SSM - Population Health 6 (2018) 149–157

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

Article

Measuring social inequality in health amongst indigenous peoples in the Arctic. A comparison of different indicators of social disparity among the Inuit in Greenland

Peter Bjerregaard[a,b,*], Inger Katrine Dahl-Petersen[a,1], Christina Viskum Lytken Larsen[a,b]

[a] National Institute of Public Health, University of Southern Denmark, Studiestræde 6, 1455 Copenhagen K, Denmark
[b] Institute for Nursing and Health Research, University of Greenland, Svend Jungep Aqq. 2, 3900 Nuuk, Greenland

ARTICLE INFO

Keywords:
Social inequality
Socioeconomic conditions
Cultural transition
Smoking
Obesity
Inuit

ABSTRACT

The purpose of the article is to compare different indicators of social position as measures of social inequality in health in a population sample from an indigenous arctic people, the Inuit in Greenland. Data was collected during 2005–2015 and consisted of information from 3967 adult Inuit from towns and villages in all parts of Greenland. Social inequalities for smoking and central obesity were analysed in relation to seven indicators of social disparity in four dimensions, i.e. education and employment, economic status, sociocultural position, and place of residence. For each indicator we calculated age-adjusted prevalence by social group, rate ratio and the concentration index. The indicators were correlated with Pearson's r ranging from 0.24 to 0.82. Concentration indices ranged from 0.01 to 0.17. We could not conclude that one indicator was superior to others. Most of the indicators were traditional socioeconomic indicators used extensively in research in western countries and these seemed to be useful among the Inuit too, in particular household assets and job. Two sociocultural indicators developed for use among the Inuit and which included parameters specific to the indigenous peoples in the transition from a traditional to a modern life style proved to be equally useful but not superior to the traditional socioeconomic indicators. The choice of indicator must depend on what it is realistic to collect in the actual research setting and the use of more than one indicator is recommended. It is suggested to further develop culture specific indicators of social position for indigenous peoples.

1. Introduction

Social factors influence health and the measurement of social position is an important tool in epidemiological research and more generally in health research and practice. Social position may be measured in a variety of ways, by single items and composite scores. It is poorly analysed to what extent the social position indicators of western societies, such as education and income, are sufficiently informative among indigenous peoples in an historical transition from a traditional hunting or agrarian society to a modern post-industrial society. It may well be the case that being a skilled hunter or an accomplished story teller or having extensive kinship ties is as important for one's position in the social hierarchy as formal western style education or monetary income. The choice of measure for social inequality depends on the investigators' perspective on social inequality in health (Mackenbach & Kunst, 1997; Harper et al., 2008). Several indicators are needed to provide a clear picture of health disparity and its change over time (Harper et al., 2008).

Recently, an increased focus has been put on indigenous and tribal peoples' health by major journals. A review of the determinants of indigenous health indicated that the transition from traditional to modern lifestyles included increasing prevalence of mental disorders, alcohol problems, obesity, and type 2 diabetes (Gracey & King, 2009). The underlying causes of health disparities between indigenous and non-indigenous people were discussed by King, Smith, and Gracey (2009) who provided an indigenous perspective to understanding these inequalities. Furthermore, a global collaborative study systematically collated data across a broader sample of countries and indicators including Greenland and recommended improved access to indigenous data within national surveillance systems (Anderson et al., 2016). Most studies of social inequality involving indigenous peoples are, however, comparisons of indigenous and non-indigenous (synonyms: western,

* Corresponding author at: National Institute of Public Health, University of Southern Denmark, Studiestræde 6, 1455 Copenhagen K, Denmark.
E-mail addresses: pb@niph.dk (P. Bjerregaard), inger.katrine.dahl-petersen@regionh.dk (I.K. Dahl-Petersen), cll@si-folkesundhed.dk (C.V.L. Larsen).
[1] Current address: Steno Diabetes Center Copenhagen, Niels Steensens Vej 6, 2820 Gentofte, Denmark.

https://doi.org/10.1016/j.ssmph.2018.08.010
Received 23 May 2018; Received in revised form 31 August 2018; Accepted 31 August 2018

white, majority) population groups within the same country. Greenland is a strong case to go beyond this and study social inequality within an indigenous people because the Inuit make up a majority in Greenland (90%) and because Greenland has its own government, own statistical bureau and own population health surveys. Data on social position and health from the Inuit in Greenland is detailed and plentiful and although each indigenous people is unique the findings from Greenland are not only relevant for the Inuit in Greenland, Canada and Alaska but also for other indigenous peoples in the Arctic and indeed for indigenous peoples globally.

Several traditional western indicators of social position have been used in epidemiological studies from Inuit populations in Greenland and Canada. These include education (Bjerregaard, 2010; Bjerregaard & Jørgensen, 2013; Riva, Larsen, & Bjerregaard, 2016; Zienczuk & Egeland, 2012), housing conditions (Egeland, Faraj, & Osborne, 2010; Riva, Larsen, & Bjerregaard, 2014a; Riva et al., 2014b; Ruiz-Castell et al., 2015), job and income (Bjerregaard & Jeppesen, 2010; Bjerregaard & Jørgensen, 2013; Zienczuk & Egeland, 2012). Studies from Alaska have taken a broader view and have included addiction; social isolation; environmental exposures; diet, nutrition and exercise; access to quality health care; access to clean water; global climate change; sexual and reproductive health; and occupational health and safety as social determinants of health (Driscoll, Dotterer, & Brown, 2013).

In order to extract information about social position that is more specific to indigenous communities undergoing a rapid cultural and economic transition, a number of additional indicators of social position have been used in Greenland. These include current place of residence (Bjerregaard & Curtis, 2002; Bjerregaard & Jeppesen, 2010; Bjerregaard & Larsen, 2015; Jørgensen, Moustgaard, Bjerregaard, & Borch-Johnsen, 2006; Jørgensen, Borch-Johnsen, Witte, & Bjerregaard, 2012), language skills (Bjerregaard & Curtis, 2002; Jørgensen et al., 2006), and composite sociocultural variables that reflect participation in the transition from a traditional hunting life to a western urban life (Bjerregaard, Larsen, Dahl-Petersen, & Buchardt, 2017; Bjerregaard & Dahl-Petersen, 2011; Larsen, Curtis, & Bjerregaard, 2013). In northern Scandinavia, reindeer herders have been shown to have lower Sense of Coherence (Abrahamsson, Lindmark, & Gerdner, 2013) and higher mortality from injuries other than suicides (Hassler, Sjölander, Johansson, Grönberg, & Damber, 2004) than other Sami from the same area.

