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ORIGINAL RESEARCH ARTICLE

A traditional Sami diet score as a determinant of mortality in a general northern Swedish population

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Objectives. To examine the relationship between "traditional Sami" dietary pattern and mortality in a general northern Swedish population.
Study design. Population-based cohort study.
Methods. We examined 77,319 subjects from the Västerbotten Intervention Program (VIP) cohort. A traditional Sami diet score was constructed by adding 1 point for intake above the median level of red meat, fatty fish, total fat, berries and boiled coffee, and 1 point for intake below the median of vegetables, bread and fibre. Hazard ratios (HR) for mortality were calculated by Cox regression.
Results. Increasing traditional Sami diet scores were associated with slightly elevated all-cause mortality in men [Multivariate HR per 1-point increase in score 1.04 (95% CI 1.01–1.07), p = 0.018], but not for women [Multivariate HR 1.03 (95% CI 0.99–1.07), p = 0.130]. This increased risk was approximately equally attributable to cardiovascular disease and cancer, though somewhat more apparent for cardiovascular disease mortality in men free from diabetes, hypertension and obesity at baseline [Multivariate HR 1.10 (95% CI 1.01–1.20), p = 0.023].
Conclusions. A weak increased all-cause mortality was observed in men with higher traditional Sami diet scores. However, due to the complexity in defining a "traditional Sami" diet, and the limitations of our questionnaire for this purpose, the study should be considered exploratory, a first attempt to relate a "traditional Sami" dietary pattern to health endpoints. Further investigation of cohorts with more detailed information on dietary and lifestyle items relevant for traditional Sami culture is warranted.

Keywords: *the VIP cohort*; *Sami, traditional food*; *traditional lifestyle*; *mortality*

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Dietary patterns are widely, and increasingly, employed in studies of the relationship between diet and health. The Mediterranean diet, based on a traditional Greek diet, is one of the most well studied, with suggested health benefits in many populations, far from the Mediterranean area (1). Today, there is an increasing demand for practical recommendations for healthy eating more tailored to regional food culture (2–4). A food pattern based on the traditional diet of the Sami people has not previously been evaluated from this perspective.

The Sami are the indigenous people of a 388,350 km^2 large area of northern Norway, Sweden, Finland and the Kola Peninsula of Russia. Over the course of history, many Sami have been assimilated by force or free will into the Swedish majority culture. During the 1800s in

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particular, political directives were implemented to assimilate non-nomadic Sami into, and segregate migratory, reindeer-herding Sami from, the Swedish non-Sami society (5,6). Definition of Sami, and therefore also traditional Sami diet, is thus complicated.

Historical sources on the subject of Sami diet are scarce (7–9), which was the motivation behind our previous study, including interviews of elderly Sami and comparisons of dietary habits in present-day reindeer-herding Sami, non-reindeer-herding Sami and non-Sami (10). Taken together, the historical and scientific literature suggest a diet characterised by high intakes of fatty fish, red meat (primarily reindeer), fat, blood and organ dishes, wild berries and boiled, unfiltered coffee, and low intakes of cultivated vegetables and fruit, bread, and fibre (8,11–15). Potatoes were introduced in the Sami region in the 1800s, and have been described as eaten when available in the early 1900s, both among Sami and non-Sami (11,16). The use of dairy products has varied among Sami populations (17). According to historical sources from Sweden and Västerbotten, milk (reindeer, goat and cow) has traditionally been part of a Sami diet, for example the use of frozen milk (in Sami ‘‘kalmat’’) during winter (7,18), whereas Russian Sami are largely lactose intolerant (17). No pronounced differences in dairy intake between Sami and non-Sami have been found in the present day in Västerbotten (10–12).

Most of the dietary factors characteristic of the traditional Sami diet have previously been observed to have mainly adverse effects on health, namely high intake of red meat and low intake of vegetables, fruit, and fibre (19,20). For boiled coffee, results are equivocal (21–24). Only high intakes of fatty fish and wild berries have been demonstrated to be positively associated with health (25,26). However, a generally physically active lifestyle, including a high proportion of strenuous activity, also typifies the traditional Sami lifestyle (10,18,27), with expected positive health effects (19).

Historically, the life expectancy of adult Sami people has been somewhat longer than non-Sami in the same geographical areas (27,28), and in recent decades life expectancies have been similar in Sami and non-Sami (29–32). Today, Sami people have a lower risk of death from some cancers (33). Furthermore, diabetes and cardiovascular disease (CVD), which are often overrepresented in other indigenous populations (34,35), are not generally associated with Sami ethnicity in Sweden (36–38). This is mainly due to equal living conditions and access to health care services across ethnic groups in Sweden. But it has also been hypothesised that elements of a traditional Sami diet and lifestyle may reduce the risk to develop chronic diseases such as cancer and CVD (30).

In order to explore possible health effects of a ‘‘traditional Sami’’ dietary pattern, we have, in a manner similar to the Mediterranean diet score, constructed and studied a traditional Sami diet score, as well as the individual components of the score, in relation to all-cause, cancer, and cardiovascular mortality. The setting was a large, mainly non-Sami population-based cohort in northern Sweden. In contrast to much research focusing on ethnic minorities, we thus examined a general population from a minority perspective.

