



## Sami dietary habits and the risk of cardiometabolic disease: a systematic review

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### ABSTRACT

This systematic literary review investigates if an association between Sami dietary habits and cardiometabolic outcomes exists, and examines the dietary characteristics and cardiometabolic status of the Sami population. Included were all articles assessing Sami dietary habits and cardiometabolic disease or risk factors. Embase, Medline and SweMed were searched on 26 September 2019 and articles were screened for eligibility in October 2019. Data were extracted according to Moose Guidelines and the Newcastle Ottawa Scale (NOS) was used to assess risk of bias. The initial search generated 4,195 articles in total. Nine articles met all inclusion criteria. Two were cohort studies and seven were cross-sectional. Rating by NOS ranked from 2/7 to 8/9 stars. The studies were largely descriptive and only few had results regarding a direct association between Sami dietary habits and cardiometabolic outcomes. The findings demonstrated no association between consumption of certain Sami food items and blood-lipids or mortality from CVD/CHD. A higher intake of fat, protein, reindeer-meat and coffee and a slightly lower blood pressure and mortality from CVD/CHD was seen among Sami compared with non-Sami. The limited amount and descriptive nature of the eligible articles indicate that research within the field is limited. Thus, additional longitudinal studies are suggested.

### ARTICLE HISTORY

Received 25 June 2020  
Revised 7 December 2020  
Accepted 3 January 2021

### KEYWORDS



Sami; arctic peoples; diet; nutrition; cardiometabolic disease; cardiometabolic risk factors


## Introduction

According to the World Health Organisation, indigenous populations are defined as communities that live within geographically distinct traditional territories and maintain cultural and social identities separate from the dominant society [1]. There are over 370 million indigenous people living in the world today and arctic indigenous peoples make up approximately 10% of the total population living in arctic areas [2,3]. The Sami from the northern parts of Norway, Sweden, Finland and the Kola Peninsula of Russia are one of these peoples. Internationally, indigenous populations are known to have poorer health compared with majority populations, e.g. lower life-expectancies and higher rates of obesity [4]. Nutrition and diet are frequently examined determinants of health and are being linked to the development of obesity and cardiometabolic diseases [5–7]. As an example, traditional dietary patterns like the Mediterranean diet and the hunter-gatherer diet have been found inversely correlated with the development of cardiovascular diseases (CVD) [8,9], whereas a Westernised diet, characterised by a high consumption of sweetened beverages, fast and

processed foods and red meats, milk, salty snacks and sweets, may increase the risk of CVD and metabolic syndrome [10,11]. Through the last century the traditional diets of arctic indigenous peoples have undergone large transformations, moving further away from traditional hunter-gatherer based food systems towards a more Westernised diet rich in carbohydrates and sugar [12–14]. This transition may have contributed to increasing risk of obesity and CVD in some arctic populations [15,16].

The indigenous Sami people encompass less than 100,000 individuals, and their share of the total population in the traditional Sami areas makes up between < 5% (Nordland, Lappi) to 25–50% (Finnmark) [17]. Their livelihood has traditionally been based on hunting, fishing and reindeer-herding, but today many Sami are occupied within other fields [18]. The Sami diet has been known historically to be rich in reindeer-meat, fish and berries, but studies indicate that the westernisation of diets may have influenced Sami dietary habits too [18–20]. This transition could have implications for the development of cardiometabolic diseases among the Sami and increase their need of health care services. However, previous research also shows that

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 Supplemental data for this article can be accessed [here](#).

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the Sami have a health status quite similar to that of the surrounding population in the Sami area [21]. Therefore, examining the dietary intake of the Sami and their cardiometabolic risk profile may provide useful information for comparing health risk markers between different indigenous circumpolar peoples and developing future guidelines for health promotion.

Up until now no unifying review examining Sami dietary habits and the association with cardiometabolic disease has been carried out. Therefore, to summarise the available evidence, a systematic review was conducted on observational studies of the association between Sami dietary habits and cardiometabolic risk factors and disease. Furthermore, the basic characteristics of Sami diets and the cardiometabolic status of the Sami population in general were examined.

## Materials and methods

This review has been carried out in accordance to Guidelines for Meta-Analyses and Systematic Reviews of Observational Studies (MOOSE) [22].

### Eligibility for inclusion

Eligibility criteria for inclusion were original articles based on data from observational studies regarding Sami dietary habits in Norway, Sweden, Finland, and/or Russia, using full or partial registration of diet or dietary components as exposure and having cardiometabolic risk factors or disease as primary or secondary outcome. The studies should be carried out in an adult population (18 years or older). Articles were excluded if they did not meet all the criteria for inclusion. Risk factors were defined as body-mass-index, blood pressure, cholesterol, HDL, LDL, triglycerides, glucose, HbA1C and metabolic syndrome. Cardiometabolic diseases were defined according to WHO's ICD-10 (2016) classifications of ischaemic heart diseases (I20-I25), cerebrovascular diseases (I60-I69), diseases of arteries, arterioles and capillaries (I70-I79) and diabetes (E10-E14) [23].

