have been implemented, but the records were not updated, whereas screening for microalbuminuria and foot examinations clearly were not routinely done in most clinics. However, differences in all process-of-care indicators were demonstrated among the districts. The great variability between the 12 districts indicated that it was realistic to improve the general management of T2DM in Greenland. The variability could partly reflect the geographical differences and regional strategies in the health care system. Diabetes was a relatively new disease in Greenland, and focus may have been more intense on other major health issues, such as tuberculosis and other infections, sexually transmitted diseases, cancer, psychiatric diseases, high rates of suicide and other acute medical conditions. However, shortage of medical staff, lack of a national diabetes program and lack of electronic diabetes registers are likely to play a role in the great variability. Monitoring the quality of management for diabetes and the possibility of improving care as a result of better management have only been evident in 2 districts.

Major variability between the medical facilities has also been reported in the Alaska Area Diabetes Program [96]. The best facilities were more likely to use an organized multidisciplinary team approach that included coordinated clinic appointments with multiple providers on the same day, maintenance of a diabetes registry, flow sheet use, intensive individual nutritional counselling, a case manager coordinator system with standing orders and strong self management support [96].Variability between rural and urban diabetes populations have also been reported in the U.S. Large rural towns provided the best diabetes care compared to small rural towns and urban areas [97]. However, in other studies no differences were observed in diabetes care between urban and rural areas. Thus, only a few differences were found regarding the quality in the diabetes care among American Indians and Alaska Natives between urban and rural health care sites [98]. Organisation of the diabetes care seemed to play an important role for the quality of the care. Improvements in diabetes care were thus realistic, even in several small local facilities [56, 99-104].

The management of T2DM thus represented a major task for the heath care system in Greenland in 2008. While the blood pressure, HbA1c and blood cholesterol was relatively adequately monitored but with enormous variability, screening for microalbuminuria and foot examinations was hardly implemented in many clinics. It was recommended that the implementation of a national strategy based on national guidelines, local diabetes registers and feedback to the districts be started immediately. These initial observations from 2008 were used in the process of creating a diabetes programme in Greenland.

8.3 QUALITY IN THE MANAGEMENT OF DIABETES GREENLAND 2008-2010

This study has demonstrated a significant improvement in all six process-of-care indicators over a relative short period despite challenges with a geographically widely spread population, arctic climate and shortage of health professionals. The health care system seemed however to be very adaptable and the relative

Table 9

Biological indicators in the management of T2DM in Greenland 2008 and 2010.

Biological indicator	The % of patients with T2DM and available data in whom/who had		Large Districts 2010	Small Districts 2010	N	P	Towns 2010	Settlements 2010	N	P
Metabolic	Glycosylated haemoglobin	< 7%	57	57	640	0.926	56	61	640	0.415
		> 9%	13	13		0.926	14	10		0.425
Blood pressure	Systolic mmHg	< 130	44	28	645	0.000	41	27	645	0.018
		> 150	15	26		0.001	18	21		0.372
Blood pressure	Diastolic mmHg	< 80	49	44	645	0.205	48	47	645	0.952
		> 90	11	6		0.327	13	9		0.330
Cholesterol	Total mmol/l	< 4.5	30	25	629	0.173	27	39	629	0.032
		> 6.0	29	29		0.956	29	27		0.624
Cholesterol	LDL mmol/l	< 2.5	32	23	541	0.038	28	37	541	0.178
		>3.5	39	43		0.402	40	42		0.843

small population as well as access to free prescribed drugs certainly facilitate the diabetes care too.

Process indicators

The quality of diabetes care in Greenland 2008 were comparable to the levels reported in older American Natives and Alaska Natives in 2004 [100, 105-106]. However, the monitoring was of a lower quality than reported more recently in the follow-up study after implementation of the Special Diabetes Program for Indians [56]. Screening rates after implementation of the Special Diabetes Program for Indians were within 12 months: 85% (lipid profile), 67% (foot exam) and 56% (eye exam) [56] compared to screening rates in this study at 91 %, 84 % and 80 % within 24 month. The improvement of process-of-care indicators demonstrated in this study was thus very high and comparable with the improvements followed by the Special Diabetes Program for Indians in Alaska based on a patient registry, standardized guidelines and annual feedback to the clinics [56]. .

