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RESEARCH ARTICLE

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Burden of selected chronic non-communicable diseases in a primary healthcare setting in Nuuk, Greenland, compared to a Danish suburb

Marie Balslev Backe^{a,b,c} , Per Kallestrup^{d,e,f}, Kurt Rasmussen^d, Marit Eika Jørgensen^{a,c,g}  and Michael Lyng Pedersen^{a,b} 

^aSteno Diabetes Center Greenland, Nuuk, Greenland; ^bGreenland Center for Health Research, Institute of Health and Nature, University of Greenland, Nuuk, Greenland; ^cSteno Diabetes Center Copenhagen, Herlev, Denmark; ^dSkødstrup Lægepraksis, General Practice Clinic, Skødstrup, Denmark; ^eResearch Unit for General Practice, Aarhus, Denmark; ^fDepartment of Public Health, Center for Global Health, Aarhus University, Aarhus, Denmark; ^gCenter for Public Health in Greenland, University of Southern Denmark, Copenhagen, Denmark

ABSTRACT

Introduction: Noncommunicable diseases (NCDs) constitute a massive global burden and are the leading cause of death and disability worldwide. In Greenland, the prevalence of NCDs has historically been low. However, during the past approximately 70 years, life circumstances have changed dramatically resulting in increased life expectancy. Today, the proportion of inhabitants in Greenland ≥ 65 years has nearly tripled since the 1980s, and the prevalence of obesity and diabetes has increased rapidly within the past decades. The aim of this study was to describe the burden of selected NCDs in a primary care setting in Nuuk and compare it to a modern westernized suburban general practice in Denmark.

Methods: The study was performed as a cross sectional register-based study using data extracted from the electronic medical records (EMR) based on diagnosis codes from inhabitants living in Nuuk, Greenland, and a suburb in Denmark. Estimates of prevalence were age-standardized to the WHO world standard population.

Results: In both Nuuk and the Danish suburb, the highest prevalence was observed for hypertension (13.2% for both populations), followed by asthma (4.4 and 9.5%, respectively) and diabetes (4.3 and 2.9%, respectively). The age-standardized prevalences of diabetes, COPD, atrial fibrillation, and heart failure, were significantly higher in Nuuk, while seven NCDs including asthma, ischemic heart disease, arthritis urica, psoriasis, hyperthyreosis, hypothyreosis and osteoporosis were significantly higher in the Danish suburb.

Conclusion: In contrast to the disease pattern observed in Greenland in the last century, the prevalence of diagnosed NCDs in Nuuk is no longer rare. Thus, the overall prevalence of NCDs in the population of Nuuk is now comparable to or even higher than in the suburb in Denmark. This calls for increased focus on all NCDs in the primary healthcare system in Greenland and adaptation of the primary healthcare services to a changed disease spectrum.

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Non-communicable diseases; prevalence; primary healthcare; Greenland; Denmark

Introduction

Noncommunicable diseases (NCDs) including cardiovascular diseases, cancer, diabetes, and chronic lung diseases account for around 74% of all deaths worldwide, equivalent to 41 million people annually [1]. Historically, NCDs have not been observed frequently in Greenland. The pioneer Alfred Berthelsen, who worked as a physician in Greenland in the beginning of the nineteenth century, thoroughly described the healthcare system and disease pattern in Greenland [2]. Chronic conditions like obesity, diabetes, and cardiovascular diseases were rarely observed. However,

the population was very young at the time with a life expectancy of approximately 24 years. A large population survey conducted in the 1960s confirmed a low prevalence of diabetes, where the population was still young compared to the present time [3]. A more recent study in the 1980s, although 40 years old, described the prevalence of selected chronic diseases [4]. Here, a low prevalence was reported for ischemic heart disease, diabetes, thyrotoxicosis, asthma, multiple sclerosis, and psoriasis compared to European populations. Also, some autoimmune diseases like rheumatoid arthritis, insulin-dependent diabetes

CONTACT Marie Balslev Backe  mariebacke8@gmail.com  Steno Diabetes Center Greenland, Nuuk, Greenland

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mellitus, Graves' disease (hyperthyreosis) and psoriasis were reported with low prevalence in Greenland in late 1980s [5]. In contrast, epilepsy and stroke were observed more commonly in Greenland [4].