Material and methods

Study cohort

Our study cohort consists of participants from the Västerbotten Intervention Program (VIP), in which health risk measures and anthropometric data are collected from residents of the county of Västerbotten turning 30 (years 1985–1996), 40, 50 and 60 years of age. The diet and lifestyle questionnaire of VIP, including a semi-quantitative food frequency questionnaire (FFQ), has been completed by almost all participants, with an average recruitment rate for period included in this study (1990–2008) of 59% within the target age-groups. In support of the population-based nature of the VIP cohort are the nearly identical cancer incidence rates in the VIP cohort and the population of Västerbotten (39), and the minimal socio-economic selection bias (40). In previous studies less than 1% (n = 595) of the VIP participants have been defined as Sami, and of these the majority are non-reindeer-herding Sami (12).

From a total of 113,205 health examinations within the VIP cohort (1992–2008), of which 26,491 were repeated measures 10 years apart, a final study population of 77,319 participants was defined, based on the following exclusion criteria: subjects with missing data for more than 10% of the items in the FFQ and/or portion size (n = 6,715); subjects lacking data for body mass index (BMI) or with BMI < 10 kg/m^2 (n = 60); subjects with unrealistic food intake level (FIL) values, defined as a ratio of total energy intake to estimated basal metabolic rate (41) in the lowest 5th percentile or the highest 2.5th percentile, determined separately for sex and FFQ version (n = 7,977); and subjects with repeated health surveys (n = 21,134), in which the most recent sampling occasion was excluded from all analyses.

Food frequency questionnaire

In the present study, 3 versions of the VIP FFQ were used: the original, 84-item FFQ (n = 25,886), an older, nearly identical, 84-item FFQ (n = 4,083), and the most recent 65-item version, in which most foods are unchanged from the 84-item versions, some food groups have been deleted, and some similar food groups have been merged (n = 47,350). All but the oldest version of the FFQ have been validated against 24-hour recalls and/or biomarkers for B vitamins fatty acids and beta-carotene (42–44). In all FFQ versions, meal-time portion sizes were estimated

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with the aid of 4 colour photographs of a plate containing proportionally increasing amounts of food stuffs representing vegetables and main sources of carbohydrate (for example, rice or pasta) and protein (for example, meat or fish). Calculation of nutrient intakes from the FFQ items and portion size estimations is described elsewhere (45). Food items were recalculated into grams/day by multiplying frequency with portion size and adjusting for validated sex- and age-specific intake levels, defined by repeated 24 hour dietary recalls (43). For boiled coffee, the original scale, occasions/day was used, to facilitate comparison with previous studies. Intakes were energy adjusted by the residual method (46).

Under-reporting

To define low-energy reporters within the data-set, a direct comparison of FIL and physical activity level (PAL) was used, which is a method appropriate for large sample sizes (47). PAL, available for 94.5% of the subjects, was estimated from 2 questions on general, work-related activity and leisure-time physical activity in exercise clothes (48). Cut-offs for definition of low-energy reporters (61.5% of subjects with PAL-data) were calculated by the Goldberg method, modified by Black (47), and applied to the FIL/PAL ratio separately for FFQ version and sex.

Traditional Sami diet score

A traditional Sami diet score was constructed in a similar manner to the Mediterranean diet score (1), by adding 1 point for each intake above or below the median intake of several dietary items characteristic or uncharacteristic of the traditional Sami diet, respectively. The selection of these dietary items was based on historical references (7–9), interviews in which elderly Sami were asked how they thought that their parents would have filled out the VIP FFQ in the 1930s–1950s (10), and present-time descriptions, including comparisons of diet and lifestyle in present-day reindeer-herding Sami, non-herding Sami and non-Sami in the VIP cohort (10–13). The score included 1 point for each intake above the median for red meat, fatty fish, total fat, berries and boiled coffee and 1 point for each intake below the median for vegetables, bread and fibre, all calculated separately for sex and FFQ version, thus creating a range from 0 to 8 points for each subject.

Ethnicity data were not available in this study. However, the Sami participants with the 84-item FFQ should overlap almost completely with the dataset from our previous study containing ethnicity data at an individual level (10). In order to provide some indication of the validity of the score, we therefore used that dataset to calculate median traditional Sami diet scores for reindeer-herding Sami, non-reindeer-herding Sami and geographically matched non-Sami.

A sensitivity analysis was performed by testing models in which the selected traditional Sami diet score items were excluded from the score one by one, yielding 8 models of 0–7 points. Heterogeneity between these reduced models and the original traditional Sami diet score were tested by chi-square tests. Furthermore, an extended, 10-point traditional Sami diet score was modelled, including intakes of blood dishes and liver/kidney, in the sub-sample of subjects with 84-item FFQs.

Identification of mortality end-points

Mortality end-points up to and including 31 December 2007, were identified by linking the VIP database with the Swedish national cause-of-death registry. 12-digit Swedish personal identification numbers were used as the linkage variable. Cancer mortality was defined as underlying cause of death, ICD-9 codes 140–208, or ICD-10 codes C00–C97. CVD mortality was defined as the main cause of death and/or underlying cause of death, ICD-9 codes 390–438, or ICD-10 codes I00–I69.