As part of the Danish National Indicator Project an annual audit on diabetes care in the primary and secondary health care system was published [90]. The most recent results cover the same observation period (2009) as the present study (Publication 3). Identical process-of-care indicator for the primary health care sector (general practice) in Denmark 2009 showed that 95 % of the patients with diabetes had their HbA1c level and 86 % their blood pressure measured within the last year, whereas 96 % had their lipid profile monitored within the last two years [90]. Screening for retinopathy and microalbuminuria was done in 48 % and 53 % whereas 93 % had their feet examined within the last two years [90]. Patients followed in the secondary health care sector (outpatient clinics affiliated to a department of endocrinology) scored somewhat higher : 97 % (HbA1c within a year), 92 % (blood pressure within a year), 92 % (lipid profile within two year), 88 % (eye examination within two years), 88 % (urine analysis within two years) and 89 % (foot examination within two years) [90]. The results presented in this study was thus almost at the level for secondary sector and much better than for the primary sector concerning screening for retinopathy and microalbuminuria [90]. However, the results are not fully comparable since the results demonstrated in this study cover all primary health clinics in Greenland whereas only 10 % of the primary health care facilities in Denmark who have voluntary participated in the monitoring are represented in the Danish results [90]. In a very recently published article concerning patients referred from the primary to the secondary health care system in Denmark the screening rates was 61 % for eye examination and 53 % for microalbuminuria within 2 years [107].

The level of process-of-care indicators in the primary health care in Greenland in 2010 are thus comparable and for some indicators even better than in Denmark.

Biological indicators

However, in some studies implementation of guidelines and organizational improvement has primarily improved the process-of-care indicators rather than the biological indicators [108]. Biological indicators could not be expected to change much in a relative short observation period of two years. However, the proportion of patients with HbA1c below 7.0 % increased significantly which may be a result of a more focused treatment. The lower diagnostic cut off may also have contributed to diagnose patients with lower HbA1c.

However, also in England the proportion of patients with HbA1c below 7.5% increased from 39.7 % to 52.1 % from 2006 to 2008 after implementation of a quality and outcome framework (QOF) [109].

The proportion of patients with systolic blood pressure below 130 mmHg has also increased significantly from 32 % in 2008 to 39 % for the whole population in Greenland, which is comparable to the 37 % reported after implementation of the Special Diabetes Program for Indians 2000-2004 [56]. This proportion seem comparable with the most recent result form the primary health care sector in Denmark where the median systolic blood pressure was 134 mmHg with 25 % and 75 % percentiles at 125 mmHg and 141 mmHg [90].

Treatment of hypertension is essential in the management of T2DM in order to prevent micro- as well as macrovascular complications [110-113] and the achieved improvement may thus have long term effects.

Surprisingly, the lipid profiles have deteriorated during this period. Before 2008, the measurements used to be taken on a fasting patient, but this requirement has been gradually loosened. LDL cholesterol used to be calculated using the Freidewald formula [114] whereas, in the autumn of 2007, a direct method for quantification of LDL cholesterol was introduced. However, this was only likely to explain a minor quantity (if any) of the difference observed. Since control of blood lipids and treatment with lipid lowering agents is essential for patients with T2DM [115], increased focus on exploring the compliance to the lipid lowering treatment needs attention.

No information about the use of lipid lowering agents in 2008 was obtainable and no information about possible dietary changes was available.

Large and small districts

The high quality of diabetes care at the end of this study was demonstrated in small as well as in large districts. Even in the settlements with the expected lowest level of health care service very high screening rates was demonstrated. Screening for microalbuminuria was the only indicator that was lower in the settlements than in the towns which may be explained by the lack of possibility to perform the analysis locally. As discussed above (8.2) diabetes care can be improved even in small rural areas. The organisation of the diabetes care seems to be very important since this is the most obviously change from 2008 to 2010.

Improvements in diabetes care

Improvement of diabetes care indicators for primary health care patients after implementation of different kind of chronic care models has been observed in several recent studies worldwide [94, 116-130] in addition to the special diabetes program in Alaska [56-57, 72] and the Canada [74-76].

A review including 68 randomised control studies and controlled before-and-after studies were selected to evaluate improvement of diabetes care in primary health care settings [131]. Forty-five studies evaluated the effect of any intervention on HbA1c. Seventeen studies presented a significant improvement in HbA1c. Nine out of 27 studies evaluating cholesterol, blood pressure and HbA1c showed a significant improvement in at least two of these factors. Audit and feedback on performance, clinical decision support systems, multi-professional teams and patient education seemed to be successful strategies [131]. However, the methodological quality of many studies was still poor and the potential of primary health care of patients with diabetes may still be underestimated [131].