### Search strategy and screening

Three different electronic databases were searched: Embase, Medline, and SweMed. The initial search was performed on September 26<sup>th</sup>, 2019 and encompassed all original articles published in English, Norwegian, Swedish, Danish, or German. The search strategy was built in collaboration with a research librarian from the University of Southern Denmark. Relevant search terms (MeSH and free-word) to identify study-population and

dietary exposure were found and can be seen in supplementary material. In order to minimise the risk of missing potentially relevant articles, only "exposure" terms were used in the initial search.

The screening process was carried out in October 2019. Initially all articles were screened by heading and abstract followed by a full-text screening of the remaining articles. A final hand search through the reference list of the included articles was done on October 28<sup>th</sup>, 2019 in order to locate additional articles missed by the initial search.

### Data extraction and quality assessment

Relevant items for data-extraction were identified according to the MOOSE guidelines [22]. The data-extraction was updated and revised continuously throughout the examination of the included articles. All items extracted can be seen in supplementary material. Due to large variations of exposure and outcomes reported in the articles, a meta-analysis could not be performed. Therefore, a descriptive approach was applied instead.

The quality of the studies included was assessed using The Newcastle-Ottawa Scale (NOS) for cohort studies and an adapted version for cross-sectional studies [24,25].

## Results

### Search outcome

The search generated a total of 5,519 articles (Embase: 2,650, Medline: 1,952 and SweMed: 917). After removal of duplicates 4,195 articles remained. Due to the large number of hits, more specific searches were also carried out, but they all resulted in exclusion of relevant papers, probably due to a quite diverse range of words/terms used to describe the Sami people within the literature. Hence, the initial screening of title and abstract excluded 4,115 articles leaving 80 articles for full-text screening. In the full-text screening 71 articles were excluded, of which ten could not be located in full-text online or through library resources. Two of these were located through direct contact to the publishing journal, but did not live up to the criteria for inclusion. A full list of articles excluded by full-text screening and reasons for exclusion can be found in appendix 3. No additional articles were found by the final hand-search through the reference lists.

Hence, a total of nine articles met all eligibility criteria and were included in this systematic review. The flow of search and study selection can be seen in Figure 1 [26].

## Study characteristics

All included articles were observational studies: two cohort studies [27,28] and seven cross-sectional studies [29–35]. Four studies were from Sweden, three were from Norway and two were from Finland. No studies from Russia were found. Most of the studies analysed data from larger community cohorts in northern municipalities, drawing samples of both Sami and controls [27–30,34,35]. In one study from Sweden, solely Sami reindeer-herding families and Sami or non-Sami lumber-jack families made up the study population [31]. Sami ethnicity was defined by either self-perception [29,34], ancestry [27,29,33,34], mastering of Sami language [29,34] or data from a Sami economic association [31]. In three articles no definition of ethnicity was given [30,32,35].

For the dietary assessments four studies used food-frequency questionnaires [28,29,32,35] and two of these had 24-hour recalls as supplement [28,32]. One study used 24-hour recalls only [31]. The rest of the studies registered specific dietary components [30,33] or coffee consumption [27,34]. Outcomes were assessed by clinical measurements (e.g. BMI, blood pressure) in all of the included studies except one, where BMI based on self-estimated height and weight [31]. The two cohort

studies by Tverdal et al. [27] and Nilsson et al. [28] used data from national death registers to assess mortality from CVD or coronary heart disease (CHD) and calculated rate ratio or hazard ratio respectively. The seven cross sectional studies used analyses of covariance and t-test to compare group means and proportions were compared using chi-square [27–33]. Study characteristics are summarised in Table 1.

## Associations between ethnicity, diet and cardiometabolic outcomes

All the included studies examined the association between ethnicity and diet and ethnicity and cardiometabolic risk factors separately, comparing means between groups and discussing whether an association between a Sami diet and cardiometabolic disease could exist. Only five studies however included statistical analyses of the strength of a potential association between ethnicity, diet and cardiometabolic outcomes together [27–29,31,34]. This descriptive nature of the included studies is reason for the scarce results reported in the following section. The cohort-study by Nilsson et al. examined a “traditional Sami diet” score (constructed from cluster analyses of previous Sami dietary questionnaires) in a mainly non-Sami population: No difference