Statistical analysis

Likely predictors of mortality, including age, body mass index (BMI, kg/m^2), current smoking (yes/no), education (lack of post-secondary, yes/no), sedentary lifestyle (no regular physical activity in exercise clothes, yes/no), and intake of alcohol (g/day), fat (g/day), saturated fat (g/day), and total energy (kcal/day), were examined for association with traditional Sami diet score categories by Kruskal–Wallis tests (Tables I and II).

Sex-specific hazard ratios (HR) for all-cause, cancer (including the most common cancer sites), and CVD mortality were calculated by Cox regression. Though all lifestyle variables were significantly associated with traditional Sami diet score categories in at least 1 sex, none met our criterion for a confounder: altering the HR for the traditional Sami diet score by 10% or more when included in a bivariate model. To facilitate comparison with other studies, common risk factors were kept in the multivariate Model 2, which thus included: age, BMI, current smoking, education, sedentary lifestyle, and intake of alcohol and total energy. Missing values, only present in categorical covariates, were included as dummy variables.

Proportional hazard assumptions were confirmed by Schoenfeld's test. With age categorised into 10-year age groups, all covariates fulfilled the criteria for the proportional hazard assumption in men, but in women the exposure variable, traditional Sami diet score, did not, P Shoenfeld's test = 0.032. This minor deviation from proportionality indicates an increased risk of unstable results in women, but probably does not otherwise affect our results materially. We have chosen to present results for both men and women, in order to provide as complete a description of the cohort as possible, but our interpretation of the results in women is conservative.

Table I. Baseline characteristics of Västerbotten Intervention Program participants according to traditional Sami diet score

Traditional Sami diet score[a]		Low (0–3 points) Number	Low (0–3 points) Median (1st–3rd quartile) or frequency (%)	Medium (4–5 points) Number	Medium (4–5 points) Median (1st–3rd quartile) or frequency (%)	High (6–8 points) Number	High (6–8 points) Median (1st–3rd quartile) or frequency (%)	p Kruskal–Wallis
Age at recruitment (years)	Men	15164	50 (40–60)	14933	50 (40–50)	7542	40 (40–50)	≤0.001
	Women	16432	50 (40–60)	15441	50 (40–50)	7807	40 (40–50)	≤0.001
Follow up (years)	Men	15164	10.0 (5.9–13.6)	14933	10.1 (5.7–13.8)	7542	9.9 (5.7–13.5)	0.072
	Women	16432	10.2 (6.8–13.8)	15441	10.7 (6.6–13.9)	7807	10.7 (6.1–13.9)	0.038
Body mass index (kg/m^2)	Men	15164	25.7 (23.8–28.0)	14933	25.8 (23.8–28.1)	7542	26.0 (24.0–28.4)	≤0.001
	Women	16432	24.5 (22.4–27.4)	15441	24.4 (22.2–27.5)	7807	24.5 (22.3–27.6)	0.202
Current smokers	Men	14979	2183 (14.6)	14699	2673 (18.2)	7404	1540 (20.8)	≤0.001
	Women	16301	2636 (16.2)	15305	3336 (21.8)	7747	2964 (25.4)	≤0.001
No postsecondary Education	Men	15090	11357 (75.3)	14848	11549 (77.8)	7501	6067 (80.9)	≤0.001
	Women	16328	10841 (66.4)	15328	10794 (70.4)	7751	5646 (72.8)	≤0.001
Sedentary lifestyle[b]	Men	15026	9681 (64.4)	14761	10386 (70.4)	7450	5479 (73.5)	≤0.001
	Women	16247	10048 (61.8)	15285	10449 (68.4)	7702	5551 (72.1)	≤0.001
Physical activity level (PAL)[c]	Men	14381	1.6 (1.5–1.7)	14211	1.6 (1.5–1.7)	7190	1.6 (1.5–1.7)	≤0.001
	Women	15462	1.6 (1.5–1.7)	14539	1.6 (1.5–1.7)	7362	1.6 (1.5–1.7)	≤0.001
Low outdoor activity[d]	Men	11386	4460 (39.2)	11139	4723 (42.4)	5554	2377 (42.8)	≤0.001
	Women	12446	5956 (47.9)	11566	5964 (51.6)	5690	2940 (51.7)	≤0.001

[a]Calculated separately for FFQ version and sex.
[b]Sedentary lifestyle was defined as no regular physical activity in exercise clothes.
[c]Physical activity level was estimated from 2 questions on general, work-related activity and leisure-time physical activity in exercise clothes (48).
[d]Low outdoor activity was defined as at most 2 regular leisure time outdoor activities among the following: walking (≥1 times/day), biking (≥1 times/day), collecting berries/mushrooms (≥1 times/week), gardening (≥1 times/week) or shovelling snow (≥1 times/week) or fishing/hunting (≥1 times/month).