However, profound changes in society and life circumstances in Greenland, especially rapidly in the first decades following World War II, altered the disease pattern and increased life expectancy [6–10]. In accordance, implementation of national strategies within the healthcare system, such as inclusion of the Bacille Calmette Guerin Vaccination (BCG) in the child vaccination program in 1955, reduced the mortality associated with tuberculosis and acute infections, which went from causing more than half of the deaths in 1925 to only causing 5% around year 2000 [11,12]. Accompanying the reduction of infectious diseases was an increase in cancer and cardiovascular diseases, and an increased prevalence of mental vulnerability and illness [6]. Also, the prevalence of obesity and diabetes has increased rapidly within the last two to three decades in Greenland [10,13]. At the same time, the proportion of the population aged ≥ 65 years increased from 3.6% in 1982 to 9.2% in 2022, and life expectancy increased from 60 years to 70 years for males and 67 years to 74 years for females within the same period [14,15]. According to WHO, the combination of populations growing older and increasing prevalence of NCDs globally, calls for national actions including monitoring of disease patterns, reducing risk factors that can lead to NCDs, and optimizing healthcare systems towards services that can focus on changing need [16].

Although the individual prevalence of a number of chronic diseases in Greenland have been estimated within the past years, the prevalence have been estimated using prescribed medicine as indicator of disease [17–19] or based on – for some diseases – a limited registration of diagnosis coding [20,21]. The up-to-date total burden of NCDs in the primary setting in Greenland is thus unexplored and following two years of mandatory registration with diagnosis codes in Nuuk, it is now possible to extract data based on diagnosis codes. Thus, the primary aim of this study was to produce a reliable estimate of the up-to-date burden of NCDs in Nuuk. Secondly, as the disease pattern in Greenland has changed towards a more westernized one, now being closer to that observed in other parts of the Danish Realm (constituted by Denmark, Greenland, and the Faroe Islands) [22], we furthermore wished to compare the burden of NCDs in Nuuk to Denmark, by identifying a Danish primary clinic of similar size and experience regarding diagnosis registration.

Methods

Study design

The study was performed as a cross sectional register-based study using data extracted from the electronic medical records (EMR) based on diagnosis codes. Data was extracted in January 2023.

Setting

Greenland is the biggest island in the world covering more than 2.6 million km^2 . Around 80% of the island is covered by permanent ice, and the population of around 56,000 people is sparsely scattered in 16 towns and approximately 60 smaller settlements [23]. The majority of the population is genetically of Inuit origin [24]. Approximately 90% of the population is born in Greenland whereas 10% are immigrants, mainly from Denmark, while immigrants from Philippines, Thailand and Poland constitute 1.6, 0.6 and 0.2%, respectively [23]. Approximately one third of the population lives in the capital Nuuk. Unlike the rest of Greenland, where recruitment of medical staff poses a major challenge, Nuuk has a great number of permanent doctors. Primary healthcare in Nuuk is delivered by Queen Ingrid Health Care Center and Steno Diabetes Center Greenland. The International Classification of Primary Care version 2 (ICPC) system is used routinely. In addition, version 10 of the International Classification of Disease (ICD) is used in Nuuk, since the EMR used in Greenland cover both primary and secondary care. Systematic diagnosis coding has been mandatory in the primary healthcare setting in Nuuk since January 2021 in all in-person consultations. Thus, diagnosis coding is far more common in Nuuk compared to the rest of Greenland [25].

Until 1992, Denmark was responsible for the healthcare system in Greenland, which is established based on the Danish model. Thus, the healthcare system in Greenland shares some similarities with the Danish including service free of charge for all citizens, with similar standards and guidelines, and with a huge number of Danish healthcare professionals employed. As such, a comparison between disease pattern and -management between the two countries is relevant. The population of Denmark is around 5.8 million people [26]. The second largest city in Denmark is Aarhus encompassing around 336,000 inhabitants, and of those, around 10,000 lives in the area of Skødstrup, a suburb to the city of Aarhus. Skødstrup is one of the largest primary clinics in Denmark, and in addition to size, this suburb resembles the primary clinic in Nuuk by having laboratory facilities as well as a small emergency. Furthermore, the

primary clinic in the suburb resembles the healthcare in Nuuk by having a great focus on diagnostics and in terms of how the inhabitants are treated and diagnosed by a permanent/fixed staff team.