The purpose of the present study was to analyse strengths and weaknesses of different indicators of social position as measures of health disparities among the Inuit in Greenland. Social inequalities for smoking and central obesity were analysed in relation to seven indicators of social disparity in four dimensions, i.e. education and employment, economic status, sociocultural position, and place of residence.

2. Methods

The total population of Greenland is 57,000 of whom 90% are ethnic Greenlanders (Kalaallit, Inuit). Genetically, Greenlanders are Inuit (Eskimos) with a 25% admixture of European, mainly Scandinavian genes (Molkte et al., 2015). The Greenlanders are closely related genetically and culturally to the Inuit/Iñupiat in Canada and Alaska and, somewhat more distantly, to the Yupiit of Alaska and Siberia (Damas, 1984).

2.1. Data collection

Data was collected in 2005–2010 and 2014–2015 as part of two countrywide cross-sectional health surveys in Greenland (Fig. 1). The health surveys were mandated by the Department of Health in Greenland with the specific aim to support the Public Health Programme. There was an overlap between participants in the two surveys and for

Fig. 1. Map of Greenland with sampling communities.

1255 persons who participated in both studies only information from the most recent survey was included (see supplementary material). The study methods were identical and a full description of the study methods is available elsewhere (Bjerregaard, 2011; Dahl-Petersen, Olesen, & Bjerregaard, 2016). In brief, the participants, aged 18 years and older, were selected through a stratified random sample of adults in Greenland, who had been born in Greenland or Denmark. The sample was a random sample of individuals and if someone refused to participate no one for the same household was included. Only participants defined at enrolment as Inuit based on their primary language and self-identification were included in the present study. Data was collected by interview and clinical examination in 11 towns and 16 villages. A town is defined historically as the largest community in each of 17 districts. In 2010, the population of the towns varied between 469 and 5460 with a further 15,469 residents in Nuuk, the capital. Population in villages varied from less than 10 to around 550. The participation rate was 67% (in 2005–2010) and 63% (in 2014–2015). Questionnaires were developed in the Danish language, translated into Greenlandic, back translated and revised. Interviews and self-administered questionnaires gave information about socio-demographic factors, self-rated health and disease, and lifestyle including diet, physical activity, smoking and alcohol use. Interviews were conducted in the language of choice of the participant, most often in Greenlandic, by native Greenlandic speaking interviewers who had been trained for 1–2 days on the job in the study procedures. A Greenlandic university trained midwife with more than 10 years' experience with interview based data collection in Greenland was responsible for collecting the data, training the interviewers and recruiting the participants. She was supervised on an almost daily basis by the PI who is a physician. A total of 3967 Inuit participated in the two surveys.

2.2. Indicators of social position

Demographic and social variables were obtained from the interview and in the case of income from Statistics Greenland (2005–2010 data only). When possible, categories were combined in order to include at least 10% of the participants in each category. The variables were

grouped into four dimensions including measures of education and employment, measures of household economic status, measures of sociocultural transition from a traditional to a modern society, and a contextual measure of urbanization and remoteness.

2.2.1. Education and employment

The interview had questions on the number of years in school and type of post school education. Based on this the following categories were defined: 1. Primary or high school only; 2. Short vocational education (1–2 years); 3. Midlevel or long education, university. Information on education was available for 3924 participants (99%).

Participants were asked about their job title. This was subsequently coded into 24 job categories. For participants below the official age of retirement (65 years) the job categories were recoded into the following categories: 1. Not gainfully employed; 2. Unskilled workers; 3. Hunters, fishermen and assisting wives; 4. Skilled workers; 5. White collar employees. Students and old age pensioners made up additional categories. Information on job was available for 3113 participants (exclusive of students) aged 18–64 years (91%).

2.2.2. Household economic status

Household asset score is a proxy indicator of wealth (Bjerregaard & Dahl-Petersen, 2008). Participants were asked whether or not they had these items in their household: video/DVD player, computer, landline telephone, refrigerator, microwave oven, washing machine and dishwashing machine and 0/1 answers (no/yes) were added giving a score ranging from 0 to 7. Scores 0, 1 and 2 were combined. Information on household economic status was available for 3962 participants (100%).

Information about disposable household income was obtained from Statistics Greenland, averaged for 2005–2007 and presented as income per person. Disposable income is the taxable income less tax plus certain non-taxable social benefits. It is estimated to be the most reliable index of consumption opportunities (Statistics Greenland, personal communication, 2009). Disposable household income per person was calculated as the average yearly disposable income for the household of the participant divided by the weighted number of household members; the weights were 1 for the first person in the household and 0.5 for each subsequent person. Information on income was only available for participants in the 2005–2010 study. Income was categorized into sextiles for direct comparison with the asset score. Information on income was available for 1831 participants (99% of participants in 2005–2010).

2.2.3. Sociocultural transition

An index of social position based on job, current residence, migration from village to town and education was developed for analyses of cardiovascular risk factors. The index was closely associated with traditional diet which is a generally accepted proxy measure of "modernity" in Greenland (Bjerregaard & Dahl-Petersen, 2011). Sociocultural position was defined for participants aged 25–64 years and was available for 2973 participants (98% of participants aged 25–64 years).

A sociocultural transition score was developed for the analysis of dietary patterns. Participants were classified according to information on place of residence 10 years old (capital or Denmark = 2; other town in Greenland = 1; village = 0), current residence (capital = 2; other town in Greenland = 1; village = 0), education (medium or long vocational education/university = 2; short vocational = 1; school/high school only = 0) and self-assessed bilingual proficiency (speaks Danish without difficulty = 2; rather well = 1; with difficulty or not at all = 0). Scores were added to give a sociocultural transition score ranging from 0 to 8 and recoded into seven categories (0–6 +) by combining the three highest scores which each had relatively few participants. The higher this sociocultural transition score, the further the participant is positioned in the transition from a traditional background as hunter to that of an urban office employee. The index was closely associated with traditional diet (Bjerregaard et al., 2017). Information was available for 3891 participants (98%).

2.2.4. Urbanization and remoteness

Current community of residence was recorded and recoded into an indicator of urbanization and remoteness (villages, small towns, regional towns and the capital). The information was available from reliable government registers. Information on this variable was available for all 3967 participants.