Table II. Baseline dietary characteristics of Västerbotten Intervention Program participants according to traditional Sami diet score

	Low (0–3 points)		Medium (4–5 points)		High (6–8 points)		
Traditional Sami diet score[a]	Number	Median (1st–3rd quartile) or frequency (%)	Number	Median (1st–3rd quartile) or frequency (%)	Number	Median (1st–3rd quartile) or frequency (%)	p Kruskal–Wallis
Energy (Kcal/day)							
Men	15164	2020 (1658–2436)	14933	1961 (1602–2401)	7542	1891 (1567–2348)	≤0.001
Women	16432	1541 (1271–1826)	15441	1492 (1238–1808)	7807	1407 (1197–1742)	≤0.001
Fat (energy%)							
Men	15164	33.1 (29.7–36.1)	14933	37.5 (34.0–41.4)	7542	40.6 (37.7–44.0)	≤0.001
Women	16432	29.5 (26.4–32.2)	15441	34.0 (30.8–37.5)	7807	36.8 (34.2–40.0)	≤0.001
Protein (energy%)							
Men	15164	14.2 (12.9–15.5)	14933	14.4 (13.0–15.9)	7542	14.9 (13.5–16.4)	≤0.001
Women	16432	14.6 (13.4–15.9)	15441	15.0 (13.6–16.4)	7807	15.4 (14.0–16.8)	≤0.001
Carbohydrates (energy%)							
Men	15164	51.7 (48.4–55.1)	14933	47.0 (43.4–50.5)	7542	43.4 (40.0–46.5)	≤0.001
Women	16432	54.7 (51.8–58.0)	15441	50.0 (46.7–53.2)	7807	46.9 (43.7–49.8)	≤0.001
Sucrose (energy%)							
Men	15164	14.2 (10.2–19.0)	14933	14.0 (9.9–19.1)	7542	13.2 (9.4–18.0)	≤0.001
Women	16432	14.4 (11.1–18.4)	15441	14.3 (10.8–18.6)	7807	13.8 (10.2–18.2)	≤0.001
Fibre (g/day)							
Men	15164	23 (19–29)	14933	18 (14–22)	7542	14 (11–18)	≤0.001
Women	16432	21 (18–26)	15441	16 (13–20)	7807	13 (11–16)	≤0.001
Ethanol (g/day)							
Men	15164	4.5 (1.4–7.8)	14933	4.8 (1.6–8.1)	7542	5.1 (2.2–8.5)	≤0.001
Women	16432	1.9 (0.2–3.5)	15441	1.9 (0.2–3.8)	7807	1.9 (0.2–3.9)	≤0.001
Red meat (g/day)							
Men	15164	45.6 (34.3–63.6)	14933	62.8 (43.8–88.8)	7542	77.6 (56.9–107)	≤0.001
Women	16432	35.3 (26.5–49.0)	15441	47.3 (32.9–63.6)	7807	54.4 (41.9–75.6)	≤0.001
Fatty fish (g/day)							
Men	15164	4.8 (0.36–9.6)	14933	8.4 (0.36–9.6)	7542	9.6 (4.8–16.0)	≤0.001
Women	16432	4.8 (0.18–4.8)	15441	4.8 (0.36–8.4)	7807	8.4 (4.8–9.6)	≤0.001
Berries (g/day)							
Men	15164	5.2 (0.20–9.1)	14933	5.2 (0.20–9.1)	7542	5.2 (5.2–9.1)	≤0.001
Women	16432	4.3 (0.16–7.6)	15441	4.3 (0.16–7.6)	7807	4.3 (4.3–7.6)	≤0.001
Vegetables (g/day)							
Men	15164	50 (21–81)	14933	28 (10–50)	7542	15 (6.8–32)	≤0.001
Women	16432	98 (56–140)	15441	51 (29–98)	7807	34 (20–57)	≤0.001

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Table II (*Continued*)

Traditional Sami diet score[a]	Low (0–3 points) Number	Low (0–3 points) Median (1st–3rd quartile) or frequency (%)	Medium (4–5 points) Number	Medium (4–5 points) Median (1st–3rd quartile) or frequency (%)	High (6–8 points) Number	High (6–8 points) Median (1st–3rd quartile) or frequency (%)	p Kruskal–Wallis
Bread (g/day)							
Men	15164	94 (68–131)	14933	65 (37–91)	7542	42 (28–67)	≤0.001
Women	16432	76 (59–104)	15441	56 (35–75)	7807	39 (25–57)	≤0.001
Boiled coffee (times/day)							
Men	15164	0.0 (0.0–0.14)	14933	0.08 (0.0–1.0)	7542	0.36 (0.08–2.5)	≤0.001
Women	16432	0.0 (0.0–0.08)	15441	0.0 (0.0–1.0)	7807	0.14 (0.0–2.5)	≤0.001

[a]Calculated separately for FFQ version and sex.

Subgroups based on metabolic risk profile and physical activity at baseline were also analysed. The subgroup with low metabolic risk profile included subjects free from hypertension, diabetes, and obesity, whereas a high metabolic risk profile included hypertension and/or diabetes and/or obesity. Hypertension was defined as systolic blood pressure $\geq$140 mm Hg and/or diastolic blood pressure $\geq$90 mm Hg and/or use of medication to lower blood pressure. For classification as non-hypertensive, blood pressure measurement was required. Diabetes was defined as self-reported diabetes and/or fasting plasma glucose $\geq$7.0 mmol/L and/or post-load glucose $\geq$12.2 mmol/L (measured in capillary plasma). For classification as non-diabetic, measurement of fasting or post-load glucose was required. Obesity was defined as BMI $\geq$30 kg/m^2. For physical activity, the cohort was stratified according to PAL above or below the median.