Study population

In Denmark, all inhabitants ≥ 20 years affiliated to the primary health clinic in the suburb Skødstrup, one of the largest clinics in Denmark, were used as denominator to estimate the prevalence (8,889 inhabitants). For Greenland, all inhabitants living in Nuuk are affiliated to the primary clinic Queen Ingrid Health Care Center, the largest primary healthcare center in Greenland [23]. We used all patients ≥ 20 years living in Nuuk as denominator (14,703 inhabitants) to calculate the prevalence.

Variables

An anonymized extraction based on diagnosis codes comprising information on age and sex was extracted from the EMR in both clinics. Information on ethnicity is not legally registered in Greenland nor in Denmark. Only adults aged ≥ 20 years were included in the study and only information on the selected NCDs was included. Patients were considered having a specific chronic disease if the specific ICPC diagnosis was recorded in their file at least once. We included the following NCDs: ischemic heart disease (K74, K75, K76), heart failure (K77), atrial fibrillation (K78), hypertension (K86, K87), stroke (K90), osteoporosis (L95), chronic obstructive lung disease (COPD) (R95), asthma (R96), psoriasis (S91), hyperthyreosis (T85), hypothyreosis (T86), type 2 diabetes (T90), and arthritis urica (T92) or in Nuuk a corresponding ICD code.

Statistics

To adjust for different age distributions in Nuuk and the Danish suburb (Supplementary Figure 1), we used the WHO world standard population ≥ 20 years to obtain age-standardized estimates of prevalence [27]. Subsequently, the age-standardized prevalence was used to calculate numerators based on the denominators in order to conduct statistical comparisons. Estimates were calculated with 95% confidence intervals (CI), and prevalence was calculated using the number of patients affiliated with the clinic in Nuuk and the Danish suburb, respectively, as background population. Proportions were compared using chi-square test. p -Values below 0.05 were considered statistically significant. Data was analysed in the R version 4.2.2.

Ethics

The study is based on data from medical and population registers only, and does not directly involve any individuals, therefore, no risks or side effects related to this study are considered. Data has been retrieved anonymously, hence all personal information such as names and unique identification numbers (CPR-number) is confidential. The study lives up to the Helsinki Declaration II and is approved by the Ethics Committee for Scientific Research in Greenland as well as the Agency for Health and Prevention in Greenland (KVUG 2022-15).

Results

Table 1 shows the age-standardized prevalence estimates for the selected NCDs in Nuuk and the Danish suburb. In Nuuk, the 14,703 inhabitants ≥ 20 years consisted of 47% females and 53% males, and the median age was 42 years (ranging from 20 to 99 years). In the Danish suburb, the 8,889 inhabitants ≥ 20 years or above consisted of 53% females and 47% males, with a median age of 54 years (ranging from 20 to 109 years). For both Nuuk and the Danish suburb, the highest prevalence was observed for hypertension (13.2 and 13.2%), followed by asthma (4.4 and 9.5%) and diabetes (4.3 and 2.9%).

Table 1. Age-standardized prevalences of NCDs among inhabitants in Nuuk and a Danish suburb ≥ 20 years of age.

Prevalence of chronic diseases, % (n), (95% CI)	Nuuk (N=14,703)	Danish suburb (N=8,889)	<i>p</i>
Ischemic heart disease (K74, K75, K76)	1.82 (235) (1.61–2.04)	2.67 (503) (2.33–3.00)	<0.001
Heart failure (K77)	1.08 (147) (0.91–1.25)	0.81 (169) (0.62–1.00)	0.040
Atrial fibrillation (K78)	2.32 (264) (2.08–2.56)	1.89 (432) (1.61–2.17)	0.028
Hypertension (K86, K87)	13.15 (1,851) (12.61–13.7)	13.21 (2,307) (12.50–13.91)	0.907
Stroke (K90)	1.80 (229) (1.58–2.01)	1.57 (297) (1.31–1.82)	0.183
Osteoporosis (L95)	0.68 (86) (0.55–0.81)	2.06 (463) (1.76–2.35)	<0.001
COPD (R95)	2.99 (427) (2.71–3.26)	1.68 (338) (1.41–1.94)	<0.001
Asthma (R96)	4.35 (648) (4.02–4.68)	9.47 (772) (8.86–10.08)	<0.001
Psoriasis (S91)	1.44 (203) (1.25–1.63)	3.3 (367) (2.93–3.67)	<0.001
Hyperthyreosis (T85)	0.58 (86) (0.46–0.70)	1.33 (174) (1.09–1.57)	<0.001
Hypothyreosis (T86)	0.66 (97) (0.53–0.79)	2.56 (324) (2.24–2.89)	<0.001
Diabetes (T90)	4.31 (606) (3.98–4.63)	2.86 (494) (2.51–3.20)	<0.001
Arthritis urica (T92)	0.67 (79) (0.54–0.81)	1.65 (277) (1.39–1.92)	<0.001