2.3. Smoking

Participants were asked 'Do you smoke?' with the possible answers 'Yes, daily', 'Yes, but there are days when I do not smoke', and 'No'. Cigarettes were the most common form of smoking (only 1.3% of daily smokers did not smoke cigarettes). Smoking prevalence was validated against import statistics (Bjerregaard & Becker, 2013). Information about smoking was available for 3959 participants (99.8%).

2.4. Obesity

Waist circumference was measured midway between the rib cage and the iliac crest. According to WHO guidelines participants were considered centrally obese if the waist circumference was 102 cm or more for men and 88 cm or more for women. Information on waist circumference was available for 3886 participants (98%).

2.5. Statistical methods

The statistics included age adjusted prevalence by social position, rate ratio of "lowest" social position divided by "highest" social position with 95% confidence intervals, and concentration index with 95% confidence intervals. Age adjusted prevalences were calculated by a univariate General Linear Model – the UNIANOVA procedure of the standard statistical programme SPSS version 23. Rate ratios were calculated in an Excel spreadsheet (Gardner & Altman, 1989). The concentration index was calculated by an SPSS syntax as described by Buyungo and Yang (2007). It corresponds to twice the area between the concentration curve and the line of equality. By convention, a negative concentration index shows increasing health with increasing social position (World Bank, 2017a, 2017b). Participants with missing values were excluded from the particular analyses.

2.6. Ethical considerations

The studies were approved by the ethical review committee for Greenland. Participants were informed by letter prior to data collection and oral and written information was given before data collection. All participants gave written informed consent.

3. Results

The age range of the 3967 participants was 18–97 years (mean 47.2) and 43% were men (Table 1). Around 60% of both men and women

Table 1
Demographic and health characteristics of the study population. N = 3967.

Age (range, mean) (missing = 0)	18–97	47.2
	n	%
Sex (missing = 0)		
Men	1718	43.3
Women	2249	56.7
Daily smokers (missing = 8)		
Men	1020	59.5
Women	1396	62.2
Central obesity (missing = 81)		
Men ≥ 102 cm waist circumference	478	28.4
Women ≥ 88 cm waist circumference	1289	58.6

Table 2
Prevalence rates of daily smoking in social groups, rate ratios between highest and lowest social group and concentration index. Greenland Inuit 2005–2015. N = 3959. 8 missing information about smoking.

	Men				Women			
	n	%	Smoking prevalence		n	%	Smoking prevalence	
Education and employment								
Education			%				%	
School/high school only	929	54.2	64.5		1364	60.8	67.5	
Short vocational	585	34.1	59.1		601	26.8	55.0	
Medium/long vocational	180	10.5	40.0		257	11.4	49.5	
Missing	20	1.2			23	1.0		
F (df)			19.6 (2)	p < 0.00001			24.3 (2)	p < 0.00001
Rate ratio (95% CI)			1.61	(1.32;1.96)			1.36	(1.19;1.55)
Concentration index (95% CI)			-0.07	(-0.06;-0.07)			-0.06	(-0.06;-0.06)
Job								
Not working	287	16.7	77.1		427	19.0	80.4	
Unskilled workers	470	27.4	63.9		651	29.0	67.4	
Hunters/ fishermen and families	202	11.8	57.1		22	1.0	65.1	
Skilled workers	271	15.8	59.0		395	17.6	53.5	
White collar employees	157	9.2	37.6		272	12.1	44.8	
Missing[a]	327	19.1			478	21.3		
F (df)			19.2 (4)	p < 0.00001			31.4 (4)	p < 0.00001
Rate ratio (95% CI)			2.05	(1.66;2.54)			1.79	(1.56;2.06)
Concentration index (95% CI)			-0.09	(-0.09;-0.10)			-0.10	(-0.10;-0.11)
Economic status								
Household assets								
0–2	259	15.1	81.6		270	12.0	80.3	
3	300	17.5	67.8		345	15.3	68.2	
4	317	18.5	65.3		450	20.0	70.6	
5	322	18.7	57.3		443	19.7	61.4	
6	294	17.1	46.2		425	18.9	51.0	
7	224	13.0	40.1		313	13.9	43.6	
Missing	2	0.1			3	0.1		
F (df)			27.1 (5)	p < 0.00001			26.5 (5)	p < 0.00001
Rate ratio (95% CI)			2.03	(1.72;2.41)			1.84	(1.60;2.12)
Concentration index (95% CI)			-0.11	(-0.11;-0.12)			-0.09	(-0.09;-0.10)
Income								
1st sextile	136	15.3	73.0		167	17.5	71.5	
2nd sextile	141	15.9	64.7		163	17.1	73.0	
3rd sextile	162	18.3	58.5		145	15.2	64.2	
4th sextile	143	16.1	61.3		158	16.6	67.0	
5th sextile	148	16.7	56.2		156	16.4	68.6	
6th sextile	151	17.0	52.9		153	16.1	57.0	
Missing[b]	6	0.7			10	1.1		
F (df)			3.2 (5)	p = 0.007			2.4 (5)	p = 0.035
Rate ratio (95% CI)			1.38	(1.16;1.64)			1.25	(1.07;1.48)
Concentration index (95% CI)			-0.06	(-0.05;-0.06)			-0.04	(-0.04;-0.04)
Sociocultural position								
Social transition								
Other in villages	198	15.6	69.7		236	13.7	74.3	
Hunters/fishermen in villages	90	7.1	62.8		112	6.5	54.8	
Migrants to towns, no education	126	9.9	65.3		217	12.6	75.3	
Residents of towns, no education	309	24.3	65.7		398	23.1	73.5	
Intermediate group in towns	410	32.2	58.1		523	30.4	54.6	
Professionals in towns	128	10.1	40.5		222	12.9	47.3	
Missing[c]	11	0.9			14	0.8		
F (df)			7.1 (5)	p < 0.00001			18.7 (5)	p < 0.00001
Rate ratio (95% CI)			1.72	(1.36;2.17)			1.57	(1.34;1.84)
Concentration index (95% CI)			-0.06	(-0.06;-0.07)			-0.08	(-0.07;-0.08)
Sociocultural transition score								
0	188	11.0	65.2		284	12.7	65.1	
1	199	11.6	64.3		308	13.7	73.7	
2	267	15.6	62.8		316	14.1	64.0	
3	241	14.1	66.8		300	13.4	67.8	
4	276	16.1	61.4		303	13.5	60.8	
5	262	15.3	57.3		298	13.3	60.0	
6+	251	14.6	44.4		392	17.5	47.1	
Missing	30	1.8			44	2.0		
F (df)			6.3 (6)	p < 0.00001			10.6 (6)	p < 0.00001
Rate ratio (95% CI)			1.47	(1.23;1.75)			1.38	(1.21;1.58)
Concentration index (95% CI)			-0.05	(-0.05;-0.05)			-0.06	(0.05;-0.06)
Place of residence								