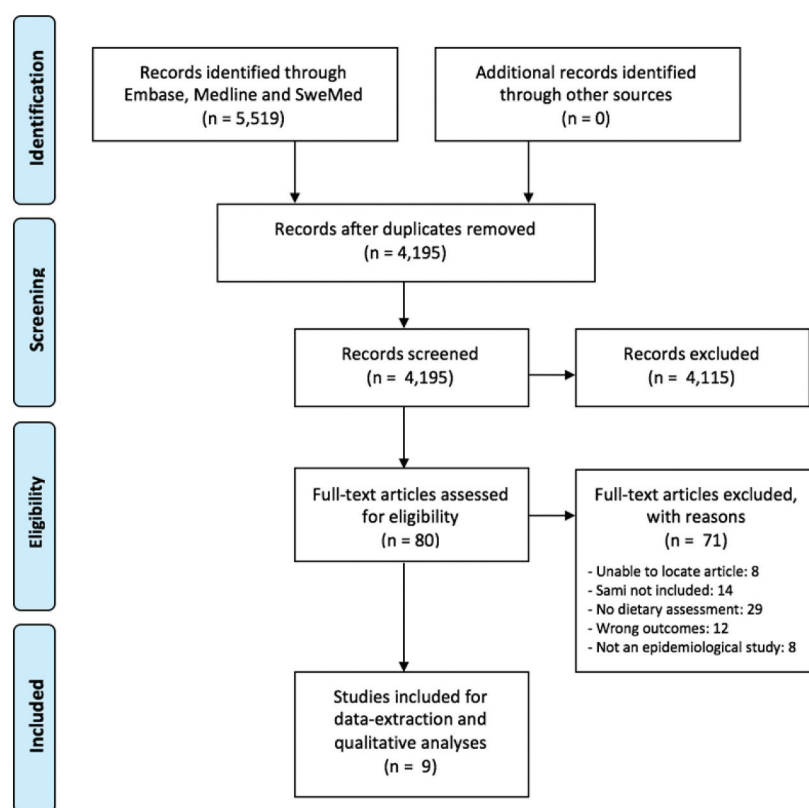


Figure 1. Flowchart of search and study selection. Design accreditation: PRISMA [26].

**Table 1.** Key characteristics of the nine articles included in this review, sorted by author.

Author (year)	Type of study	Study period	Study population	Total no. participants	Definition of Sami ethnicity	Exposure(s)	Outcome(s)	Risk association
<b>Brustad et al. (2008 29)</b>	Cross-sectional study	2003–2004	Subjects from the municipalities in Norway included in the SAMINOR study	Sami:4,267 Norwegians: 8,544 Total: 12,811	Based on language or Sami affiliations (e.g. self-perceived ethnicity)	Food-frequency questionnaire	BMI	Mean or frequency with all p-values >0.05
<b>Edin-Liljegren et al. (2004 30)</b>	Cross-sectional study	1990–2001	Sami and non-Sami participants from the Västerbotten Intervention Programme of Sweden	Sami: 661 Swedish:1,222 Total: 1,833	No information given	Consumption of saturated fats, as times consumed per day, measured by questionnaire	BMI, BP, cholesterol, lipoprotein, triglycerides, glucose	Mean ± SD with p-values
<b>Haglin (1999 31)</b>	Cross-sectional study	1990–1991	Sami families (reindeer herders or forestry Lapps) and lumberjack families from northern Sweden	Sami: 56 Swedish Lumberjacks: 65 Total:121	Based on data from Sami economic associations	24-hour recalls repeated four times. Portion sizes estimated by photographs of plates with food	BMI (by self-estimated weight and height)	Mean ± SD with p-values
<b>Laitinen et al. (1996 32)</b>	Cross-sectional study	1986	Male Finnish and Sami reindeer-herders	Sami: 56 Finns: 497 Unknown: 115 Total: 668	No information given	Food-frequency questionnaire and 24-hour recall interview	BMI, BP, cholesterol, triglycerides	Mean ± SD with p-values
<b>Luoma et al. (1995 33)</b>	Cross-sectional study	1989	Male Finnish and Sami reindeer-herders	Sami: 71 Finns: 265 Mixed: 14 Total: 350	Based on ancestry	Questionnaire regarding consumption of reindeer-meat and fish (meals per week) and biomarkers	Cholesterol, triglycerides, mortality from CHD	Mean with p-values and CI
<b>Nilsson et al. (2012 28)</b>	Retrospective cohort study	1992–2007	Mainly non-Sami participants from the Västerbotten Intervention Programme of Sweden	Low sami diet score: 31,595 Medium sami diet score: 30,374 High sami diet score: 15,349 Total: 77,318	*	Food-frequency questionnaires, 24-hour recall interviews and biomarkers Cluster analyses to create “traditional Sami diet” score	Mortality from CVD	Median with P-values and CI Hazard ratio for mortality
<b>Nystad et al. (2010 34)</b>	Cross-sectional study	2003–2004	Subjects from the municipalities in Norway included in the SAMINOR study	Sami: 3,997 Norwegian: 7,997 Total: 11,994	Based on language or Sami affiliations (e.g. self-perceived ethnicity)	Consumption of coffee as times per day, measured by self-administered questionnaire	BMI and cholesterol	Mean with p-values and CI
<b>Ross et al. (2009 35)</b>	Cross-sectional study	1990–2001	Sami participants from the Västerbotten Intervention Programme of Sweden	Sami: 595 Swedish:1,000 Total: 1,595	No information given	Food-frequency questionnaire	BMI, BP, cholesterol, lipoprotein, triglycerides, glucose	Log-transformed mean with p-values
<b>Tverdal, (1997 27)</b>	Prospective cohort study	1974–1992	Participants from a cardiovascular screening programme in Finnmark, Norway	Sami: 1,103 Finnish: 1,428 Norwegian: 4,100 Total: 6,631	Based on ancestry	Consumption of coffee and beer as times per day, measured by self-administered questionnaire	BMI, BP, cholesterol, HDL, triglycerides, coronary death, CVD death	Rate ratio with CI

