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ORIGINAL ARTICLE

Mortality in the Sami population of North Norway, 1970–98

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Abstract

Aims: The pattern of mortality among many groups of indigenous people has been shown to be disadvantageous in comparison with the general population. Knowledge regarding causes of death among the Sami population in the northern part of Norway is limited. The Sami constitute an ethnic minority whose lifestyle diverges from that of the rest of the population. *Methods:* A cohort of 19,801 persons of Sami origin was followed up to evaluate specific causes of mortality during the period 1970–98. Standardized mortality rates (SMR) were calculated using the rural population of the three Norwegian counties included in the study as a reference population. *Results:* Among Sami, 5,955 total deaths were observed, as opposed to 5,537 expected (SMR=1.08). For both Sami women and men a significantly higher SMR for cerebrovascular diseases was found, which was more pronounced for women. For Sami men, an excess SMR for violent death was observed (SMR 1.32, 95% confidence interval (CI) 1.20–1.46); this was highest among Sami men living in a reindeer-breeding family. For both genders, mortality from all malignant neoplasms combined was lower than in the reference population. SMRs were 0.86 (95% CI 0.79–0.94) and 0.89 (95% CI 0.80–0.99) for men and women, respectively. Low SMRs were also observed for chronic liver diseases, 0.18 (95% CI 0.02–0.63) and 0.12 (95% CI 0.00–0.68) for Sami men and women, respectively. To be a member of a reindeer breeding household appeared to offer protection from mortality caused by circulatory system diseases in men, especially mortality from ischaemic heart disease. *Conclusions:* The total mortality in the North Norway Sami population, an ethnic minority in Norway, was slightly higher when compared with a regional reference population. The differences observed when evaluating mortality by diagnosis might be due to lifestyle, diet, psychosocial, and/or genetic factors.

Key Words: *Arctic populations, cohort, epidemiology, Sami*

Introduction

Epidemiological studies of unique human populations give an opportunity to study mortality and specific cause of death in relation to lifestyle and habits shared by the group studied. The Sami are an ethnic minority in Norway. Their traditional homeland is the northern areas of Norway, Sweden, Finland, and the Kola Peninsula in Russia. In Norway they are considered as an indigenous population according to international conventions [1].

The Sami are a minority in Norway, but in a few municipalities in Troms and Finnmark, the two northernmost counties, they constitute the majority population [2]. In 1970, the majority of the Sami in North Norway were living in rural areas. The majority of the Sami had occupations linked to the primary sector of economic life at this time [2]). There are about 50,000–70,000 Sami in Norway today, of whom 2,500 are reindeer breeders [3].

Tverdal [4] reported cardiovascular and total mortality by ethnic groups (Sami, Finnish, and ethnic Norwegian) from a cardiovascular disease study in Finnmark. Tverdal reported lower overall total mortality and lower coronary heart disease in men and women who registered as Sami, although this result was not significant for women. Njølstad et al. [5] reported no ethnic differences in the incidence of cardiovascular diseases between Sami, ethnic Norwegian, and Finnish populations in Finnmark after adjustment for major cardiovascular risk factors and height. Wiklund et al. [6] analysed the mortality

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pattern among Swedish reindeer-breeding Sami and reported that total death from disease was similar to the general population, while lower mortality was observed for malignant tumours and diseases of the circulatory and digestive systems. Increased mortality was reported for external causes of injury among men and for cerebrovascular diseases among female Sami. A recent report by Hassler et al. [7] indicated that mortality of the Sami in Sweden was similar to that of their non-Sami neighbours. However, an excess mortality of external causes was reported for men. For Sami women, a higher mortality than expected was reported from diseases of the circulatory system, ischaemic heart disease, diseases of the respiratory system, and subarachnoid haemorrhage.

Studies of mortality in native populations elsewhere have often shown an unfavourable pattern in comparison with the general population. This pattern is often caused by unfavourable changes in health and living conditions of many natives in transition from a traditional lifestyle to a Westernized way of living. For instance among natives in Canada and Greenland alcohol- and accident-related deaths have increased considerably during the last 50 years while deaths from infectious diseases have dropped [8,9].

The aim of this project was to study the mortality pattern among the Sami population in the northern part of Norway in comparison with their non-Sami neighbours.