(*continued on next page*)

Table 2 (*continued*)

	Men				Women			
	n	%	Smoking prevalence		n	%	Smoking prevalence	
Village	391	22.8	66.2		454	20.2	66.0	
Small town	663	38.7	60.1		848	37.8	68.9	
Regional town	340	19.8	59.8		441	19.6	56.0	
Capital	320	18.7	52.3		502	22.4	52.5	
Missing	0	–			0	–		
F (df)			4.9 (3)	p = 0.002			15.9 (3)	p < 0.00001
Rate ratio (95% CI)			1.27	(1.11;1.44)			1.26	(1.13;1.40)
Concentration index (95% CI)			-0.04	(-0.04;-0.04)			-0.05	(-0.05;-0.06)

Notes
[a] old age pensioners and students excluded
[b] only available for the 2005–2010 survey
[c] only defined for 25–64 year old participants

were daily smokers and 46% were centrally obese (men 28%, women 59%) according to WHO's guidelines for waist circumference.

In Tables 2 and 3, statistics for each of the seven indicators of social position are presented for daily smoking and waist obesity, respectively. The general pattern for all seven socioeconomic variables was a decreasing trend of daily smoking by higher social position and, for men, an increasing trend of obesity by higher social position. The ratio between the lowest and the highest category of social position ranged between 1.25 and 2.05 for daily smoking and between 0.35 and 0.96 for obesity. The concentration index varied between -0.04 and -0.11 for smoking and between 0.01 and 0.17 for obesity.

For smoking, the inequality patterns were similar for men and women, i.e. a linearly decreasing prevalence of daily smoking by social position. Household assets and job presented the most social inequality while income and place of residence displayed the least social inequality in health. The distributions of prevalence rates by social position were all statistically significant.

For obesity, the inequality patterns were different for men and women. While men showed a linearly increasing prevalence of waist obesity by social position, the social inequality among women was much less pronounced especially among the higher groups of social position. For men, household assets and job presented the most social inequality in health similar to the case for smoking. Except for place of residence among women, the distribution of all prevalence rates by social position were statistically significant.

While the concentration index presents inequality as a single easily interpretable number the concentration curve and the specific prevalence rates show which categories of social position are responsible for the inequality. This is illustrated in Fig. 2 for two cases with similar concentration indices but different distribution of prevalence rates (CI = 0.13). For the sociocultural transition score the association with waist obesity was almost linear throughout the whole range and each level accordingly contributed to the inequality. For income there was no difference among the prevalence of waist obesity of the four lowest income levels while increased prevalence was prominent at the highest level. The same can be visually seen from the concentration curves (Fig. 3).

Table 4 shows that all seven indicators of social position were significantly associated in bivariate correlations with Pearson r-values ranging from 0.24 to 0.82. Correlations within dimensions of social position (r = 0.45–0.82) were as expected larger than correlations between dimensions (mean r = 0.35–0.65). Fig. 4 shows how job, current residence, sociocultural score and household assets were related to each other. With sociocultural score at the x-axis and household assets at the y-axis, job categories were plotted separately for residents of villages and towns. With the unemployed at the bottom left of the graph (low sociocultural score and low household asset score), manual labourers, hunters/fishermen, skilled workers and white collar employees had increasingly higher sociocultural score and household asset score. For each job category, residents of villages were situated below and to the left of residents of towns, i.e. having lower sociocultural as well as household asset scores. The unemployed, retired persons and students had notably lower household asset scores than those currently employed.

4. Discussion

We explored social inequality measured by seven indicators of social position of which four were mainstream socioeconomic indicators and three included issues specific to the Inuit in Greenland such as rural vs. urban residence in childhood and currently, migration from village to town, and proficiency in the Danish language. As outcome variables were chosen an example of health behaviour (daily smoking) and a clinical measure (central obesity) which were both known from previous studies among the Inuit to exhibit social variation.

For each indicator we calculated several statistics. The age-adjusted prevalence rates by categories of social position gave an overview of the pattern of health outcome by social group but not a direct estimate of the degree of social inequality. The F-statistics were all very large and the p values very small which made ranking of little relevance. The prevalence rates had the advantage that the indicator of social position is categorical and may have more than one dimension but several prevalence rates are less convenient to compare across indicators than single digits. The ratio between the prevalence rates of the lowest and the highest social groups had the advantage of giving a single estimate of social inequality but they only estimate the differences between the extremes of the distribution and are as such dependent on the number of categories and sizes of the extreme categories. Confidence intervals were large because only a minor proportion of the data was used. The concentration index and concentration curve summarized the social inequality of the entire dataset and especially the concentration index is a good measure of social inequality across different health outcomes and for comparison of different indicators of social position (Wagstaff, Paci, & van Doorslaer, 1991). It requires, however, that the indicator of social position is unidimensional (ordered from "low" to "high" or vice versa). The size of the concentration index depended on the number of categories; in our data the concentration index for daily smoking by household assets was −0.090 when household assets were recoded into three categories, −0.094 with four categories and −0.102 with six or eight categories. There was evidently an effect of the number of categories albeit a small one.

4.1. The social indicators

The traditional western indicators each had different strengths and weaknesses. Information on education was available for all age groups

Table 3
Prevalence rates of waist obesity in social groups, rate ratios between highest and lowest social group and concentration index. Greenland Inuit 2005–2015. N = 3886; 81 missing information about waist.