\* = This study investigates the effect of a traditional Sami diet in a mainly non-Sami population, therefore no definition of Sami ethnicity is given

in hazard ratio for mortality from CVD was found for participants with a high traditional Sami diet score compared with a low, except in men with a low metabolic risk profile, where those with a high Sami diet score had a small increased hazard ratio compared to those with a low (HR = 1.10, CI [1.01–1.20] and  $p = 0.023$ ) [28]. The Swedish study by Luoma et al. found no association between consumption of reindeer-meat or fish and blood-lipids in a population of Finns and Sami reindeer-herders [33]. Håglin found no relation between energy-intake and BMI in Norwegian Sami when compared to Norwegian lumber-jacks [31]. On the other hand, another Norwegian study by Brustad et al. found that a participant group defined by a “reindeer pattern diet” had the highest proportion of obese participants (BMI > 30 = 34.3%,  $p < 0.05$ , no OR) and participants with high Sami-affiliation (Sami I) [29]. Overall, ethnicity did not play a major role in predicting dietary patterns though, except for subjects in the reindeer cluster who lived in inland areas. Lastly, two studies examined coffee intake among Sami and non-Sami and cardiometabolic outcomes: Nystad et al. stratified their study population by ethnicity in Norwegian, Sami I (Sami used as a home language for three generations), and Sami II (participants with at least one Sami identity marker) and observed that Sami II people drank about twice as much unfiltered coffee than Sami I and Norwegian [34]. They found that a high total coffee consumption regardless of brewing type was associated with increased total cholesterol in both men and women overall and stratified by the three ethnic groups, although not in Sami I men. Nystad et al found no association between unfiltered coffee intake and serum cholesterol concentration for the two Sami groups, only in the Norwegian and in all groups together, an association between unfiltered coffee intake and serum cholesterol was seen [34]. However, the difference in serum cholesterol among subjects with  $\geq 9$  cups of coffee per day and subjects drinking less than 5 cups per day are not likely to be of clinical importance (mean cholesterol 6.25 vs 6.07 mmol/L). Tverdal et al. found the rate ratio of mortality from CHD and CVD to be significantly lower among men of Sami origin compared to non-Sami (RR CHD = 0.24, [95% CI 0.09–0.63] and RR CVD = 0.31, [95% CI 0.15–0.67]), but no differences in coffee-consumption was found to account for this [27].

### Results on dietary assessment

Results regarding overall energy intake showed a lower intake [28,31], a higher intake [35] or no difference [32] when comparing Sami to non-Sami controls or a high

“traditional Sami diet” score to a low. As for the macronutrients, Ross et al. and Håglin respectively found a slightly higher intake of fat as percentage of total energy intake (E%) among Sami men compared to Swedish community controls (difference in SEM = 0.00617,  $p < 0.05$ , no absolute values reported) or Swedish lumberjacks (39 E% vs 36 E%, no CI or  $p$ -value reported) [31,35]. Nilsson et al. also found a higher intake of fat as E% to be associated with a high traditional Sami diet score compared to a low (median 40.6 E% vs 33.1 E% among men and 36.8 E% vs 29.5 E% among women,  $p < 0.001$ ) [28]. Furthermore, Ross. et al and Edin-Liljegren et. al both found an increased intake of saturated fat in their cross-sectional studies of Swedish Sami compared to community controls [30,35]. The studies reporting a higher intake of fat among Sami participants are all from the year 1999 and forward. On the other hand, one earlier study from 1996 by Laitinen et al. reports a lower intake of both fat (39 E% vs 42 E%,  $p < 0.01$ ) and saturated fat (21 E% vs 24 E%,  $p < 0.01$ ) when comparing Sami reindeer-herders to Finnish reindeer-herders [32]. For protein, three studies all found a higher intake of protein as a proportion of energy among Sami compared to community controls [31,32,35]. Nilsson et al. also found a higher intake of protein among participants with a high traditional Sami diet score compared to a low, but the difference was small (+ 0.7 E% for men and + 0.8 E% for women,  $p < 0.001$ ) [28]. Four studies had data on carbohydrates; among these, three Swedish studies found Sami diets to be associated with a lower intake compared to non-Sami diets [28,31,35]. One study from Finland found no difference in intake of carbohydrates between Sami and Finnish participants [32].

Results regarding specific food items suggested that Sami dietary habits were associated with a lower intake of bread, fibre, vegetables, and a higher intake of meat and reindeer meat, fish and coffee [28,29,32–35]. Results are summarised in Table 2.

### Results on cardiometabolic diseases and risk factors

The Norwegian cross-sectional study by Nystad et al. found a higher BMI in Sami compared with non-Sami Norwegians (28.0 vs 27.1 kg/m<sup>2</sup>,  $p = 0.0001$ ) [8]. Brustad et al. observed that a “reindeer pattern diet” had the highest proportion of participants with Sami ethnicity and obesity (BMI >30 kg/m<sup>2</sup> = 34.3%) [29]. Five studies however found no differences in BMI between Sami and non-Sami [27,30–32,35]. These included samples from all countries and from the years 1974–2001.