Material and methods

In connection with the national census in 1970, a survey of Sami ancestry was performed in preselected census wards in the three counties of Norway: Nordland, Troms, and Finnmark. The study was done by the Central Bureau of Statistics (now Statistics Norway) in cooperation with Sami organizations [2]. Established knowledge and pilot studies on Sami habitation were used to select the areas. The selected census wards covered 6.1%, 22.9%, and 89.7% of the population in Nordland, Troms, and Finnmark, respectively. In these areas the census was supplemented with four questions on Sami ancestry. The additional questions were: (1) Was Lappish the first language spoken by the person? (2) Was Lappish the first language spoken by one of the person's parents? (3) Was Lappish the first language spoken by one of the person's grandparents? (4) Does the person consider him/herself to be a Lapp [2]? Parents were allowed to answer on behalf of their children. The 19,801 persons who answered yes to at least one of these questions were included in our cohort. Information on date of birth, gender, residence, and occupation was supplied from the regular census and individuals living in the same household were identified. Basic characteristics of the Sami cohort are presented in Table I.

The Sami population was divided into four groups, indirectly characterized by the level of reindeer-meat consumption. The highest category included all those living in a household of reindeer herders. The next category included others living in the core areas for reindeer breeding. The rest of the population was divided into two groups according to whether they were living in a municipality with some or with no reindeer breeders. This categorization ranked Sami according to access to reindeer meat and indicated one of the known differences in dietary habits within the Sami [10–12]. The variable was first used in a previously published cancer incidence study of this Sami population as an indirect measure of radiation dose [13]. This categorization may be regarded as being more or less related to the traditional Sami way of life and culture.

The follow-up of mortality was from 1 November 1970 (date of census) until the end of 1998. All Norwegian death certificates are coded at Statistics Norway according to a Norwegian adaptation of the International Classification of Diseases (ICD) and strict rules for selecting underlying causes of death. The death registry includes all Norwegian citizens. The obligatory death certificate is issued by the responsible physician and contains information on cause of death. Historically, ICD-8 (1969–85), ICD-9 (1986–95) and ICD-10 (1996 and after) have been used. Information on emigrations and deaths was obtained from the Norwegian system of

Table I. Basic characteristics of the Sami 1970 census cohort

	Total no. (%)
Study subjects	
Total	19801 (100)
Men	10573 (53)
Women	9228 (47)
Age at end of 1970	
0–19	7793 (39)
20–49	6759 (34)
50–79	4837 (24)
80+	412 (2)
Distribution of answers	
Lappish person's first language	10529 (53)
Lappish parents' first language	16803 (85)
Lappish grandparents' first language	19621 (99)
Consider oneself to be a Lapp?	9163 (46)
County	
Finnmark	14064 (71)
Troms	5847 (25)
Nordland	890 (4)

statistics. Cohort members migrating to other parts of Norway after 1970 were not excluded from the study material. Data sources were linked by use of the unique identification number for residents in Norway. Person-time from start of follow-up to date of death, date of emigration, or end of follow-up was calculated for all individuals. Migration within Norway was not taken into account.

Standardized mortality rates (SMR) were calculated using the rural population of the three included counties as a reference population weighted according to the number of Sami in the county. Comparisons were also performed with the mortality in the general population of Norway. Reference rates were computed for five-year calendar periods and five-year age groups. Expected values were computed by multiplying the observed person-time in the cohort by the reference rates. SMRs were computed by taking the ratio of observed to expected causes of death. For these estimates the 95% confidence interval (95% CI) was computed, based on the assumption that observed cases follow the Poisson distribution. Trends in SMRs across categories were tested by assigning equidistant scores and including them as a numerical covariate in a Poisson regression. The software package Stata was used in the analysis [14].

Results

The follow-up of the 19,801 persons in our cohort included 471,028 person-years and 172 emigrations. For the period 1970–98 a total of 5,955 deaths were observed, 3,564 among men and 2,391 among women. Corresponding SMRs were 1.06 (95% CI 1.03–1.09 and 1.10 (95% CI 1.06–1.15) for men and women, respectively, using the rural reference population as the reference entity (Table I). Higher SMRs for all deaths were also seen when the Sami were compared with the total Norwegian population, with an SMR for men of 1.23 (95% CI 1.19–1.27), and 1.20 (95% CI 1.15–1.25) for women (table not shown).