An ongoing randomized trial in Switzerland is addressing this problem [132]. The researchers challenged the hypothesis that

the Chronic Care Model can easily be implemented by practice nurse focused approach [132].
In conclusion, we have demonstrated improved quality in the diabetes care in Greenland. The combined effect of a diabetes concept introduced in this diabetes programme in Greenland based on national guidelines, an electronically record with possibilities of a diabetes registry and feed back to the districts are most likely reason for the improved quality demonstrated in a two year period.
It is strongly recommended to maintain focus on quality on the diabetes care in order to benefit from the programme in a long term perspective.

8.4 PREVALENCE OF DIAGNOSED TYPE 2 DIABETES MELLITUS 2008-2010

The prevalence of diagnosed T2DM increased 19 % in a period of just two years.
Increasing prevalence principally can reflect increasing proportion of older people in the population, increasing surveillance of patients with T2DM, increasing detection rate or increasing incidence in the population. However, the age distribution in Greenland has not changed radically from 2008 to 2010. Furthermore the increase was observed in almost every age group. Increased surveillance among patients are not likely to change must in just two years of observation although decreasing mortality has been observed after inclusion in a diabetes register [84]. This increase in prevalence of T2DM among Greenlanders in Greenland may thus predominantly reflect an increasing detection rate, although an increasing incidence may also have contributed. Repetitive systematic, population-based screening surveys would however be needed to determine the relative contribution of each of these two factors. The decrease of diagnostic cut off can also be part of the explanation for an increased detection rate (see methods). It is important to underline that the diagnosed cases have been identified by case finding among patients in the health care system using fasting whole blood glucose as screening tool whereas no systematic screening procedure have been done. This indicates that the number of undiagnosed patients probably still was very high in Greenland. The recently proposed possibility of using HbA1c as a screening and diagnostic tool would probably facilitate the diagnostic procedure and thereby increase the detection rate in Greenland [133-135].
The situation in Greenland with high prevalence of diabetes (mainly undiagnosed) reported from population surveys [9] based on oral glucose tolerance test and a relative low but increasing detection rate (and correspondingly low prevalence of diagnosed diabetes) was very similar to the situation reported in Alaska during the mid 1990ies [20]. The incidence and prevalence was recently reported to steadily increase [57] and the largest increase occurred from 1999 to 2001 where case-finding activity increased as a consequence of increased diabetes funding [57] similar to the present situation in Greenland. Likewise, a further increase in both prevalence and incidence in Greenland must bee expected and has also been predicted [28]. Thus, with a prevalence of diagnosed diabetes at 2.7 % (95%CI: 2.5; 3.0) among Greenlanders aged 40 years old or above in 2010 compared with 3.4 % among Inuit in Alaska 2006 [28], Greenland still seems to lack temporarily behind Alaska in time. Unfortunately, Greenland seems to follow the same tendency as in Alaska and as in the rest of the world where the number of patients has doubled since 2000 now affecting 285 million people worldwide [136].
Recently the prevalence of gestational diabetes mellitus in Greenland has been reported low and it was concluded that Greenland was lacking temporarily behind the world in time concerning the wide epidemic of diabetes mellitus [137].
Lifestyle changes thus also in Greenland seem to be responsible for the increasing prevalence of diabetes in Greenland [6-7]. Population surveys have documented an increased prevalence of overweight among adult Greenlanders from 1993 to 2007 (predominantly among females) [6-7]. During the last three decades increasing overweight has also been documented among children in Greenland [8, 138]. The prevalence of metabolic syndrome was also reported high (17.9 % -20.7 % depending on definition used) among adult Greenlanders [139]. Furthermore, the same association among obesity and abnormal glucose metabolism was demonstrated between Greenlanders and Danes although Greenlanders had lower levels of metabolic disturbances than Danes at the same level of obesity [140].
The increasing prevalence of T2DM in Greenland also raises the concern for increasing prevalence of micro- and macrovascular complications to diabetes. Inuit in Alaska were at higher risk of cerebrovascular events but lower risk of ischemic heart disease than Indians [57]. Ischemic stroke has been reported common among young Greenlanders [16, 141-143] and thus Greenlanders may be prone to cerebrovascular complications too. Recently microvascular and macrovascular complications rates among Greenlanders and Danes with T2DM living in Nuuk, Greenland, have been reported similar but for the macrovascular events the low power in the study did not allow a final conclusion [144].