Three of them also reported no differences in total cholesterol [30,32,35]. A total of four studies, representing study populations from all three different countries, measured triglycerides and HDL and found no differences between Sami and non-Sami [27,32,33,35]. However, the Swedish study by Edin-Liljegren et al. found slightly lower levels of both triglycerides and HDL (TG: 1.4 vs 1.5 mmol/L,  $p = 0.019$  and HDL: 1.3 vs 1.5 mmol/L,  $p = 0.044$ ) when comparing Sami to community controls [30]. The same study also found lower blood pressure among Sami participants (126/78 vs 128/79 mmHg,  $p < 0.029$ ). A slightly lower blood-pressure among Sami participants compared to Norwegian controls was likewise found in the cohort by Tverdal et al. (134/83 vs 135/86 mmHg in men and 131/81 vs 130/81 mmHg in women), but with no indication of significance [27]. Two studies from Finland and Sweden found small differences in lower systolic blood pressure (134 vs 139 mmHg,  $p < 0.001$ ) and diastolic blood pressure (77 vs 81 mmHg,  $p = 0.0266$  in males) respectively [32,35]. LDL was only measured in two studies [30,33] and no differences were found. In summary, results indicated a higher BMI among Norwegian Sami compared to non-Sami, a slightly lower blood-pressure among Sami compared to non-Sami and no differences in cholesterol, lipoproteins or triglycerides. Results are summarised in Table 2.

### **Mortality**

The Norwegian cohort study by Tverdal et al found the rate of mortality from CHD and CVD to be significantly lower among male participants of Sami origin compared to those of Norwegian (RR CHD = 0.24, 95% CI [0.09–0.63] and RR CVD = 0.31, 95% CI [0.15–0.67]) [27]. The same trend was seen for women, but results were not significant. In the second cohort study by Nilsson et al., no overall difference in adjusted hazard ratio for mortality from CVD was found when comparing participants with a high Sami diet score to those with a low [28]. One exception however was in men with a low metabolic risk profile (HR = 1.10, 95% CI [1.01–1.20],  $p = 0.023$ ). Results are summarised in Table 2.

### **Assessment of risk of bias**

The overall quality of the studies was ranked from two stars out of seven as the lowest [31] to eight stars out of nine as the highest [28] on the Newcastle Ottawa Scale. In the cross-sectional studies, the items where most articles received a low score were on justification for sample size and characteristics of non-respondents, and high scores were seen within the categories of outcome and comparability. Both cohort studies were judged of

high quality (seven stars out of nine) although none of them had accounted for the adequacy of their follow up [27,28]. The quality assessments are shown in Table 3.

## **Discussion**

### **Findings**

Through a systematic search only nine articles were found eligible for this review about Sami dietary habits and the association with cardiometabolic diseases. The broad inclusion criteria caused for large variation in the included articles as regards to study design and methods.

Results regarding an actual association between Sami dietary habits and cardiometabolic risk or disease were limited. No overall association between a high traditional Sami diet score and mortality from CVD was found except for the subgroup “men with a low metabolic risk profile” [28] and no significant association between consumption of reindeer meat or fish and blood-lipids was seen in a population of Finns and Sami reindeer-herders either [33]. Furthermore, no association between Sami ethnicity, coffee intake and total cholesterol or mortality from CVD/CHD was found [27,34]. Only the results from the Norwegian study by Brustad et al. [29] suggested an association between a “reindeer pattern diet” and a higher proportion of obese participants and participants with high Sami-affiliation (Sami I). Hence, the overall findings in this review do not point to a strong association between Sami diet and cardiometabolic risk or disease, but the small amount of studies eligible for inclusion and the large heterogeneity in study design and results show an absence of evidence within the field. Furthermore, it has limited the possibility of noticing changes in association over time.

When examining Sami dietary habits, observations from the included articles regarding overall energy intake among Sami compared to non-Sami pointed in different directions [28,31,32,35]. Results regarding intake of fat, saturated fat and protein mainly suggested a higher intake among the Sami or participants adhering to a traditional Sami diet compared to controls [28,30–32,35]. These findings could be due to a higher intake of fatty fish and meat, and a lower intake of carbohydrates, vegetables and fibre [28,32,33,35].