	Men				Women			
	n	%	Waist ≥ 102 cm		n	%	Waist ≥ 88 cm	
Education and employment								
Education			%				%	
School/high school only	914	54.2	24.1		1332	60.5	54.5	
Short vocational	575	34.1	31.4		595	27.0	67.5	
Medium/long vocational	178	10.6	37.4		251	11.4	61.8	
Missing	19	1.1			22	1.0		
F (df)			9.3 (2)	p = 0.00001			15.3 (2)	p < 0.00001
Rate ratio (95% CI)			0.64	(0.52;0.80)			0.88	(0.79;0.98)
Concentration index (95% CI)			0.12	(0.11;0.12)			0.04	(0.04;0.05)
Job								
Not working	282	16.7	19.3		416	18.9	48.6	
Unskilled workers	463	27.5	27.1		643	29.2	61.2	
Hunters/ fishermen and families	202	12.0	24.3		21	1.0	68.6	
Skilled workers	269	16.0	33.2		392	17.8	68.9	
White collar employees	155	9.2	46.9		267	12.1	67.1	
Missing[a]	315	18.7			461	21.0		
F (df)			11.7 (4)	p < 0.00001			10.8 (4)	p < 0.00001
Rate ratio (95% CI)			0.41	(0.31;0.55)			0.72	(0.64;0.83)
Concentration index (95% CI)			0.16	(0.16;0.16)			0.07	(0.06;0.07)
Economic status								
Household assets								
0–2	253	15.0	15.2		263	12.0	43.2	
3	290	17.2	17.5		338	15.4	50.1	
4	314	18.6	25.2		434	19.7	56.5	
5	316	18.7	30.0		436	19.8	63.3	
6	290	17.2	38.1		421	19.1	64.1	
7	221	13.1	43.4		305	13.9	71.3	
Missing	2	0.1			3	0.1		
F (df)			17.3 (5)	p < 0.00001			13.8 (5)	p < 0.00001
Rate ratio (95% CI)			0.35	(0.25;0.48)			0.61	(0.52;0.71)
Concentration index (95% CI)			0.17	(0.17;0.18)			0.07	(0.07;0.07)
Income								
1st sextile	131	15.1	22.1		160	17.3	44.5	
2nd sextile	142	16.4	18.7		161	17.4	56.7	
3rd sextile	158	18.3	21.3		142	15.4	42.9	
4th sextile	141	16.3	19.5		153	16.5	60.2	
5th sextile	142	16.4	26.8		153	16.5	61.5	
6th sextile	146	16.9	38.9		147	15.9	60.5	
Missing[b]	5	0.6			9	1.0		
F (df)			5.0 (5)	p = 0.0002			4.5 (5)	p = 0.0005
Rate ratio (95% CI)			0.57	(0.37;0.86)			0.74	(0.59:0.92)
Concentration index (95% CI)			0.13	(0.13;0.14)			0.06	(0.06;0.07)
Sociocultural position								
Social transition								
Other in villages	197	15.7	15.3		235	13.9	56.3	
Hunters/fishermen in villages	90	7.2	21.9		112	6.6	65.4	
Migrants to towns, no education	125	10.0	26.7		209	12.3	53.2	
Residents of towns, no education	302	24.1	30.7		390	23.0	61.1	
Intermediate group in towns	402	32.0	34.0		519	30.6	68.3	
Professionals in towns	127	10.1	36.0		217	12.8	63.4	
Missing[c]	12	1.0			13	0.8		
F (df)			6.0 (5)	p = 0.00002			3.9 (5)	p = 0.0015
Rate ratio (95% CI)			0.43	(0.28;0.63)			0.89	(0.76;1.03)
Concentration index (95% CI)			0.13	(0.13;0.13)			0.03	(0.03;0.03)
Sociocultural transition score								
0	186	11.0	15.4		284	12.9	51.2	
1	197	11.7	19.1		299	13.6	50.6	
2	265	15.7	26.1		305	13.9	61.6	
3	237	14.1	25.1		294	13.4	58.6	
4	270	16.0	30.3		301	13.7	62.4	
5	256	15.2	37.2		293	13.3	63.8	
6+	245	14.5	38.2		382	17.4	62.7	
Missing	30	1.8			42	1.9		
F (df)				p < 0.00001				p = 0.0007
Rate ratio (95% CI)			0.40	(0.28;0.58)			0.82	(0.71;0.94)
Concentration index (95% CI)			0.14	(0.14;0.14)			0.03	(0.04;0.04)
Place of residence								

(*continued on next page*)

Table 3 (*continued*)

	Men				Women			
	n	%	Waist ≥ 102 cm		n	%	Waist ≥ 88 cm	
Village	389	23.1	18.1		452	20.5	57.1	
Small town	658	39.0	29.3		833	37.9	58.9	
Regional town	331	19.6	27.5		432	19.6	59.4	
Capital	308	18.3	37.7		483	22.0	59.4	
Missing	0	0.0	–		0	–		
F (df)			12.1 (3)	p < 0.00001			0.2 (3)	p = 0.87
Rate ratio (95% CI)			0.48	(0.37;0.62)			0.96	(0.86;1.07)
Concentration index (95% CI)			0.11	(0.11;0.11)			0.01	(0.01;0.01)

Notes
[a] old age pensioners and students excluded
[b] only available for the 2005–2010 survey
[c] only defined for 25–64 year old participants

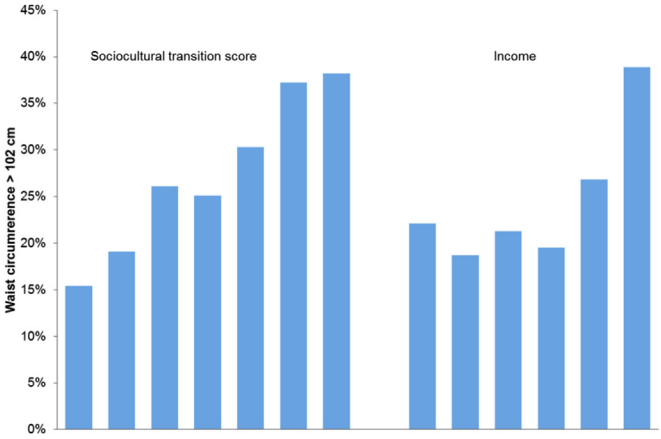

Fig. 2. Prevalence rates of waist obesity in categories of sociocultural transition score (n = 1656) and income (n = 860). Inuit men 2005–2015, adjusted for age.

but had the disadvantage of having a very skewed distribution. As we used the indicator there were only three categories and more than half of the participants belonged to the lowest category. In addition the level and dispersion of formal education has changed a lot over the lifespan of the participants in the surveys due to rapid and frequent changes in the educational system in Greenland. A few years ago grade 7 was the highest attainable level for the majority of Greenlanders but now 10 years of schooling is compulsory. Social position which in a cross sectional epidemiological study is a relative measure must be assumed to be the same for a participant born in 1950 with 7 years of school as for a participant born in 2000 with 10 years of school.

The respondent's job category had the disadvantage that it is well defined only for participants past education and until retirement (18–64 years). Students and old age pensioners were hence included as separate categories. The job categories were coded from free text answers to a question about job title and the translation of the multitude of job titles into a hierarchical system was not straightforward. Since the first population survey in Greenland in 1993 an inflation of job titles has been noted with an increasing proportion of participants having pompous managerial job titles which by scrutiny do not correspond to the real contents of the job. Also job titles seem to become more indecipherable to the social scientist who is outside the specific branch of work.