Coronary heart disease was almost not observed 50 years ago in Greenland [145] and a recent evaluation of ECG performed in the east Greenland population in 1963 documented low occurrence of ischemic heart disease [145]. The low prevalence of ischemic heart disease among Inuit led started the hypothesis of the benefits of lipids in the marine diet [146-148]. A theory that has been questioned in recent years [149] since Inuit with high consumption of omega three fatty acids also got heart disease. There was thus no association between current omega-3 fatty acids consumption/blood concentrations and the presence of coronary heart disease [149]. Analysis of the ECG performed in Greenland showed left ventricular hypertrophy with a peak at 30 years old male and with no relation to blood pressure level [150]. This could reflect high physical activity among Greenlanders 40 years ago [150]. High physical activity was also observed among the Inuit in Alaska 50 years ago [31].
It is plausible that the Inuit in Greenland used to be much more physically active than to day and this might be part of the explanation for the increasing prevalence of obesity and diabetes seen in Greenland. Thus, Greenland could benefit from lacking temporally behind the rest of the world in time concerning the diabetes epidemic.
Several initiatives have been taken to increase awareness and prevention of T2DM in the health care system, in the general population and among patients and relatives affected by T2DM (see section 10).
The special diabetes programme in Alaska was also accompanied with primary prevention initiatives to increase physical activity levels and promoting healthy nutrition [72] like “10.000 steps”, school-based physical activity programs etc. This may have a long or short term effects on prevalence and incidence of diabetes. Both the prevalence and incidence of diabetes has however steadily been increasing and the epidemic was thus not under control [57]. In the whole world the epidemic of diabetes seems to bee out of control. The number of people with diabetes has more than doubled from 2000 to 2010 to 285 million [136].

The recently held 70th Scientific Sessions meeting of the American Diabetes Association in Orlando Florida resulted in a special issue of The Lancet on diabetes (136, Lancet 2010). The editor concluded that the glaring absence of research on lifestyle interventions was problematic and continued: "In this respect, medicine might be winning the battle of glucose control, but is losing the war against diabetes" [136]. To lessen the burden of diabetes requires a substantial change in diet and routine [136]. The fact that type 2 diabetes, a largely preventable disorder, has reached epidemic proportion is a public health humiliation [136]. World leader were encouraged to reflect on these challenges and initiate a debate on a more inclusive and effective strategy to control diabetes [136].
Increased awareness of healthy lifestyle and political willingness to support preventing initiatives in Greenland are certainly important. However, in order to reduce the incidence and prevalence of diabetes a new radical strategy including several aspects of daily routines is urgently needed.

9. CONCLUSION IN SUMMERY

Hypothesis 1

The quality of the management of type 2 diabetes mellitus was higher in districts with than without a database in 2008.

Hypothesis 2

The quality in the diabetes care showed extensive variability among districts in Greenland 2008.
Monitoring HbA1c, blood pressure and blood cholesterol was done routinely in most districts. Screening for diabetic retinopathy seems to have been implemented, but the records were not updated, whereas screening for microalbuminuria and foot examinations clearly were not routine.

Hypothesis 3

All six process-of-care indicators improved, documenting that the organisation of care has improved from 2008 to 2010. Furthermore both HbA1c and systolic blood pressure improved indicating improved care, but in the same period a significant deterioration in lipid-levels was observed.

Hypothesis 4

A significant increase in the prevalence of diagnosed T2DM has been observed in the period from 2008 to 2010.