Violent death showed a significantly excess risk among men with an SMR of 1.32 (95% CI 1.20–1.46). However, both genders showed a significantly lower risk of death from malignant neoplasms (Table II). Also, a significantly lower mortality than the reference population was observed among Sami men for cancer of the colon, respiratory tract, prostate, and kidney. Among women mortality was significantly lower for cancer of the ovary and kidney in Sami compared with the rural reference population. An excess mortality from cancer of the oesophagus was, however, observed among Sami men.

Mortality from diseases of the circulatory system and respiratory system were significantly higher for both genders in the Sami cohort compared with the reference population (SMR=1.07 and 1.17 respectively, see Table II). Mortality from diseases of the digestive system was, however, below unity both for men and women, although not significantly (see Table II).

For Sami men, diseases of the circulatory system including ischaemic heart disease, other heart diseases, and to some extent total deaths and cerebrovascular diseases showed a decreasing SMR with regard to the indirect measure of reindeer-meat consumption (Table III). Trends were statistically significant for all causes of death presented for men in Table III, except other heart diseases. Sami women did not show this clear pattern regarding the indirect measure of reindeer-meat consumption and a significant trend was observed only for all diseases of the circulatory system combined. Cerebrovascular disease showed an excess risk in women, significant for all households except reindeer-breeding households (Table III).

Mortality from chronic liver disease was significantly lower than in the rural reference population for both genders. Sami men also showed a significantly lower mortality from diseases of the musculoskeletal system/connective tissue and from rheumatoid arthritis/osteoarthritis (see Table II).

Mortality was also analysed by using the questions addressing language spoken by the subject or the closest relatives. No clear pattern or risk was seen. In a further analysis evaluating SMRs over three time periods, the only tendency to an increasing trend was seen for mortality from diabetes among Sami men.

Discussion

The main finding of this study is that among the Sami death from all causes was significantly slightly higher than in the local reference population and even higher when compared with the general population in Norway. Mortality from all malignant neoplasms combined and for chronic liver diseases was significantly lower for both genders than in the reference local rural population.

For men in particular, but also for women, an assumed higher intake of reindeer meat seemed to protect against diseases of the circulatory system. This finding was most pronounced for ischaemic heart disease in Sami men. Several other protective factors for circulatory diseases, for which we have no

Table II. Mortality by selected underlying causes of death for 19,801 people of Sami ancestry, 1970–98

	Men				Women			
	Obs	Exp	SMR	95%CI	Obs	Exp	SMR	95%CI
Deaths, total	3564	3364.7	1.06	1.03–1.09	2391	2172.6	1.10	1.06–1.15
Violent deaths, total	400	302.9	1.32	1.20–1.46	100	91.4	1.09	0.90–1.33
Accidents	313	235.9	1.33	1.19–1.48	76	74.1	1.03	0.81–1.28
Suicide and intentional self-harm	70	55.1	1.27	0.99–1.61	19	14.9	1.27	0.77–1.99
Homicide, assault	12	8.3	1.44	0.75–2.52	4	1.7	2.41	0.66–6.16
Events of undetermined intent	3	2.3	1.31	0.27–3.82	0	0.4	0.00	0.00–10.09
Deaths from diseases, total	3164	3061.8	1.03	1.00–1.07	2291	2081.1	1.10	1.06–1.15
Infectious and parasitic disease	21	20.8	1.01	0.62–1.54	18	15.5	1.16	0.69–1.84
Neoplasms	556	643.3	0.86	0.80–0.94	382	423.3	0.90	0.82–1.00
Malignant neoplasm	535	620.5	0.86	0.79–0.94	364	408.4	0.89	0.80–0.99
Malignant neoplasm of oesophagus	28	16.1	1.74	1.16–2.52	4	5.2	0.77	0.21–1.97
Malignant neoplasm of colon	22	33.6	0.65	0.41–0.99	25	36.1	0.69	0.45–1.02
Malignant neoplasm of larynx/trachea/bronchus/lung	90	147.6	0.61	0.49–0.75	23	34.1	0.68	0.43–1.01
Malignant neoplasm of breast	0	0.7	0.00	0.00–4.97	48	57.4	0.84	0.62–1.11
Malignant neoplasm of prostate	38	65.4	0.58	0.41–0.80	–	–	–	–
Malignant neoplasm of kidney, except renal pelvis	4	19.0	0.21	0.06–0.54	2	12.4	0.16	0.02–0.58
Diabetes mellitus	28	24.3	1.15	0.77–1.66	35	30.2	1.16	0.81–1.61
Diseases of the circulatory system	1757	1647.6	1.07	1.02–1.12	1262	1077.7	1.17	1.11–1.24
Ischaemic heart disease	1049	988.2	1.06	1.00–1.13	522	477.3	1.09	1.00–1.19
Other heart diseases	185	177.4	1.04	0.90–1.20	186	144.8	1.28	1.11–1.48
Cerebrovascular disease	362	317.8	1.14	1.03–1.26	431	336.2	1.28	1.17–1.41
Diseases of the respiratory system	339	302.1	1.12	1.01–1.25	270	219.9	1.23	1.09–1.38
Diseases of the digestive system	59	73.6	0.80	0.61–1.03	66	71.5	0.92	0.71–1.17
Ulcer of stomach, duodenum, and jejunum	8	14.0	0.57	0.25–1.12	8	10.4	0.77	0.33–1.52
Chronic liver disease	2	11.4	0.18	0.02–0.63	1	8.2	0.12	0.00–0.68
Diseases of musculoskeletal system/connective tissue	3	10.2	0.29	0.06–0.86	12	15.6	0.77	0.40–1.35
Rheumatoid arthritis and osteoarthritis	1	5.7	0.17	0.00–0.97	7	11.5	0.61	0.25–1.26
Unknown and unspecified causes	177	161.1	1.10	0.95–1.27	63	72.6	0.87	0.67–1.11