In 1996, Laitinen et al. found a lower intake of fat among Sami participants vs non-Sami participants [32]. This is contrary to the findings of four of the more recent studies from 1999–2012, where a higher intake

**Table 2.** Summary of dietary assessments and cardiometabolic outcomes found in the nine included articles.

	Diet (Sami vs. controls)										Cardiometabolic outcomes (Sami vs. controls)								
	Overall energy intake	Fat	Saturated fat	Carbohydrates	Protein	Meat	Fish	Bread + fibre	Vegetables	Coffee	BMI	Cholesterol	HDL	LDL	Triglycerides	Systolic BP	Diastolic BP	Glucose	Mortality
Brustad et al. (2008) <sup>a</sup> [29]	/	/	/	/	/	↑	/	/	NS	↑	↑	/	/	/	/	/	/	/	/
E.-Liljegren et al. (2004 30)	/	/	↑	/	/	/	/	/	/	/	NS	↓	NS	↓	↓	↓	↓	NS	/
Haglin (1999 31)	↓	↑	/	↓	↑	/	/	↓	/	/	NS	/	/	/	/	/	/	/	/
Laitinen et al. (1996 32)	NS	↓	↓	NS	↑	↑	NS	NS	NS	NS	NS	NS	/	NS	↓	NS	/	/	/
Luoma et al. (1995 33)	/	/	/	/	/	↑	↑	/	/	/	/	↑	NS	NS	/	/	/	/	↑ <sup>c</sup>
Nilsson et al. (2012) <sup>b</sup> [28]	↓	↑	/	↓	↑	↑	↑	↓	↑	↑	/	/	/	/	/	/	/	/	NS
Nystad et al. (2010 34)	/	/	/	/	/	/	/	/	↑	↑	↑	/	/	/	/	/	/	/	/
Ross et al. (2009 35)	↑	↑	↑	↓	↑	↑	↑	↓	NS	NS	NS	NS	/	NS	NS	↓	↓	↑*	/
Tverdal (1997 27)	/	/	/	/	/	/	/	/	NS	↑*	↑	NS	/	NS	NS	↓	↓	/	↓ <sup>Λ</sup>

↑ = higher for Sami vs. controls, ↓ = lower for Sami vs. controls, NS = no significant diff. between Sami and controls, / = no data collected, *a* = comparison of participants with a "reindeer pattern diet" to four other patterns, *b* = comparison of participants with a high Sami diet score to those with a low *c* = comparison of mortality from CHD in traditional Sami communes compared to traditional non-Sami communes, \* = for females only, ^ = for males only, ^ = lower in both groups, only significant for men, (-) = data not applicable in this model

Table 3. Quality assessments.

Authors	Selection			Comparability		Outcome		Overall quality report
	Representative study sample size	Ascertainment of exposure	Non-respondents	1) Study controls for most important factor)	1) Study controls for additional important factor	Assessment of outcome	Statistical test	
<b>Brustad et al.</b> [29]	a ((★)	c	b	Smoking ((★)	Age ((★)	/	a ((★)	(★(★) / (★(★) / (★ (5 out of 7) (★(★) / (★(★) / (★ (4 out of 9)
<b>Edin-Lijegren et al.</b> [30]	b ((★)	c	c	b	b	b ((★(★)	a ((★)	(★(★) / (★(★) / (★ (5 out of 7) (★(★) / (★(★) / (★ (4 out of 9)
<b>Häglin</b> [31]	c	c	c	b	Age ((★)	/	a ((★)	- / (★) / (★ (2 out of 7)
<b>Laitinen et al.</b> [32]	c	c	b	b	Age ((★)	b ((★(★)	a ((★)	- / (★) / (★(★) / (★ (4 out of 9)
<b>Luoma et al.</b> [33]	c	b ((★)	c	Smoking ((★)	Age ((★)	b ((★(★)	b	(★) / (★(★) / (★(★) (5 out of 9)
<b>Nystad et al.</b> [34]	a ((★)	c	a ((★)	Smoking ((★)	Age ((★)	b ((★(★)	a ((★)	(★(★) / (★(★) / (★(★) / (★(★) (8 out of 9)
<b>Ross et al.</b> [35]	b ((★)	c	b	b	Total energy intake ((★)	b ((★(★)	a ((★)	(★) / (★) / (★(★) / (★(★) (5 out of 9)

Stars are assigned according to pre-defined questions and answers (see appendix 4). Answers are a, b, c or d, a being the highest quality and d the lowest. \* = in this version for cross sectional studies it is possible to get two stars in the category "assessment of outcome", therefore max. points is 9.  
/ = in these two studies, nutritional values based on diet registration is primary outcome, and since these are not measurable through validated laboratory methods (as asked for in the Newcastle Ottawa Scale), this category is left out. For these articles, 7 stars are the highest number attainable.



of fat was seen, and could indicate an ongoing dietary transition. However, Laitinen et al. only included Finnish and Lapp reindeer-herders, and therefore the results are likely not directly comparable to the later studies. Overall, no clear pattern of a relevant change in intake of macronutrients over time was seen.

The studies suggest on average a slightly lower systolic and in particular diastolic blood pressure among Sami compared with non-Sami [27,30,32,33]. This is generally associated with a lower risk of CVD [36], but this link was not examined in any of the included studies. Furthermore, blood pressure is associated to a number of different determinants, such as diet, smoking and genetics [37], but the lower blood pressure found in the included studies was not preceded by a likewise lower prevalence of smokers or a favourable dietary composition among Sami compared to non-Sami to account for this. Neither were any statistically significant differences in mean age between Sami and non-Sami observed, except for in the study by Ross et al. (Sami subgroups 0.9–5.4 years younger than controls), which may account for the difference in diastolic BP found here. Hence, other factors (e.g. genetics) may explain the lower blood pressure found in the three other studies. However, whatever the reason for the observed differences in blood pressure between the Sami and non-Sami, the difference is small and therefore the clinical impact may be of less importance.