10. INITIATIVES TAKEN TO HIGHLIGHT AWARENESS AND PREVENTION ASPECTS WITHIN THE PROGRAMME

Awareness and prevention in the health care system

Awareness of diabetes mellitus in the health care system has been promoted in many ways.
First of all the whole implementation of the diabetes programme including distribution of national guidelines in paper form, via an intranet for health care professionals and through courses for different health care professionals and feedback and continuously information to the primary health care centres through letters and with articles about diabetes in every ordinary publication of Puilasaq (This is a newsletter for health care professionals in Greenland with 3-4 annual publications) [151].
Health care professionals from 15 (Qaanaq, Upernavik, Ummanaaq, Ilulissat, Qeqertarsuaq, Qasianguit, Aasiat, Sisimiut, Manitsoq, Nuuk, Paamiut, Qaqortoq, Narsaq, Nanortalik and Taasilaq) out of the 16 health care districts have participated in the two first courses held in Nuuk November 2008 and October 2009.
A course in diabetes for health care professionals with shorter education (typically employed in the small health care settlements) was held in Nuuk March 2010 with 11 participants.
Three articles has been published in Nakorsanut (Published by the local Assembly of Physicians in Greenland) in the period 2009-2010: one about smoking cessation, two about quality monitoring and developing systems concerning diabetes care in Greenland [152-154].
Results from the initial studies have been presented on a conference for all leaders in the public health care system of Greenland with participation of the Minister for Health affaires (February 2009 and August 2010).
These initial results have also been presented at a public meeting in The Society for Greenlandic Medicine [155] in Nuuk March 2009 and at NunaMed (a medical congress for Greenlandic Health issues) [156] September 2010 in Nuuk. Lectures for local health workers about diabetes and the diabetes programme have been held at several occasions both in the primary and secondarily health care system and in Nuuk and Sisimiut.

Awareness and prevention in the general population

Several articles about diabetes, healthy lifestyle and lifestyle diseases like obesity, cardiovascular diseases and diabetes has been published in the National and local Newspapers in Greenland.
Of those around ten articles has been published as a result of activities from the DiabetesGroup including research, teaching, events etc.
These activities has also resulted in both interviews and comments in radio and television in KNR (the national public radio and television of Greenland) and in Nuuk local television.
Awareness of diabetes in the general population has also been promoted by several events and arrangements including the so called Cultural Night in Nuuk (held annually in January) where information about diabetes was given including the possibility of a blood glucose test.
The international diabetes (The 14th of November) day was also celebrated annually with diabetes events including information and blood glucose test. In 2008 the celebration resulted in an initiative for a local assembly for patients with diabetes in Nuuk. A general assembly was hold in April 2009.
In 2009 the minister for health joined the diabetes day celebration in Nuuk.

The Diabetes Group participated in another important event "Gør Maj Sund" [157] - Do May Healthy (which is pronounced the same way as "Do Me Healthy") initiated on a private basis in Nuuk in 2007 with daily free of charge events for all citizen promoting different kind of physical exercise during the month of May. The number of participants whom participated in the events has grown from around 2000 the first year to more than 16.000 in 2010 in Nuuk alone. "Gør Maj sund" was in 2010 adapted in other towns (Aasiat, Sisimiut and Qaqortoq) of Greenland too. The huge number of participants in this private initiated event also demonstrated a possible synergy effect in joint venture programmes with private and public actors
To keep focus on physical activity after "Gør Maj Sund" 2009 a pilot project "Tour de Greenland" was introduced in Nuuk by the DiabetesGroup. Participants allocated to the tour as teams and based on pedometers they reported their distance weekly to the DiabetesGroup. The purpose was then for the team to "walk from Qaanaq in Northwest Greenland via South Greenland ending in Ittorqotomiit in Northeast Greenland" – a distance of 3823 km.

The tour became an overwhelming success and a total of 610 persons completed the mission during the period July to September 2009. The average participant increased their walking distance with approximately one kilometre a day. The pilot project has been followed up as Nunawalks and participating through a website (www.Amisut.gl) allow participants from all over Greenland to join the different tours [158]. The website also provides information in both Greenlandic and Danish about healthy lifestyle. The website continuously keeps the focus on the many possibilities for healthy lifestyles activities in Greenland.

Teaching

In addition to teaching health care professionals as mentioned above there has been held a number of lectures in institutions (old people's home, high school in Nuuk and some companies).
In corporation with the local health care worker in Nuuk initiatives has been taken to promote healthy lifestyle among children. First of all common advises concerning the dietary and physical activity habits were incorporated in the home visit to families with 2½ year old kids. Secondly, an appointment book with focus on possible life stile changes for pupils was introduced as a tool for healthy lifestyle dialogs.
Thirdly, a theme week including teaching healthy diet and use of pedometers was introduced among pupils in the Fourth class (10 years old) in all schools in Nuuk, which resulted in heavily physically activity at least for the week they were monitored.
In corporation with The National Board of Prevention - Paarisa [159] - an education programme concerning nutrition directed to public school teachers and workers in institutions for school children has been developed and so far two out of the four counties have received the programme.