Observed number of cases (Obs) and expected number of cases according to a regional reference population (Exp). Standardized mortality ratios (SMR) and 95% confidence intervals (95% CI).

exposure records in our study, may also have contributed to this lower risk.

An important question that remains is whether the observed differences in mortality are caused by differences in health status, lifestyle factors, environmental factors etc. or diagnosis and registration errors of cause of death. Errors in the notifications of cause of death to Statistics Norway can be introduced when the physicians fill in their diagnosis on the relevant form. However, if comparisons are made with a group from the same geographical area, such errors and biases are of minor importance since they are likely to influence the study cohort and the reference population in the same manner. The majority of the Sami live in a few municipalities, and we cannot rule out that the diagnoses on death certificates are less valid in Sami areas compared with other municipalities in Norway, but there are no indications that differences in registration explain the differences observed in our study. The Sami cohort shows no overall excess mortality from other ill-defined or unknown diseases; analysis by time periods indicates, however, that mortality from such causes was more pronounced in the earliest period evaluated (1970–80).

Our cohort did not include all people of Sami origin in North Norway. Some Sami were living in census wards not covered by the 1970 census study on Sami descent. In addition, some respondents might have disapproved of questions on ethnic background because they were perceived as controversial at the time. Therefore, some under-reporting of Sami origin is possible and, in computing the local reference rates, we were unable to exclude the Sami non-respondents in reference areas [2]. Our estimates of the relative risks for Sami people might therefore be slightly biased towards unity.

Our results for total mortality among Sami were similar to the results reported by Hassler et al. [16]. The relative mortality (SMR) observed in our data is, however, lower than in several indigenous populations previously studied [9,15]. This may be related

Table III. Trends in standardized mortality ratios (SMRs) by involvement in reindeer breeding for selected underlying causes of death