In order to ensure that dietary changes due to disease did not affect the results, we did analysis with excluding all subjects with follow-up times shorter than 2 years. Analyses were also performed after excluding low-energy reporters. In addition we replaced the sedentary lifestyle variable in the multivariate model with PAL or with a variable representing low physical activity outdoors, the latter encompassing questions on walking, biking, picking berries or mushrooms, gardening, shovelling snow, and hunting and fishing.

Statistical analyses were performed with IBM SPSS software, version 19.0. All tests were 2-sided, and p-values $<$0.05 were considered statistically significant.

Ethics

The study protocol and data handling procedures were approved by the Regional Ethical Review Board of Northern Sweden (Dnr 07-165M). Evaluation by a specific ethical review board representing the Sami society would also have been desirable, but such a board does not exist in Sweden at present. All study subjects provided written informed consent, and the study was conducted in accordance with the Declaration of Helsinki.

Results

Among the 77,319 subjects included in the study, a total of 2,383 deaths occurred, including 975 cancer related and 681 CVD related. The median age at recruitment was 49 years. Follow-up times ranged from 1 day to 19 years, with a median of 10 years. In the study population, 20.0% of men and 19.7% of women had high traditional Sami diet scores (6–8 points). Table I shows baseline characteristics of the Västerbotten Intervention Program participants according to traditional Sami diet score. A high traditional Sami diet score was associated with lower age, education level and PAL, and higher prevalence of smoking, sedentary lifestyle and low outdoor

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activity level. In men, a high traditional Sami diet score was also associated with higher BMI.

Table II shows the intake levels of various food items, including those making up the traditional Sami diet score, as well as total energy and ethanol intakes. The greatest variability was found for vegetables and bread, of which subjects with high traditional Sami diet scores had reported intakes of at most half those of subjects with low traditional Sami diet scores. Intakes of red meat and fatty fish also varied considerably, with higher intakes associated with higher traditional Sami diet scores. Further, a high traditional Sami diet score was associated with a lower total energy intake and a higher ethanol intake, especially in men.

In Table III, HRs for all-cause, cancer and CVD mortality per 1-point increase in traditional Sami diet score are shown. In the crude Model 1, adjusted only for age, increasing traditional Sami diet score was associated with an elevated all-cause mortality in both men and women [Crude HR for men 1.07 (95% CI 1.04–1.10) $p \leq 0.001$; Crude HR for women 1.06 (95% CI 1.02–1.11) $p \leq 0.001$]. In the multivariate Model 2, adjusted for age, BMI, current smoking, education, sedentary lifestyle, and intake of alcohol and total energy, risk associations were attenuated and only statistically significant in men [Multivariate HR for men 1.04 (95% CI 1.01–1.07), $p = 0.018$; Multivariate HR for women 1.03 (95% CI 0.99–1.07), $p = 0.130$]. In the subgroup analyses, a statistically significantly elevated all-cause mortality risk was found only in men with a low metabolic risk profile, that is, free from hypertension, diabetes and obesity [Multivariate HR 1.06 (CI = 1.02–1.11) $p = 0.008$], and in men with a low PAL [Multivariate HR 1.05 (CI = 1.01–1.09) $p = 0.019$].

For cancer and CVD mortality, HRs were above 1 and statistically significant in both men and women in Model 1. However, associations were not statistically significant in the multivariate Model 2, except for CVD mortality in men with a low metabolic risk profile [Multivariate HR 1.10 (CI = 1.01–1.20) $p = 0.023$]. Risk associations were above or very close to 1, but not statistically significant, for the most common cancer sites: colorectum (127 deaths), pancreas (93 deaths), breast (80 deaths), prostate (60 deaths), and stomach (52 deaths) (data not shown), with the possible exception of respiratory tract cancer (122 deaths), in which an increased risk with increasing traditional Sami diet score of borderline statistical significance was observed [Multivariate HR 1.11 (CI = 1.00–1.24) $p = 0.053$].

In the subsample of 29,969 subjects with the 84-item FFQ (992 male deaths, 673 female deaths), for whom liver/kidney and blood dishes were added to the traditional Sami diet score (0–10 points), results were weaker (data not shown). Results were stronger in subjects who reported a more adequate total energy intake [Multivariate HR for all-cause mortality in men 1.07 (CI = 1.02–1.13) $p = 0.009$; and women1.08 (CI = 1.00–1.16) $p = 0.047$, for all-cause mortality]. Excluding subjects with < 2 years of follow-up, or replacing the sedentary lifestyle variable with PAL or low outdoor physical activity in the multivariate model, had no material effect on the results for all-cause, cancer or CVD mortality, except a reduction in power due to more missing values (data not shown).