Awareness and prevention among patients

During the diabetes program several initiatives for patients and their relatives have been directed. A free of charge Greenlandic (and Danish) information book concerning T2DM for patients and relatives have been published and distributed to all districts in Greenland.
A one day diabetes education for patients and relatives have been developed in Nuuk and around ten courses has so fare have been held in Nuuk. In addition to that the education program was available on the intranet and could be used locally by health care professionals after participating in the diabetes courses mentioned above. The Diabetes Group has however also been travelling around and education for patients and relatives has been held in most districts of Greenland (Taasilaq, Nanortalik, Narsaq, Qaqortoq, Paamiut, Ilulissat) and in Aasiat, Qeqartarsuaq, Qaasianguit and Sisimiut by local health care workers.

The guidelines and the systematizes approach to the diabetes care was eased after equipment of the local districts with DCA-Vantage [87] which in addition to measurement of HbA1c also allows screening for microalbuminuria (U-ACR). Screening for neuropathy was strengthened by employment of a state registered chiropodist located in Nuuk but travelling to each district with ten or more patients within a two year period. She has thus visited 14 out of 16 districts (including Nuuk) and in addition to examinations of patients she taught the local health care professionals about the foot examination procedures.
Screening for retinopathy used to be done by travelling ophthalmologist but in Nuuk a photography of the retina with a special camera (Zeiss) has been implemented as a routine and eye examinations was thus performed locally since 2008 which has simplified the screening for retinopathy dramatically.

Governmental awareness

Politically the public health issue seems to be very important. A national public health programme - Inuuneritta, [160] -with different targets concerning the public health 2007-2012 was lanced including purposes to achieve healthier diet and exercise patterns and reducing smoking rates.
The minister of health care in Greenland has in 2009 initiated the establishment of so called lifestyle centres which should be a part of the health care service in Greenland promotion the preventive and health promoting medicine. The lifestyle centres should be based on activities to identify persons at risk for lifestyle diseases, motivating to a healthier lifestyle and further systematize the health care of chronic diseases within the health care system.

11. PERSPECTIVE

Despite many challenges including a geographically widespread population shortage of health care professionals in Greenland the diabetes care has improved enormously in just two years. The awareness of diabetes and lifestyle related diseases have increased in the general population, in the health care system, among patients and among politicians. This allows some kind of optimism in a country facing the beginning of the obesity epidemic seen worldwide. A special effort can provide results in Greenland too.
The rapid increase in prevalence of diagnosed T2DM demonstrated in this study indicates that the number of undiagnosed patients with diabetes is still high which raises the question where the recently proposed possibility of using HbA1c [133-135] as a screening and diagnostic tool should bee implemented in Greenland instead of examination whole blood glucose with Hemocue® on fasting patients (not recommended by internationally WHO [26]. This would probably facilitate the diagnostic procedure and thereby increase the detection rate in Greenland further [133-135].

Prevalence of overweight and obesity had increased during the last three decades among all age groups [6-8]. The prevalence of overweight among pregnant women has recently been reported high, and the low prevalence of GDM demonstrated in the same study probably only indicates that Greenland is lagging temporarily behind the diabetes epidemic seen world-wide. The decreasing but still very high prevalence of smoking [6-7] only underlines the need for awareness of and action against unhealthy lifestyle trends.

The lesson from this diabetes programme in Greenland could be used to organize, systematize and optimize care of other chronic diseases like diagnosed hypertension and chronic obstructive lung disease in Greenland. The combination of national guidelines, systematized recording in the electronically medical record and feed back to the clinics has proven effects on the quality of the health care. To ensure a long term effect of the programme focus on both diabetes care and management of other chronic diseases needs continuous attention.