	Men					Women				
Cause of death	Obs	Exp	SMR	95%CI	*p*-value trend test	Obs	Exp	SMR	95%CI	*p*-value trend test
Deaths, total										
No reindeer breeding	1330	1197.2	1.11	1.05–1.17		877	753.5	1.16	1.09–1.24	
Some reindeer breeding	1350	1246.6	1.08	1.03–1.14		917	875.4	1.05	0.98–1.12	
Core areas of reindeer breeding	634	657.0	0.97	0.89–1.04		461	408.0	1.13	1.03–1.24	
Reindeer breeding households	250	267.9	0.94	0.83–1.07	0.00	136	135.7	1.00	0.85–1.19	0.15
Violent deaths, total										
No reindeer breeding	119	98.6	1.21	1.01–1.44		28	30.55	0.92	0.61–1.32	
Some reindeer breeding	127	109.9	1.16	0.97–1.37		37	35.59	1.04	0.73–1.43	
Core areas of reindeer breeding	104	64.6	1.61	1.33–1.95		27	18.42	1.47	0.97–2.13	
Reindeer breeding households	50	29.8	1.68	1.25–2.21	0.01	8	6.89	1.16	0.50–2.29	0.15
Diseases of the circulatory system										
No reindeer breeding	710	593.9	1.20	1.11–1.29		487	377.99	1.29	1.18–1.41	
Some reindeer breeding	687	613.6	1.12	1.04–1.21		484	437.79	1.11	1.01–1.21	
Core areas of reindeer breeding	271	316.1	0.86	0.76–0.97		222	198.64	1.12	0.98–1.27	
Reindeer breeding households	89	124.0	0.72	0.58–0.88	0.00	69	63.33	1.09	0.85–1.38	0.03
Ischaemic heart disease										
No reindeer breeding	425	354.6	1.20	1.09–1.32		213	167.56	1.27	1.11–1.45	
Some reindeer breeding	413	371.0	1.11	1.01–1.23		187	192.28	0.97	0.84–1.12	
Core areas of reindeer breeding	159	187.3	0.85	0.73–0.99		91	88.55	1.03	0.83–1.26	
Reindeer breeding households	52	75.3	0.69	0.52–0.91	0.00	31	28.87	1.07	0.73–1.52	0.07
Other heart diseases										
No reindeer breeding	78	64.1	1.22	0.96–1.52		75	50.2	1.49	1.17–1.87	
Some reindeer breeding	63	64.3	0.98	0.75–1.25		71	60.3	1.18	0.92–1.49	
Core areas of reindeer breeding	31	35.5	0.87	0.59–1.24		30	26.2	1.15	0.77–1.64	
Reindeer breeding households	13	13.5	0.97	0.51–1.65	0.12	10	8.1	1.23	0.59–2.26	0.20
Cerebrovascular disease										
No reindeer breeding	139	116.1	1.20	1.01–1.41		146	118.41	1.23	1.05–1.45	
Some reindeer breeding	147	117.2	1.25	1.07–1.47		176	136.79	1.29	1.11–1.49	
Core areas of reindeer breeding	58	62.0	0.94	0.71–1.21		85	61.86	1.37	1.10–1.70	
Reindeer breeding households	18	22.5	0.80	0.47–1.26	0.04	24	19.17	1.25	0.80–1.86	0.57

to the fact that many Sami still are involved in agricultural work, fishing, and reindeer breeding, indicating a more traditional lifestyle than that of other native populations in transition to a more Western lifestyle. Wiklund et al. [6] reported total mortality similar to the entire Swedish population for Swedish reindeer-breeding Sami. In our data, Sami living in a reindeer-breeding household in Norway had a slightly lower mortality than expected (see Table 3). Excess mortality among Sami men from violent death, including accidents and suicide, was also reported in the recent Swedish Sami study [16]. Motorization of reindeer breeding may have added to this risk. Studies among other native populations have also shown excess mortality from violent death [8,9].

Our finding of lower mortality for all neoplasms, malignant neoplasms, cancer of lung, colon, prostate gland, and kidney in men and for all neoplasms,

malignant neoplasms, and cancer of kidney in women corroborates a previous report on cancer incidence in the same Norwegian Sami population as in the present study [13] and, to some extent, a previous study of the Swedish Sami [16]. For Sami living in Sweden, a lower mortality from cancer among men but not among women was reported [7].

Relatively high physical activity and a diet rich in fish is suggested as a probable cause explaining the low cancer incidence in our previous incidence analysis [13]. High intake of selenium has also been suggested to protect from death due to cancer [17]. For example, an inverse association between selenium status and lung cancer has been suggested [18], and in a prospective study from the Netherlands the protective effect of selenium was seen in particular among subjects with a relatively low dietary intake of beta-carotene or vitamin C [18]. The traditional Sami diet is rich in selenium (reindeer meat and liver) and low in beta-carotene and vitamin C (low intake of vegetables and fresh fruit). A high intake of vitamin A (in particular from reindeer liver), more than 10 times the recommended level for men and more than twice that for women [11], may also have contributed to the lower lung cancer risk [19]. Smoking habits among Sami men have been reported to be similar to those of non-Sami men in a survey from the mid-1970s [20], but the lower mortality of lung cancer might indicate favourable smoking habits among Sami men in former decades.