Overall, the estimated age-standardized prevalence of the four NCDs diabetes, COPD, heart failure, and atrial fibrillation was significantly higher in Nuuk compared to the Danish suburb, while the seven NCDs asthma, ischemic heart disease, arthritis urica, psoriasis, hyperthyreosis, hypothyreosis and osteoporosis were significantly more common in the Danish suburb. The prevalence of hypertension and stroke was similar in Nuuk and the Danish suburb.

Table 2 shows the age-standardized estimates of prevalence stratified by sex. As expected, in both cities, a significantly higher proportion of females were diagnosed with hyperthyreosis, hypothyreosis, and osteoporosis compared to males, while significantly more males were diagnosed with ischemic heart disease, heart failure, and atrial fibrillation. There was no difference in the prevalence of psoriasis or stroke between males and females for both inhabitants in Nuuk and Skødstrup. In contrast, the prevalence of diabetes and arthritis urica was higher among males in the Danish suburb, whereas no sex-specific difference was observed among patients in Nuuk. Furthermore, the prevalence of COPD and asthma was higher among females than for males in Nuuk, whereas no sex-specific difference was observed in the Danish suburb. For hypertension, significantly more females than males were

diagnosed in Nuuk, while the opposite was found for the Danish suburb.

Discussion

In this study, we describe the burden of selected NCDs in Nuuk, Greenland, and compare it to a similar primary healthcare setting in a Danish suburb to the city of Aarhus. The most prevalent NCD included in this study, hypertension was observed with the same prevalence in both clinics. Furthermore, the prevalence of the four NCDs diabetes, COPD, heart failure, and atrial fibrillation was higher in Nuuk indicating that NCDs are now common among Greenlanders. Still, the prevalence of asthma, ischemic heart disease, arthritis urica, psoriasis, hyperthyreosis, hypothyreosis, and osteoporosis was lower in Nuuk compared to the Danish suburb.

The higher prevalence observed in Nuuk for diabetes, COPD, heart failure, and atrial fibrillation may partly be explained by higher diagnostic activity of these NCDs compared to the others in Greenland. Thus, national initiatives have been implemented within recent years focusing on early detection and registration of diagnostic codes, for diabetes with documented improvements of early detection since 2008 [10,28]. Also, for COPD, national and local initiatives

Table 2. Age-standardized prevalences of NCDs among inhabitants in Nuuk and a Danish suburb ≥ 20 years of age stratified by sex.