Increasing BMI is likewise well established as a risk factor for cardiometabolic disease [38]. Our findings only point to an increased BMI among Norwegian Sami compared to non-Sami [34] or Norwegian participants with a “reindeer pattern diet” compared to participants with other dietary patterns [29]. These studies are from 2010 and 2008 respectively, and when comparing the results to those of the earlier Norwegian study by Tverdal et al. (1996), where only a slightly increased BMI was seen for Sami women, a possible increase in BMI over time among Norwegian Sami is observed. However, the three Swedish [30,31,35] and one Finnish study [32] included in this review found no differences in BMI between Sami and non-Sami, suggesting a possible variation between the Sami from the three respective countries.

Overall, the differences in cardiometabolic risk factors between Sami and non-Sami were small, and may not be of great clinical importance. They may however indicate, where changes due to the westernisation of diets may be occurring, as seen in the BMI for the Norwegian Sami population.

### **Findings of this review in relation to other studies**

Diet and nutrition have in previous studies been linked to cardiometabolic disease; it would therefore be

reasonable to assume that the traditionally high intake of meat and low intake of fruits and vegetables as found among Sami participants in some of the included studies would result in an unfavourable lipid-profile and higher prevalence of cardiometabolic disease [5–7]. Surprisingly this is not reflected in the studies. As an example, the two cohort studies by Tverdal et al. and Nilsson et al. found no increase in hazard ratio for mortality from CVD with increasing Sami diet score and a lower rate ratio for mortality from coronary or cardiovascular death among Sami men respectively [27,28]. In contrast to this, other studies not included in this review have investigated the prevalence of self-reported angina pectoris, stroke and subarachnoid haemorrhage in Norway and Sweden and found a higher prevalence of these among Sami than non-Sami [39,40]. For instance, in 2014 Eliassen et al. found the odds ratio for angina pectoris symptoms to be 1.42 ( $p < 0.001$ ) for Sami women and 1.62 ( $p < 0.001$ ) for Sami men compared to their non-Sami counterparts [39]. Additionally, a recent study from 2019 by Michalsen et al. found a slightly larger increase of metabolic syndrome severity in Sami men compared to non-Sami men, but no difference in women [41]. Sami dietary habits were not investigated in any of these studies, but it is possible that the increasing westernisation of diets is perhaps more detrimental to Sami cardiovascular health than non-Sami. However, the limited amount of research within the field makes it difficult to determine specific trends for the relation between dietary habits and cardiometabolic diseases in the Sami.

Results regarding intake of fat, fatty acids and protein seen in this review resemble the results of a review of Sami lifestyle, genetics and disease by Ross et al. from 2006 [18] and two more recent studies of food and food and nutritional adequacy in relation to Sami ethnicity from the SAMINOR clinical survey of Norway by Petrenya et al. [42,43]. The differences detected in these two studies were small though (3–4%) and overall, no ethnic disparities in nutritional adequacy were found. They also found a higher intake of vitamin B12, iron, zinc and sodium among Sami compared to non-Sami. Red meat is an important dietary source of these micronutrients and therefore these findings could support the observed higher intake of meat among the Sami in the articles of our present review.

In general, the transition towards a more westernised diet among the Sami described in earlier studies should be kept in mind when analysing the dietary results from the older studies in this review, as they are not necessarily directly comparable to the present [19,20]. It is possible that this dietary transition could account for the relatively small differences in nutritional

intake among Sami compared to non-Sami seen in this review, as dietary differences diminish over time.

### ***Risk of bias in the included studies***

The Newcastle Ottawa Scale is originally developed for cohort and case-control studies primarily, but since seven of the nine studies included in this review were cross-sectional studies a supplementary version was included [25]. The overall difference in rating (two out of seven stars to eight out of nine) pointed towards a substantial span in quality. Most of the cross-sectional studies had high scores within the categories of outcome and to some extent comparability. The overall low scores for justification of sample size and characteristics of non-respondents indicates risk of sample selection bias, potentially compromising the representativeness of the study populations. Most of the cross-sectional studies had low scores on ascertainment of exposure as well since ethnicity and diet were self-reported. However, these are variables that are difficult to measure in other ways. Both cohort studies in the present review received high quality assessment scores (seven stars out of nine) indicating a low risk of bias [27,28]. It is important to note that neither of the two versions of the Newcastle Ottawa Scale have been validated. Therefore, we cannot be certain of the external validity of the rating. Nonetheless, they are a useful tool to examine where the overall strengths and weaknesses are in the studies included in this review.