Household assets is a score of wealth calculated from seven household items assumed to be above the basic items found in a household. It has the advantage over income that it is a measure of what the income is spent on by ways of durable goods. It is available for all age groups. One disadvantage of this indicator is that the relevant items change over time as the society becomes more affluent. In 1993, for instance, when the indicator was first used, it included ownership of a telephone; this was in subsequent surveys changed to a land line telephone and will in the future be left out altogether due to the technological development which has endowed everybody with a mobile phone and with a land line phone being an indicator of old age, not of wealth.

Income statistics was collected for tax purposes and it is questionable whether it reflects individual or family spending power to the same degree as the measure of household assets. Pearson's r^2 between income and household assets was only 0.20 which suggests that the two indicators measure different aspects of personal economy. It has the advantage of being a continuous measure that can be grouped into any number of categories of equal size.

Among the indicators constructed in order to incorporate local and culture sensitive items, the indicator of social transition was based on

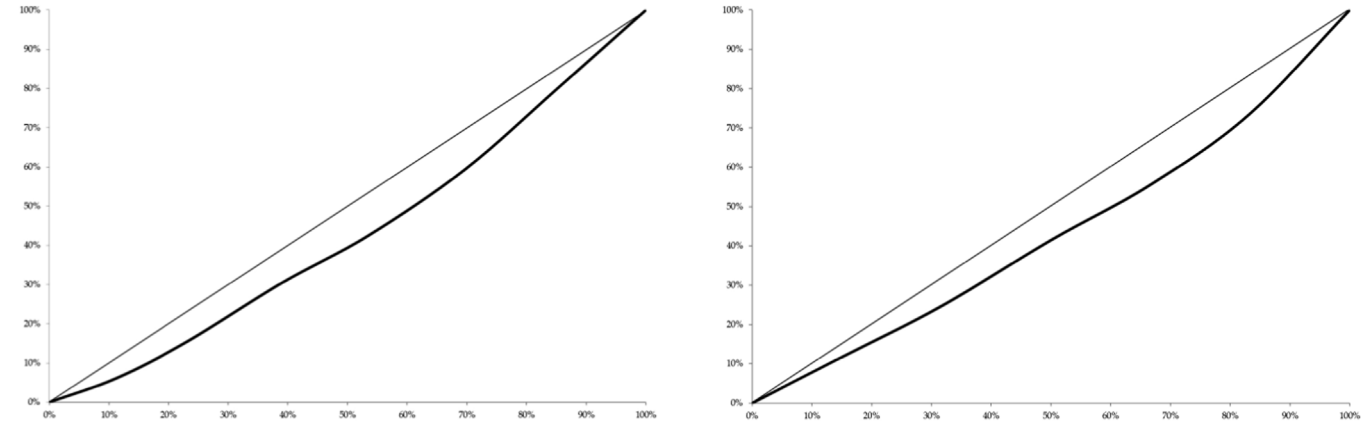

Fig. 3. Concentration curves for sociocultural transition score (left; n = 1656) and income (right; n = 860) by waist obesity. Inuit men 2005–2015.

Table 4
Bivariate correlations between indicators of social position. Pearson's r; all p values < 0.00001. Men and women. N in parentheses.

	Education	Job	Household assets	Income	Sociocultural position	Sociocultural transition score
Job	0.57 (3138)					
Household assets	0.35 (3919)	0.44 (3157)				
Income	0.36 (1801)	0.40 (1466)	0.45 (1826)			
Sociocultural position	0.65 (2961)	0.41 (2810)	0.39 (2971)	0.50 (1335)		
Sociocultural transition score	0.62 (3891)	0.45 (3116)	0.42 (3886)	0.48 (1768)	0.82 (2948)	
Urbanization	0.31 (3924)	0.24 (3159)	0.31 (3962)	0.40 (1831)	0.69 (2973)	0.71 (3891)

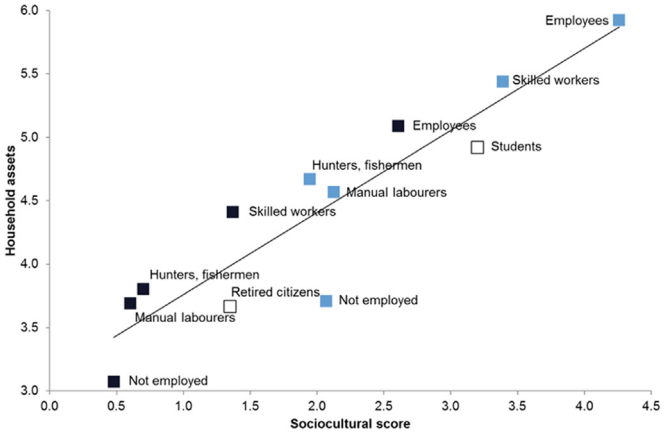

Fig. 4. Job category and current place of residence plotted against sociocultural score and household asset score. Inuit 2005–2015. Dark marks = villages; light/blue marks = towns; white marks = both towns and villages. N = 3748 for sociocultural score and 3816 for household assets. Linear regression line.

own job, residence as adult, migration from village to town, and education. It included factors that were not settled among the young (job, residence, migration) and that were no longer relevant among the elderly (job) and was thus in its current state only defined for participants aged 25–64. It would be worthwhile to further develop this indicator for participants outside the current age bracket.

The sociocultural transition score is a further development of the above indicator of social transition. It was calculated from two structural aspects of integration into modern society in Greenland vs. adherence to traditional village life, i.e. place of residence in childhood and current place of residence, and two individual variables, i.e. level of education and self-assessed proficiency in the Danish language. These four variables each represent a gradient from the most traditional life pattern (childhood and current residence in a village, no formal education and no command of any language beyond the vernacular) to the most modern life pattern (childhood and current residence in the capital, medium high or high education and good command of Danish as a second language). Other variables that were considered for inclusion were occupation of father, place of birth of the mother, ethnicity of grandparents and self-assessed proficiency of the Greenlandic language. For a variety of reasons these were not included in the score: father's occupation and ethnicity of grandparents had many missing values while place of birth of the mother as well as proficiency in the Greenlandic language showed little dispersion, because most mothers were born in a village (74%) and the majority of Greenlanders are fluent in the Greenlandic language (97%). In the absence of a solid theoretical framework for the assessment of sociocultural transition from the selected variables it was chosen to let each variable contribute equally to the calculation of the score by recoding into three levels, assigning these levels the values 0, 1 and 2 and adding the values. It is thus implicit that, for instance, growing up in Nuuk as opposed to another town carried the same weight as having a medium long education as opposed to a short education. The validity of these assumptions may of course be questioned but their face value appears reasonable to the authors who have many years of experience with both daily life and epidemiological studies in different parts of Greenland. The score was normally distributed and had the further advantage that it may be calculated for all age groups.