The need for a national strategy for prevention and health promotion is urgently needed. The national board of prevention (Det Nationale Forebyggelsesråd) in Denmark [161] has recently published a strategy based on three key elements: Health in daily life,

specific prevention and early awareness risk factors including early diagnosis of chronic diseases and finally the systematized management of the chronic diseases. While the two last elements show obvious similarities with the parts of the diabetes programme described in this thesis the first element represents a broader society based issue that needs political attention. To prevent and reduce lifestyle related health problems on a population basis and to reduce the health inequalities the health politics needs to make the healthier chooses easier and cheaper than the unhealthy chooses. The individuals certainly has a responsibility for own lifestyle. However, in order to reduce lifestyle related health problems and social inequalities in health in the population structural changes in the society are needed.
Prevention and health promotion is a question of the environment and context that surrounds the individuals so that health is not only based on self-discipline [161]. The potential for example daily physical activity for all age groups does not seem to be fully explored or implemented. The increased awareness of health issues in the general population as well as among politicians underlines the hope for good initiatives in the near future.

The consequences of unhealthy lifestyle in a population are seen with a delay of several years and through the intrauterine environment probably transited to the next generation. Thus efforts to optimize the living conditions for children much have high priority including focus on gestational diabetes mellitus. To change direction of a floating ice berg strong efforts and patience are needed.

12. FUTURE RESEARCH

The results represented in this thesis demonstrated radical short term effects of a national diabetes programme in Greenland. However, the question on long term effects is present. The prevalence of diagnosed diabetes as well as complications to diabetes in Greenland is likely to further increase for many years as seen among Inuit in Alaska and Canada. To monitor complication and mortality rates among patients with diabetes a national diabetes database for Greenland should be established.
Monitoring available indicators of the lifestyle in the society in order to evaluate the preventive initiatives are a research area that needs to be explored and prioritized. Annually follow up on for example proportion of overweight among children at school entrance would allow decision makers to evaluate the preschool health promotion initiatives. Many other already available data could be used to follow the population health in a systematized way allowing evaluation of the preventive initiatives in order to produce evidence for the prevention and to adjust initiatives when needed.
The growing proportion of overweight among children in Greenland [8] raises the question of undiagnosed diabetes among children in Greenland as seen in among indigenous people in Canada where the diabetes epidemic is still in the upswing and also show trends of younger diagnosed people [54] and where the epidemic of obesity among Inuit children is still running [163].
The prevalence of autoimmune diabetes among Greenlanders is unknown. This could be explored in order to optimize individual treatment recommendations as well as directing preventive initiatives since this kind of diabetes are not preventable in the way T2DM is.
Prevalence and quality in the management of many other chronic diseases in Greenland like diagnosed hypertension and chronic obstructive lung disease represents important unexplored research areas.
The health care system in Greenland represents a major financial burden for the whole society despite being cheaper than many other countries in the western world. In order to use the resources in the best way initiatives to secure and monitor health care issues and health care services seems highly important needed.

13. ENGLISH SUMMARY

Fifty years ago type 2 diabetes mellitus was very rare in Greenland. Recent epidemiological studies have found a high prevalence of diabetes among Greenlanders comparable to levels among Inuit populations in Canada and Alaska.
In 2008 a national diabetes programme was implemented aiming to improve the care for patients with type 2 diabetes mellitus in Greenland based on a donation from Novo Nordisk A/S to the national health care service. A diabetes concept based on national guidelines, systematized recording in an electronically medical record and feedback to the clinics were used to improve the diabetes care.
The overall aim of this thesis was to evaluate if implementation of a diabetes programme in Greenland would have a measurable effect on the quality in diabetes care including diagnostic activity and screening for diabetic complications.
Two observational and cross sectional studies were performed in Greenland 2008 and 2010 before and after implementation of the diabetes programme.
The medical records of patients with diabetes were reviewed. The prevalence was estimated using the whole adult population in Greenland as background population. The quality of the diabetes care was monitored by 12 health care indicators.
The prevalence of diagnosed cases with type 2 diabetes mellitus among Greenlanders has increased over a period of two years. In the same period a significant increase in the quality of care in diabetes in Greenland has been documented concerning all process-of-care indicators. Significantly regional variation in the diabetes care was demonstrated in 2008. The quality in the diabetes care was best in clinics with a database. In 2010 a more homogenate quality among the clinics in the diabetes care was demonstrated. These effects could be a result of the diabetes programme implanted in between the two observations.
In conclusion, improved quality in the diabetes care along with an increasing prevalence of diagnosed type 2 diabetes mellitus has been documented after implementation of a diabetes programme. It is strongly recommended to maintain focus on the quality on the diabetes care in order to benefit from the programme in a long-term perspective.

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