Prevalence of chronic diseases, % (n), (95% CI)	Nuuk (N=14,703)			Danish suburb (N=8,889)			Total (N=23,592)	
	Males (N=7,766)	Females (N=6,937)	p	Males (N=4,176)	Females (N=4,713)	p	Males vs. males (N=11,942) p	Females vs. females (N=11,650) p
Ischemic heart disease (K74, K75, K76)	2.47 (166) (2.13–2.82)	1.08 (69) (0.84–1.32)	<0.001	3.64 (312) (3.07–4.21)	1.80 (191) (1.42–2.18)	<0.000	<0.001	0.001
Heart failure (K77)	1.38 (96) (1.12–1.64)	0.76 (51) (0.56–0.97)	0.000	1.15 (107) (0.83–1.47)	0.51 (62) (0.31–0.71)	0.001	0.293	0.096
Atrial fibrillation (K78)	2.59 (161) (2.24–2.94)	2.02 (103) (1.69–2.35)	0.022	2.47 (250) (2.00–2.94)	1.38 (182) (1.05–1.71)	<0.001	0.687	0.010
Hypertension (K86, K87)	12.37 (923) (11.64–13.11)	14.03 (928) (13.21–14.84)	0.003	14.08 (1,103) (13.03–15.14)	12.43 (1,204) (11.49–13.38)	0.022	0.008	0.013
Stroke (K90)	2.67 (113) (1.39–1.96)	1.92 (116) (1.59–2.24)	0.267	1.81 (152) (1.39–2.20)	1.35 (145) (1.03–1.69)	0.140	0.624	0.022
Osteoporosis (L95)	0.23 (19) (0.12–0.34)	1.18 (67) (0.93–1.44)	<0.001	0.74 (74) (0.48–1.00)	3.23 (389) (2.72–3.73)	<0.001	<0.001	<0.001
COPD (R95)	2.45 (192) (2.10–2.79)	3.59 (235) (3.15–4.03)	<0.001	1.65 (159) (1.27–2.04)	1.70 (179) (1.33–2.07)	0.868	<0.001	<0.01
Asthma (R96)	2.30 (178) (1.97–2.64)	6.03 (470) (6.05–7.22)	<0.001	8.98 (342) (8.11–9.85)	9.91 (430) (9.06–10.76)	0.136	<0.001	<0.001
Psoriasis (S91)	1.48 (113) (1.21–1.75)	1.40 (90) (1.12–1.67)	0.675	3.18 (154) (2.65–3.72)	3.39 (213) (2.88–3.91)	0.580	<0.001	<0.001
Hyperthyreosis (T85)	0.21 (16) (0.11–0.31)	0.99 (70) (0.76–1.23)	<0.001	0.34 (29) (0.16–0.51)	2.21 (145) (1.79–2.63)	<0.001	0.178	<0.001
Hypothyreosis (T86)	0.17 (14) (0.08–0.26)	1.20 (83) (0.94–1.45)	<0.001	0.67 (43) (0.42–0.92)	4.24 (281) (3.67–4.82)	<0.001	<0.001	<0.001
Diabetes (T90)	4.44 (336) (3.98–4.90)	4.15 (270) (3.68–4.62)	0.386	3.76 (309) (3.16–4.31)	2.08 (185) (1.67–2.49)	<0.001	0.066	<0.001
Arthritis urica (T92)	0.79 (54) (0.59–0.98)	0.55 (25) (0.37–0.72)	0.078	2.95 (219) (2.43–3.46)	0.51 (58) (0.31–0.71)	<0.001	<0.001	0.779

implemented since 2011 has increased usage of spirometry and registration of diagnoses, thereby contributing to the observed high prevalence of COPD [19,21,29]. Establishment of the Steno Diabetes Center Greenland in 2020 has, in addition to diabetes and COPD, contributed to increased focus on hypertension. Hypertension has previously been observed with low prevalence, possibly due to underdiagnosis [17,30], but in the present study, hypertension is the NCD with highest prevalence in Nuuk (and in the Danish suburb), suggesting that the initiatives are effective in ensuring detection and diagnosis of the disease. The final two NCDs more prevalent in Nuuk compared to the Danish suburb, were atrial fibrillation and heart failure. Also for these NCDs, recent quality assurance-projects has resulted in increased focus and more patients being diagnosed with these diseases [31–33].

In addition to the specific diagnostic focus in Nuuk, the high prevalence of diabetes, COPD, atrial fibrillation, and heart failure relate to other causes. Thus, genetic factors are believed to play a large role for the drastic increase in NCDs in Greenland, such as diabetes. In accordance, recent studies suggest that nearly one in five diabetes cases in Greenland are associated with genetic variants in the gene *TBC1D4* and in the *HNF1a* gene [34–36]. The variant in the *TBC1D4* gene, which has been shown to be associated with insulin resistance in skeletal muscle and deterioration of postprandial glucose homeostasis, is believed to explain 15% of all diabetes cases in Greenland [37]. Furthermore, lifestyle factors such as smoking and obesity, which are two major risk factors for developing NCDs such as diabetes, COPD, and cardiovascular diseases, constitute a severe health concern in Greenland. In accordance, the proportion of overweight individuals has more than doubled from 1993 to 2018, where it was estimated that 27% of the population were obese (BMI >30) [13]. Furthermore, as 55% of the Greenlandic population aged 15–94 years smoke on a daily basis, it seems plausible that the prevalence of COPD is actually higher in Nuuk compared to the Danish suburb [13]. Regarding asthma, the high prevalence observed in the Danish suburb is most likely associated with a higher diagnostic focus in Denmark compared to in Greenland. In Greenland, the past years focus has been on COPD rather than asthma, and all inhabitants above 40 years of age living in Nuuk receiving medication for obstructive lung diseases were in 2021 and 2022 summoned to a spirometry test. In line with that, we recently reported asthma to be underdiagnosed in Greenland [20]. In contrast to the Danish suburb, significantly more females in Nuuk were diagnosed with asthma compared to males. This finding is most likely