In Table IV, HRs for all-cause mortality for the individual dietary items included in the traditional Sami diet score items are presented. For most of the positively defined traditional Sami diet score items (1 point for intake $>$ median) there were no associations. Exceptions were higher intake of red meat in women [Multivariate HR 1.17 (CI = 1.02–1.34) $p = 0.023$] and higher intake of fat in men [Multivariate HR 1.12 (CI = 1.01–1.25) $p = 0.037$]. In negatively defined traditional Sami diet score items (1 point for intake $<$ median), statistically significant risk associations were observed for low intake of vegetables [Multivariate HR 1.14 (CI = 1.02–1.27) $p = 0.016$] and bread [Multivariate HR 1.14 (CI = 1.03–1.27) $p = 0.014$] in men.

The results of the sensitivity analysis are shown in Table V. The risk association for all-cause mortality was not materially affected by the removal of any 1 dietary item included in the score. These analyses were performed in men only because of the instability of the traditional Sami diet score Cox regression model in women, as noted in the materials and methods section.

Applying the traditional Sami diet score on the dataset used in our previous study (10), yielded a median (1st–3rd quartile) score of 6.0 (4.0–7.0) points in reindeer-herding Sami, 4.5 (3.0–6.0) points in non-reindeer-herding Sami, and 4.0 (3.0–5.0) points in geographically matched non-Sami ($p \leq 0.001$).

Discussion

In this largely non-Sami, population-based cohort study of 77,319 men and women in northern Sweden, with up to 19 years of follow up, higher traditional Sami diet scores were associated with a weak increase in all-cause mortality in men. This increased risk may be equally attributed to CVD and cancer, since HRs above 1 were the general pattern for both endpoints, but it appeared to be particularly pronounced for CVD mortality in men with a low metabolic risk profile (free from diabetes, hypertension and obesity). In women, we found no stable risk associations for traditional Sami diet score, though all HRs were ≥ 1.

Our findings, in a largely non-Sami population, are generally in line with the evidence to date for the individual components of the traditional Sami diet score. Although the score is high in some foods widely considered to be healthy, such as fatty fish (25) and berries

Table III. Hazard ratios for all-cause, cancer and cardiovascular disease mortality by traditional Sami diet score in participants of the Västerbotten Intervention Program cohort 1990–2008

	Men					Women				
		Model 1[b,c]		Model 2[b,d]			Model 1[b,c]		Model 2[b,d]	
Traditional Sami diet score[a]	Number of deaths	Hazard ratio (95% CI)	p	Hazard ratio (95% CI)	p	Number of deaths	Hazard ratio (95% CI)	p	Hazard ratio (95% CI)	p
All-cause mortality										
All subjects	1460	1.07 (1.04–1.10)	≤0.001	1.04 (1.01–1.07)	0.018	923	1.06 (1.02–1.11)	≤0.001	1.03 (0.99–1.07)	0.130
Low metabolic risk[e]	721	1.09 (1.04–1.14)	≤0.001	1.06 (1.02–1.11)	0.008	521	1.07 (1.01–1.12)	0.012	1.02 (0.97–1.08)	0.350
High metabolic risk[f]	739	1.04 (1.00–1.09)	0.043	1.02 (0.97–1.06)	0.455	402	1.06 (1.00–1.12)	0.060	1.03 (0.97–1.10)	0.262
Low PAL[g]	868	1.07 (1.03–1.11)	≤0.001	1.05 (1.01–1.09)	0.019	551	1.04 (0.99–1.10)	0.081	1.01 (0.96–1.06)	0.702
High PAL[h]	592	1.07 (1.02–1.13)	0.003	1.03 (0.98–1.08)	0.216	372	1.09 (1.03–1.16)	0.004	1.06 (1.00–1.13)	0.050
Cancer mortality										
All subjects	493	1.07 (1.01–1.13)	0.013	1.05 (0.99–1.10)	0.102	482	1.06 (1.00–1.11)	0.038	1.03 (0.97–1.09)	0.304
Low metabolic risk[e]	288	1.08 (1.00–1.15)	0.036	1.05 (0.98–1.13)	0.141	301	1.05 (0.98–1.12)	0.161	1.01 (0.94–1.08)	0.768
High metabolic risk[f]	205	1.06 (0.98–1.15)	0.167	1.04 (0.95–1.13)	0.430	181	1.07 (0.98–1.16)	0.119	1.06 (0.97–1.15)	0.233
Low PAL[g]	301	1.06 (0.99–1.13)	0.112	1.05 (0.98–1.12)	0.194	294	1.03 (0.96–1.10)	0.360	1.00 (0.94–1.08)	0.885
High PAL[h]	192	1.09 (1.00–1.19)	0.043	1.05 (0.97–1.15)	0.241	188	1.09 (1.01–1.19)	0.036	1.08 (0.99–1.17)	0.086
CVD mortality										
All subjects	500	1.06 (1.00–1.12)	0.032	1.02 (0.97–1.08)	0.370	181	1.10 (1.01–1.20)	0.025	1.05 (0.96–1.15)	0.287
Low metabolic risk[e]	210	1.12 (1.04–1.22)	0.004	1.10 (1.01–1.20)	0.023	79	1.18 (1.04–1.34)	0.012	1.10 (0.96–1.25)	0.179
High metabolic risk[f]	290	1.01 (0.94–1.08)	0.872	0.98 (0.91–1.05)	0.485	102	1.03 (0.92–1.16)	0.570	1.00 (0.89–1.13)	0.953
Low PAL[g]	302	1.07 (1.00–1.14)	0.058	1.05 (0.98–1.12)	0.174	108	1.07 (0.96–1.19)	0.254	1.02 (0.91–1.14)	0.715
High PAL[h]	198	1.04 (0.96–1.14)	0.305	1.00 (0.92–1.08)	0.952	73	1.15 (1.00–1.31)	0.042	1.08 (0.94–1.23)	0.297