Finally, place of residence had the advantage that it can be used outside the context of a population health survey, for instance for the analyses of mortality or admission to hospital since place of residence is usually registered as basic information in these and many other cases, but compared with the other indicators that we have analysed it did not discriminate health inequality well.

A good indicator of social position for health research has several categories of approximately equal size and is not skewed towards either side, has few missing values, is valid for all age groups and both genders and is easy to collect valid information on. A further advantage would be a continuous and normally distributed variable which can be recoded into any number of categories as desired. However, in real life the researcher will have to do with less and primarily the choice of indicator depends on the research question. Indicators of social position are closely associated and to a large extent show similar associations with health outcomes although to different degrees and it is not possible or relevant to choose one as superior to the others in every situation. First, theoretical considerations must help the investigator to decide whether the relevant aspect of social position is education, job, economy, sociocultural transition or place of residence. Within each of these dimensions the sensitivity of the indicator relative to the underlying distribution of the data can help to decide which indicator to choose. Assuming that there is an underlying inequality in the data that we are trying to reveal it is fair to conclude that the indicator of social position that reveals the largest inequality statistics is the better measure of inequality. According to this assumption, in our data household assets and, for participants aged 18–64 years, job category were the indicators of choice both for daily smoking and waist obesity. On the other hand, a statistic like the concentration index that incorporates the whole distribution of data in a single digit has the advantage of convenient comparisons across relevant indicators and surveys.

4.2. Strengths and weaknesses of the study

It is a strength of the study that compared with many other studies among indigenous peoples it comprises a large number of participants and a large proportion of the population (11% of the adult Inuit population in Greenland) and that even the most remote parts of the country were represented. It is furthermore unique that the study was conducted within an indigenous population instead of as a comparison between indigenous and non-indigenous populations.

It is a weakness of the study that the indicators used in the present study were mostly socioeconomic indicators adopted from studies in Europe and other western countries, i.e. education, job and income. The two indicators of sociocultural transition incorporated topics specific to Inuit life (migration, hunting, language) but they did not describe health inequality any better (rather slightly worse) than the household asset score which is a measure of the ownership of modern material goods. The use of further culture specific indicators such as, for example, cultural knowledge, being a skilled hunter, family relations and subsistence economy requires further conceptualization and qualitative

studies in order to formulate questions for a questionnaire based survey. We hope in the future to be able to operationalize non-Western indicators. The study was cross sectional which limits the predictive value of the associations. Data was collected during a period of 11 years but long data collection periods are usually necessary in Greenland in order to collect a sufficiently large number of participants in the small and scattered population. Although society changes over time it is not reasonable to think that social factors and their association with health outcomes change greatly during so few years. Smoking and central obesity were used as examples of health outcomes and results are specific to these outcomes and may be different for other health outcomes. Most variables were validated in separate studies from Greenland or came from government registers, which are considered very reliable in Greenland as in the Scandinavian countries. Only information about education and current employment was not validated.

4.3. Conclusion

Seven indicators of social position for the study of social inequality of health have been analysed but we cannot conclude that one indicator is superior to others. Most of the indicators were traditional socioeconomic indicators. Two sociocultural indicators developed for use among the Inuit which included parameters specific to indigenous peoples in a transition from a traditional to a modern life style proved to be equally useful but not superior to the purely socioeconomic indicators. The choice of indicator must depend on what is available and realistic in the actual research setting and the use of more than one indicator is recommended. It is suggested to further develop culture specific indicators of social position for indigenous peoples.

Data statement

The data is deposited at Dansk Data Arkiv (https://www.sa.dk/en/services/dda-danish-data-archive/) from where anonymous data can be requested.

Funding source

Free Research Council of Denmark, grant number DFF-4004-00029 (2014).

Appendix A. Supplementary material

Supplementary data associated with this article can be found in theonline version at doi:10.1016/j.ssmph.2018.08.010.

References

Abrahamsson, A., Lindmark, U., & Gerdner, A. (2013). Sense of coherence of reindeer herders and other Samis in comparison to other Swedish citizens. *International Journal of Circumpolar Health, 72*, 20633. https://doi.org/10.3402/ijch.v72i0.20633.

Anderson, I., Robson, B., Connolly, M., Al-Yaman, F., Bjertness, E., King, A., et al. (2016). Indigenous and tribal peoples' health (The Lancet–Lowitja Institute Global Collaboration): A population study. *Lancet, 388*(10040), 131–157.

Bjerregaard, P. (2010). Childhood conditions and education as determinants for adult height and obesity among Greenland Inuit. *American Journal of Human Biology, 22*, 360–366.

Bjerregaard P. (2011). Inuit Health in Transition – Greenland survey 2005–2010. Population sample and survey methods. 2nd revised revision. Copenhagen: National Institute of Public Health. Cited 1 May 2016. Available from: ⟨http://si-folkesundhed.dk/upload/inuit_health_in_transition_greenland_methods_5_2nd_revision.pdf⟩.

Bjerregaard, P., & Becker, U. (2013). Validation of survey information on smoking and alcohol consumption against import statistics, Greenland 1993–2010. *International Journal of Circumpolar Health, 72*, 20314.

Bjerregaard, P., & Curtis, T. (2002). Cultural change and mental health in Greenland. The association of childhood conditions, language and urbanization with mental health and suicidal thoughts among the Inuit of Greenland. *Social Science & Medicine, 54*, 33–48.

Bjerregaard, P., & Dahl-Petersen, I. K. (Eds.). (2008). *Befolkningsundersøgelsen i Grønland 2005–2007 [Population health survey in Greenland 2005–2007. In Danish]* (pp. 174). Copenhagen: National Institute of Public Health.

Bjerregaard, P., & Dahl-Petersen, I. K. (2011). How well does social variation mirror secular change in prevalence of cardiovascular risk factors in a country in transition? *American Journal of Human Biology, 23*, 774–779.

Bjerregaard, P., & Jørgensen, M. E. (2013). Prevalence of obesity among Inuit in Greenland and temporal trend by social position. *American Journal of Human Biology, 25*, 335–340.