When assessing the risk of bias, the issue of determining ethnicity is worth mentioning as well. Finding correct ethnic classifications to identify a representative study population and ensure comparability can present a methodological challenge [44]. Misclassification may introduce selection bias by failing to correctly separate Sami individuals from controls, thus resulting in weakened external and internal validity of the study results, restricting the ability to generalise them to a larger population and directly affecting the differences or similarities found in the sample. The nine included studies applied different definitions of ethnicity, such as mastering the Sami language or having Sami affiliations (e.g. self-perceived ethnicity) [29,34]. This definition appears broad, but if the aim is to examine people who comply to a specific set of cultural norms, asking for self-perceived ethnicity may be more accurate than e.g. seeking to determine a genetic origin. Overall, difficulties in defining ethnicity may represent a potential source of selection bias in the included articles. Additionally, the Sami have historically been subject to discrimination and abuse [45] and this may affect the attendance rate and their willingness to in fact

describe themselves as Sami, increasing the risk of selection bias.

Another important potential source of bias in the included studies is information bias introduced by the applied methods for assessing dietary intake. The food frequency questionnaire has been shown to misjudge different nutrients e.g. underestimation of energy, fat and added sugar, but is nevertheless a valid tool for assessing foods eaten frequently and energy percentages [46]. The 24-hour dietary recall gives more detailed intake data, but it only provides a dietary “snapshot” and not the average individual intake when unrepeatable [47]. All nine included studies used self-reported measurement tools such as the above mentioned and these methods are prone to non-differential misclassification, due to recall bias and differences in perception of food intake. Non-differential misclassification may impact the absolute nutritional results found in the studies and reduce statistical significance of observed differences between Sami and non-Sami, pushing the results of this review in the direction of no-association. Lastly, the FFQ should ideally be validated for use in the population in which it is used [48], but none of the FFQ’s used in the studies in this review had been validated in a Sami population [28,29,32,35].

### ***Strengths and limitations of this review***

This study has several strengths. We identified several articles (4,195) in the initial search. This was largely due to a broad search strategy, including search terms such as “arctic region\*” and “circumpolar indigenous\*”. In total, only nine articles examined both Sami dietary habits and cardiometabolic risk factors or disease and were included. This indicates a limited amount of research within the field. Considering this, the broad search strategy poses a strength of this review, reducing the risk of missing potentially eligible studies. The methodological approach applied by following the MOOSE guidelines is likewise considered a strength, ensuring comparability of the analytical examination (including data extraction and bias assessment) of the articles. Furthermore, the included articles represented data from all three northern Scandinavian countries, making it possible to compare and detect possible inter-country variations.

On the other hand, the limited number and descriptive nature of the articles made it difficult to determine if an association between Sami dietary habits and the development of cardiometabolic risk factors or diseases exists. The broad inclusion criteria may account for substantial heterogeneity among the included articles,

which made it impossible to perform a meta-analysis. Instead of this, a qualitative approach was applied in order to assess the findings. This method is more prone to confirmation bias than the meta-analysis. Another potential weakness in this review, and in systematic reviews in general, is the risk of publication bias, which may occur because statistically significant findings are more likely to be published than nonsignificant [49]. Since only databases containing published articles were searched in this review, it is possible that non-significant research results were missed. This could lead to overestimation of the real magnitude of differences between Sami and non-Sami. However, no association between Sami dietary habits and cardiometabolic outcomes was found in this review, a result that is unlikely to have been affected by publication bias.

### Clinical impact

Due to social transformations bringing along dietary changes, high smoking levels and pollution among others, obesity rates and prevalence of CVD among indigenous circumpolar peoples have been increasing within the last century at a higher rate than observed in surrounding populations [21]. In this context, the overall minimal disparities between the Sami and their non-Sami counterparts in Norway, Sweden and Finland are unique [50]. Results from our review suggest small nutritional differences in intake of fat, protein and certain foods between Sami and non-Sami, and no differences or lower levels of certain cardiometabolic risk factors and diseases. We do not yet know, if these relatively small differences are of significant clinical importance for the Sami, when matching them to their non-Sami counterparts in their homelands, but comparing the nutritional transition of the Sami to that of e.g. the Inuit in Greenland and Canada may help us understand the Sami's favourable health status compared to other circumpolar indigenous peoples [21]. This knowledge could be important to developing future dietary guidelines for circumpolar minorities. Furthermore, the finding of an increasing BMI among Norwegian Sami suggests that future focus on the transition of Sami diets is still needed and underlines the importance of obtaining knowledge about indigenous peoples' dietary habits.

### Conclusion

Our findings suggest no association between consumption of specific traditional Sami food items such as boiled coffee, reindeer-meat and fish and blood-lipids or mortality from CVD/CHD. However, the limited amount and large heterogeneity of articles eligible for inclusion indicate that

literature regarding an association between Sami dietary habits and cardiometabolic disease is relatively scarce. Most studies within the field are purely descriptive. Further studies, examining and comparing the transition of diets among the Sami and other circumpolar indigenous peoples, could provide a valuable insight into the determinants of health among these minority populations.

### Acknowledgments

The authors thank the SAMINOR research group at the University of Tromsø, Norway, for sharing their facilities and their knowledge about the Sami people, and cand.med. and doctoral research fellow Vilde L. Michaelsen, University of Tromsø, and cand.med. Rasmus Jørgensen, University of Southern Denmark, for valuable advice and support throughout the process of writing this review

### Disclosure statement

No potential conflict of interest to report

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