[a]Based on intake of red meat, fatty fish, fat, berries, boiled coffee, vegetables, bread and fibre, which are intake variables characteristic of traditional Sami culture (10–13).
[b]Hazard ratios were determined by Cox regression analyses.
[c]Age included as strata.
[d]Further adjusted for BMI, sedentary lifestyle, education, current smoking, intake of alcohol and total energy.
[e]Free from diabetes and hypertension and body mass index <30.00.
[f]Diabetes and/or hypertension and/or body mass index ≥ 30.00.
[g]Physical activity level ≤ 1.6 (median). Estimated from 2 questionnaire items on work-related and leisure-time physical activity (48).
[h]Physical activity level PAL >1.6 (median). Estimated from 2 questionnaire items on work-related and leisure-time physical activity (48).

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Table IV. Hazard ratios for all–cause mortality according to the "traditional Sami" dietary elements included in the traditional Sami diet score

		Men				Women		
		Model 1[a,b]	Model 2[a,c]	Mutually adjusted[a,d]		Model 1[a,b]	Model 2[a,c]	Mutually adjusted[a,d]
Sami diet elements	Number of deaths	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Number of deaths	Hazard ratio (95% CI)	Hazard ratio (95% CI)	Hazard ratio (95% CI)
Red meat (>Median)	1460	0.93 (0.83–1.03)	0.92 (0.82–1.03)	0.89 (0.80–1.00)	923	1.20 (1.05–1.37)	1.17 (1.02–1.34)	1.18 (1.03–1.35)
Fatty fish (>Median)	1460	1.02 (0.92–1.14)	1.03 (0.92–1.14)	1.05 (0.94–1.17)	923	0.94 (0.83–1.08)	0.96 (0.84–1.10)	0.94 (0.92–0.98)
Fat (>Median)	1460	1.22 (1.10–1.35)	1.12 (1.01–1.25)	1.11 (0.99–1.24)	923	1.17 (1.02–1.33)	1.06 (0.92–1.22)	1.03 (0.88–1.19)
Berries (>Median)	1460	0.92 (0.82–1.02)	0.94 (0.84–1.05)	0.94 (0.84–1.05)	923	1.04 (0.91–1.19)	1.04 (0.90–1.21)	1.06 (0.91–1.23)
Boiled coffee (>Median)	1460	1.20 (1.09–1.33)	1.10 (0.99–1.22)	1.09 (0.98–1.22)	923	1.10 (0.96–1.25)	1.00 (0.87–1.15)	0.99 (0.86–1.14)
Blood dishes[e] (>Median)	939	1.01 (0.89–1.15)	1.00 (0.88–1.14)	0.98 (0.86–1.12)	641	0.92 (0.79–1.08)	0.94 (0.80–1.10)	0.94 (0.79–1.10)
Liver/kidney[e] (>Median)	939	1.12 (0.98–1.27)	1.10 (0.95–1.26)	1.10 (0.96–1.27)	641	1.12 (0.96–1.31)	1.04 (0.87–1.23)	1.07 (0.89–1.27)
Vegetables (<Median)	1460	1.28 (1.15–1.42)	1.14 (1.02–1.27)	1.12 (1.00–1.25)	923	1.15 (1.01–1.31)	1.08 (0.94–1.24)	1.07 (0.93–1.24)
Bread (<Median)	1460	1.16 (1.05–1.29)	1.14 (1.03–1.27)	1.16 (1.03–1.31)	923	1.05 (0.92–1.20)	1.00 (0.87–1.15)	0.96 (0.83–1.12)
Fibre (<Median)	1460	1.15 (1.03–1.28)	1.09 (0.97–1.21)	0.96 (0.84–1.09)	923	1.17 (1.02–1.33)	1.07 (0.93–1.23)	1.03 (0.87–1.22)

[a]Hazard ratios were determined by Cox regression analyses.
[b]Age included as strata.
[c]Further adjusted for BMI, sedentary lifestyle, education, current smoking, intake of alcohol and total energy.
[d]Adjusted as in footnote 3, as well as for the remaining items in the traditional Sami diet score.
[e]Inclusion in the traditional Sami diet score tested in subjects with data on intake of blood dishes and liver/kidney (subjects with a more extensive version of the food frequency questionnaire).

(26), it is also rich in foods associated with negative health outcomes such as red meat for colorectal and other cancers (19), and lacking in foods associated with positive health outcomes such as vegetables for reduced CVD risk (20).

Null associations were also found for fatty fish and berries. In a previous report from the same northern Swedish population, no associations between reported fish consumption (lean and fatty fish combined) and risk of acute myocardial infarction were observed (49). In our previous interviews with elderly Sami 50–70 years ago, we found that intakes of both fatty fish and berries were likely much higher than the intakes of either Sami or non-Sami in Västerbotten today (10). Thus, the present-day diet in the population of Västerbotten may deviate from the "traditional Sami" diet to such a degree that potential health effects cannot be revealed.