Bjerregaard, P., & Jeppesen, C. (2010). Inuit dietary patterns in modern Greenland. *International Journal of Circumpolar Health, 69*, 13–24.

Bjerregaard, P., & Larsen, C. V. L. (2015). Time trend by region of suicides and suicidal thoughts among Greenland Inuit. *International Journal of Circumpolar Health, 74*, 26053. https://doi.org/10.3402/ijch.v74.26053.

Bjerregaard, P., Larsen, C. V. L., Dahl-Petersen, I. K., & Buchardt, B. (2017). Stable isotopes of carbon and nitrogen as markers of dietary variation among sociocultural subgroups of Inuit in Greenland. *American Journal of Human Biology, 23018*(29e), 1–12.

Buyungo P., Yang H. (2007). Equity Analysis: Computing the Concentration Index. PSI Research Division. Cited December 2017 from ⟨http://www.psi.org/wp-content/uploads/drupal/sites/default/files/publication_files/Concentration-Index-Toolkit.pdf⟩.

Dahl-Petersen I., Olesen I., Bjerregaard P. (2016). Health survey in Greenland 2014. Population sample and survey methods. Copenhagen: National Institute of Public Health. Cited 15 May 2018 from ⟨http://www.si-folkesundhed.dk/upload/greenlandsurvey2014_methods_final_revideret.pdf⟩.

Damas, D. (1984). *Handbook of North American Indians, 5*, Washington DC: Smithsonian Institution829 (Arctic).

Driscoll, D., Dotterer, B., & Brown, R. A. (2013). Assessing the social and physical determinants of circumpolar population health. *International Journal of Circumpolar Health, 72*, 21400.

Egeland, G. M., Faraj, N., & Osborne, G. (2010). Cultural, socioeconomic, and health indicators among Inuit preschoolers: Nunavut Inuit Child Health Survey, 2007–2008. *Rural Remote Health, 10*, 1365.

Gardner M., Altman D. (1989). Statistics with confidence – Confidence intervals and statistical guidelines. London, BMJ.

Gracey, M., & King, M. (2009). Indigenous health part 1: Determinants and disease patterns. *Lancet, 374*, 65–75.

Harper, S., Lynch, J., Meersman, S. C., Breen, N., Davis, W. W., & Reichman, M. E. (2008). An overview of methods for monitoring social disparities in cancer with an example using trends in lung cancer incidence by area-socioeconomic position and race-ethnicity, 1992–2004. *American Journal of Epidemiology, 167*, 889–899.

Hassler, S., Sjölander, P., Johansson, R., Grönberg, H., & Damber, L. (2004). Fatal accidents and suicide among reindeer-herding Sami in Sweden. *International Journal of Circumpolar Health, 63*(Suppl 2), 384–388.

Jørgensen, M. E., Borch-Johnsen, K., Witte, D. R., & Bjerregaard, P. (2012). Diabetes in Greenland and its relationship with urbanization. *Diabetic Medicine, 29*, 755–760.

Jørgensen, M. E., Moustgaard, H., Bjerregaard, P., & Borch-Johnsen, K. (2006). Gender differences in the association between westernization and metabolic risk among Greenland Inuit. *European Journal of Epidemiology, 21*, 741–748.

King, M., Smith, A., & Gracey, M. (2009). Indigenous health part 2: The underlying causes of the health gap. *Lancet, 374*, 76–85.

Larsen, C. V., Curtis, T., & Bjerregaard, P. (2013). Gambling behavior and problem gambling reflecting social transition and traumatic childhood events among Greenland Inuit: A cross-sectional study in a large indigenous population undergoing rapid change. *Journal of Gambling Studies, 29*, 733–748.

Mackenbach, J. P., & Kunst, A. E. (1997). Measuring the magnitude of socio-economic inequalities in health: An overview of available measures illustrated with two examples from Europe. *Social Science & Medicine, 44*, 757–771.

Molkte, I., Fumagalli, M., Korneliussen, T. S., Crawford, J. E., Bjerregaard, P., Jørgensen, M. E., Grarup, N., Gulløv, H. V., Linneberg, A., Pedersen, O., Hansen, T., Nielsen, R., & Albrechtsen, A. (2015). Uncovering the genetic history of the present-day Greenlandic population. *American Journal of Human Genetics, 96*, 54–69.

Riva, M., Larsen, C. V. L., & Bjerregaard, P. (2014a). Household crowding and psychosocial health among Inuit in Greenland. *International Journal of Public Health, 59*, 739–748.

Riva, M., Plusquellec, P., Juster, R. P., Laouan-Sidi, E. A., Abdous, B., Lucas, M., Dery, S., & Dewailly, E. (2014b). Household crowding is associated with higher allostatic load among the Inuit. *Journal of Epidemiology and Community Health, 68*, 363–369.

Riva, M., Larsen, C. V. L., & Bjerregaard, P. (2016). Association between individual-level and community-level socio-economic status and blood pressure among Inuit in Greenland. *International Journal of Circumpolar Health, 75*, 32757. https://doi.org/10.3402/ijch.v75.32757.

Ruiz-Castell, M., Muckle, G., Dewailly, É., Jacobson, J. L., Jacobson, S. W., Ayotte, P., & Riva, M. (2015). Household crowding and food insecurity among Inuit families with school-aged children in the Canadian Arctic. *American Journal of Public Health, 105*, e122–e132. https://doi.org/10.2105/AJPH.2014.302290.

Wagstaff, A., Paci, P., & van Doorslaer, E. (1991). On the measurement of inequalities in health. *Social Science & Medicine, 33*, 545–557.

World BankUndated. The concentration index. Quantitative Techniques for Health Equity Analysis, Technical Note #6: 1-5. Undated a. Cited December 29, 2017a from ⟨http://siteresources.worldbank.org/INTPAH/Resources/Publications/Quantitative-Techniques/health_eq_tn06.pdf⟩.

World Bank. Undated. The concentration index. Quantitative Techniques for Health Equity Analysis, Technical Note #7: 1-6. Undated b. Cited December 29, 2017b from ⟨http://siteresources.worldbank.org/INTPAH/Resources/Publications/Quantitative-Techniques/health_eq_tn07.pdf⟩.

Zienczuk, N., & Egeland, G. M. (2012). Association between socioeconomic status and overweight and obesity among Inuit adults: International Polar Year Inuit Health Survey, 2007–2008. *International Journal of Circumpolar Health, 71*, 1–7.