associated with more females being obese as well as the fact that females more often seek contact with the primary care, compared to males [13,25]. In addition to asthma, recent studies suggest that the prevalence of the NCDs arthritis urica, psoriasis, and osteoporosis are also underdiagnosed in Greenland [18,38,39]. This may explain the lower prevalence of these diseases in Nuuk compared to the Danish suburb. However, for some NCDs, the prevalence might actually be lower in Nuuk than in the Danish suburb. Thus, certain autoimmune diseases such as rheumatoid arthritis, psoriasis, asthma and thyroid disease have been reported as low in Greenland [5]. Two more recent studies also support this finding. In accordance, a study from 2022 found a low occurrence of thyroid autoantibodies among Inuit in Greenland [40,41]. Furthermore, autoimmune diabetes in Greenland is rare and a study from 2014 reported low levels of circulating Glutamin-Acid-Decarboxylase 65 antibodies (GADab) among Greenlanders (Inuit) both with and without diabetes [42].

Strengths and limitations

This is the first study to make a comparison of the combined burden of NCDs between two major primary healthcare settings in Greenland and Denmark. In both clinics, diagnosis coding using ICPC-2 is used routinely. However, the results must be interpreted with some clear reservations. Until 2020, diagnosis coding in Greenland was sparsely used in contrast to the primary healthcare clinic in Denmark, where it has been used routinely for years. Thus, some patients with known disease in Nuuk may not have been seen in the period after mandatory diagnosis coding was implemented in Nuuk and have therefore not been registered with a diagnosis code. This would lead to the underestimation of the true prevalence in Greenland compared to Denmark. However, since more than 85% of the population in Greenland has at least one contact to the healthcare system within one year, this underestimation is not considered of major importance [25]. Yet, in both clinics the prevalence of NCDs is expected to be underestimated compared to the real prevalence, since not all patients with a diagnosed disease are followed in the primary setting. Furthermore, the comparison between Nuuk and the Danish suburb cannot be generalized to a comparison between Greenland and Denmark. Thus, there are indeed differences between Nuuk and the rest of Greenland regarding the prevalence of a number of diagnosed NCDs such as asthma and COPD, as well as the extent of overweight and obesity [20,21,43,44]. This difference is most likely a consequence of mandatory diagnosis coding in Nuuk in contrast to the rest of

Greenland and higher number of physicians working permanently in Nuuk compared to high turnover of short-term physicians in the rest of Greenland. Similarly, also the prevalence of NCDs in Denmark vary hugely geographically from one primary setting to another [45]. On this scale, the Danish suburb Skødstrup may be a clinic with a lower prevalence of NCDs compared to all of Denmark. Thus, to make an example the prevalence of diabetes in this study was quite low compared to approximately 6% in all of Denmark [46].

Conclusion

In contrast to the disease pattern observed in Greenland in the last century, the occurrence of diagnosed NCDs in Nuuk are no longer considered rare. The burden of NCDs in Nuuk shared similarities with the Danish suburb. A similar prevalence of hypertension, the most frequently observed NCD included in this study, were observed in both populations. The prevalence of four NCDs in Nuuk including diabetes, COPD, atrial fibrillation, and heart failure were higher in Nuuk, while seven NCDs including asthma, ischemic heart disease, arthritis, urica, psoriasis, hyperthyreosis, hypothyreosis and osteoporosis were significantly higher in the Danish suburb. Thus, the overall prevalence of NCDs in the population of Nuuk now seems comparable to or even higher than in the western suburb in Denmark. This calls for increased focus on all NCDs in the primary healthcare system in Greenland and an adaption of the primary healthcare service to a changed disease spectrum.

Disclosure statement

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ORCID

Marie Balslev Backe  <http://orcid.org/0000-0001-5442-0818>
 Marit Eika Jørgensen  <http://orcid.org/0000-0001-8356-5565>
 Michael Lyng Pedersen  <http://orcid.org/0000-0001-8059-9188>

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