Former studies have suggested that the slightly reduced cancer risk in Sami populations might be due to traditional Sami diets (30). Our results do not seem to support this suggested explanation. However, not only does the present-day diet in Västerbotten deviate considerably from our definition of "traditional Sami" diet, but it is also possible that our traditional Sami diet score does not closely enough reflect the "traditional Sami" diet, which is, in itself difficult to define. Knowledge of the diet prior to the 1700s is limited (7,9), and the centuries since then have been marked by considerable change for the Sami population (10). Dietary habits have also varied within the Sami population (8). Furthermore, the VIP FFQ was not designed to capture a "traditional Sami" diet, for example by distinguishing between different kinds of red meat, such as wild game and reindeer meat and commercial beef, or fish bought and fish caught in the wild, or wild berries and greens and cultivated ones. Such foods may differ not only in biochemical composition (26,50), but also in related social or behavioural elements not otherwise accounted for in the statistical analyses. Thus, the VIP FFQ is inevitably an imprecise tool for the construction of a score representing a "traditional Sami" dietary pattern.

The traditional Sami diet score was not intended to reflect the diet of the Sami today. However, we have previously observed differences in the diet of present-day reindeer-herding Sami, non-reindeer-herding Sami and non-Sami groups using the VIP FFQ (10,12). Furthermore, traditional Sami diet scores were high in reindeer-herding Sami compared to the other groups in that dataset (10), suggesting some degree of validity for the score, even in the present day.

In diet score methodology, overall effects of adherence to a certain dietary pattern are studied, allowing for a single measure encompassing all potential interactions among the dietary components included, but also preventing the detection of effects related to the specific components or interactions. Dietary patterns are thus considered more relevant for public health recommendations, but less relevant for understanding underlying mechanisms (51). Diet scores inevitably provide a rough estimate of diet. To preserve power and limit complexity, they are often restricted to relative, dichotomous, rather than absolute, multiple, cut-offs, and equal weighting of a limited number of dietary components comprising the score. However, as the success of the Mediterranean diet illustrates, diet scores can be an important tool in the field of nutritional epidemiology.

The intervention built into the Västerbotten Intervention Program, in which diabetes and hypertension diagnosed through the health survey are treated, may have diluted our results. The weaker risk associations in men with metabolic risk factors at baseline may reflect

Table V. Sensitivity analysis for the traditional Sami diet score in men, a comparison of all-cause mortality using 8 reduced models, in which the traditional Sami diet score items were excluded from the score one by one

Component excluded from traditional Sami diet score:	Number of deaths	Model 2[a,b] hazard ratio (95% CI)	p heterogeneity[c]
None (complete traditional Sami diet score)	1460	1.04 (1.01–1.07)	Reference
Fat excluded	1460	1.04 (1.00–1.07)	0.904
Fatty fish excluded	1460	1.04 (1.01–1.08)	0.903
Fibre excluded	1460	1.04 (1.01–1.08)	0.875
Bread excluded	1460	1.04 (1.00–1.07)	0.875
Boiled coffee excluded	1460	1.04 (1.00–1.07)	0.871
Vegetables excluded	1460	1.03 (1.00–1.07)	0.741
Berries excluded	1460	1.05 (1.01–1.08)	0.710
Red meat excluded	1460	1.06 (1.02–1.09)	0.522

[a]Hazard ratios were determined by Cox regression analyses.
[b]Adjusted for age, BMI, sedentary lifestyle, education, current smoking, intake of alcohol and total energy.
[c]Tests for heterogeneity between the result presented and the result for the complete traditional Sami diet score were performed by a chi-square test.

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such an effect. Chance findings may have occurred due to multiple testing, and p-values should therefore be interpreted conservatively. There is also a substantial risk of residual confounding due to factors not, or not adequately, assessed by the VIP questionnaire and health survey, such as smoking history, defined only as current smoker, yes/no, and socioeconomic status, represented by education level, in the present study.

Physical activity, in particular physical activity patterns of the traditional Sami lifestyle, is another important example of residual confounding. Much of the extensive physical activity, while not directly related to occupation, was conducted essentially by need and not as leisure-time or recreational activity (10). Furthermore, recreational physical activity in exercise clothes is a rough measure of physical activity. This question, and the work-related physical activity question, in the VIP FFQ are therefore probably inadequate for the assessment of physical activity as a confounder or effect modifier of the relationship between traditional Sami diet score and mortality. However, replacing the sedentary lifestyle variable with a low outdoor physical activity variable did not materially affect the main findings.

The main strengths of this study were the population-based cohort design, the long follow up (up to 19 years), and the large sample size, as well as the rather unique aspect of examining the general population from a minority perspective. This was also the first study to examine a "traditional Sami" dietary pattern in relation to any health outcome.

In conclusion, a weak increased mortality was observed for subjects with higher traditional Sami diet scores. Given the inherent limitations of the questionnaire used, and the difficulty defining a score reflecting traditional Sami diet, this study should be considered exploratory, a first attempt to address this topic. Further study of cohorts with more detailed information on dietary and lifestyle items relevant for traditional Sami culture is warranted.

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