Excess mortality in Sami women from diseases of the circulatory system is supported by results reported for Sweden [7], although the authors reported no such excess risk for men, as observed in our study. The Sami women but not men have been reported to have more favourable smoking habits compared with the non-Sami population [20]. Our results for mortality from diseases of the circulatory system in reindeer-breeding Sami that consume most reindeer meat, which is significantly higher than the reference population for women and lower for men, corroborates with the findings by Hassler et al. [7]. Wiklund et al. [6] reported that Sami women had a significantly higher mortality from diseases of the circulatory system (SMR=1.19) in relation to men (SMR=0.48); corresponding figures for reindeer breeding Sami in the study by Hassler et al. were 1.13 and 0.91, respectively. Although high intake of reindeer meat might be an explanation for the lower risk in Sami men, several other factors may have contributed to this lower risk; candidates are: higher physical activity, high consumption of fish, and a more rural lifestyle with less smoking and drinking. We do not have any exposure data in this study to evaluate whether those factors are of importance.

The potentially protective effects of reindeer meat cannot be conclusively investigated using our applied study design, and the finding of a decreasing mortality in men from diseases of the circulatory system, including ischaemic and other heart diseases (see Table III), with regard to the indirect measure of reindeer-meat consumption may have several explanations. The fact that this pattern is seen for men but not for women opens up an alternative explanation: that men living in a reindeer-breeding household are more physically active and therefore protected from circulatory diseases. Fat content is, however, low and the fraction of polyunsaturated fat is high in meat from reindeer fed on natural pastures [21]. In a Finnish study [22], serum concentrations of alpha-tocopherol in the Sami correlated with consumption of reindeer meat, and the lower coronary mortality observed among Sami compared with Finns in Northern Finland was suggested to be attributed to diet rather than to genetics [22]. Very high levels of selenium have also been measured in reindeer liver, and the selenium content is 5–10 times higher in reindeer compared with cow meat [23].

The fact that the highest mortality from circulatory diseases for both men and women is seen in the Sami population living in areas with no reindeer breeding might, however, be an indication of other potential risk factors explaining the risk. The excess risk of cerebrovascular diseases, higher for women than men, may have several explanations. Older Sami women have a higher body mass index (BMI) indicating obesity [24], and they are more likely to be less physically active. This may have contributed to the observed excess cerebrovascular mortality. Tverdal [4] reported the highest BMI in Sami women as compared with ethnic Norwegian and Finnish women. Hassler et al. [7] also reported excess death from subarachnoid haemorrhage in women. This has been reported among Greenland Inuits and is suggested to be related to genetic factors [25]. For Sami men in northern Norway, lower SMR for cerebrovascular diseases was seen among those living in a reindeer-breeding household compared with non-breeders. This correlation was not seen for women and we cannot explain this difference from our data. A study of stroke incidence in Finland indicated that low plasma vitamin C was associated with an increased risk of strokes, especially among hypertensive and overweight men [26]. The traditional Sami diet is low in vitamin C [11].

Lower mortality from chronic liver disease observed for both genders may have several explanations. Traditionally, the Sami population may have been less exposed to hepatotoxic viruses. The use of alcohol was reported to be similar for Sami men

compared with their Norwegian neighbours in the late 1970s [4]. The traditionally high intake of vitamin A may also have provided Sami people with protection against chronic liver diseases. Decreased plasma vitamin A and retinol binding protein have been reported in patients with liver disease who have no alcohol intake [27]. The low intake of beta-carotene may also have contributed to decreasing this risk due to the fact that the combination of beta-carotene and ethanol results in hepatotoxicity [23].

In conclusion, Sami mortality was slightly higher than the mortality observed in the local reference population, and relatively more advantageous than among other indigenous populations in transition. Violent deaths were higher for Sami men, and highest among those living in a reindeer-breeding household. Lower mortality for Sami compared with the reference population for major cancer sites and for chronic liver disease was also observed. The traditional rural lifestyle with higher physical activity and traditional Sami diet with a higher intake of reindeer meat and fish seems to have provided effective protection regarding mortality from cardiovascular diseases for men.

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