ORIGINAL ARTICLE

DISTRIBUTION OF APOB/APOA-1 RATIO AND BLOOD LIPIDS IN SAMI, KVEN AND NORWEGIAN POPULATIONS: THE SAMINOR STUDY

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ABSTRACT

Objectives. To assess the distribution of blood lipids, lipoprotein and apoB/apoA-1 ratio in a multi-ethnic population of Sami, Kvens and Norwegians in Norway.
Study design. A population-based cross-sectional study was carried out in 2003-2004 in an area with a mixed Sami, Kvens/Finns and Norwegian population, the SAMINOR study.
Methods. A self-administrated questionnaire was distributed and total cholesterol, HDL cholesterol, triglycerides, apoB and apoA-1 counts were analysed in 6,461 women and 5,772 men between the ages of 36 and 79.
Results. In 36–64 age group, Sami men and women had the highest apoB/apoA-1 ratio of the ethnic groups. The ethnic differences remained after adjustment for waist hip ratio, cigarette smoking, systolic and diastolic pressures, alcohol consumption, physical activity during leisure time and family history of myocardial infarction (MI). There were no significant ethnic differences in apoB/apoA-1 ratio in the older age group. Total cholesterol was significantly lower among Sami men and women, aged 65–79 years, than among the Norwegian. The opposite occurred in the 36–49 age group, with higher levels in the Sami population. We found no ethnic differences in HDL cholesterol and triglycerides.
Conclusions. Middle-aged Sami women and men have increased levels of apoB/apoA-1 ratio and total cholesterol compared with Norwegians. *(Int J Circumpolar Health 2008; 67(1):67-81)*

Keywords: Sami, SAMINOR, apoB/apoA-1 ratio, total cholesterol, ethnic, cardiovascular disease

INTRODUCTION

The Sami are an indigenous people living in the northern parts of Norway, Sweden, Finland and Russia. The highest proportion of the Sami population lives in Norway. They have their own language and culture. Another ethnic group is the Kvens who are immigrants from the northern part of Finland. The traditional life-style in the Sami areas has changed during the last decades to a more Westernized way of living. This transition may have an affect on cardiovascular disease (CVD) patterns in subgroups within a geographically defined population.

Previous studies have shown divergent results regarding cardiovascular mortality in ethnic groups in Norway. A follow-up of the first and second Finnmark study showed lower mortality rates from coronary heart disease in Sami men and women than in Norwegians, although the results were not significant for women (1), but no ethnic differences in incidence of myocardial infarction or stroke were found after adjustment for risk factors and height (2). A follow-up of the third Finnmark study found a similar prevalence of myocardial infarction in the ethnic groups (3). A recent study found higher mortality from diseases of the circulatory system, particularly from cerebrovascular disease, in the north Norway Sami population when compared with the general population which was more pronounced for women (4). Hassler et al. reported a higher mortality rate than expected from diseases of the circulatory system and particularly ischemic heart disease in Swedish Sami women (5).

Cardiovascular mortality has decreased in Norway since the 1970s and in particular during the last decade (6). Parallel with this, the level of total cholesterol has decreased (7) and the traditional life-style in the Sami areas has changed. This may have influenced ethnic differences in the risk of cardiovascular disease.

High concentrations of total cholesterol, LDL C and triglycerides and low concentrations of HDL C are all risk factors for atherosclerotic CVD. Previous reports from a multiethnic population of Sami, Finnish/Kvens and Norwegians have shown higher levels of total cholesterol and high density cholesterol (HDL) in the Sami population when compared with the Norwegian population (1,2,8). Utsi et al. reported no differences in blood lipids between the ethnic groups (3). ApoB/apoA-1 ratio has been reported as a cardiovascular (CV) risk factor in prospective studies (9–13), and in a case-control study, as the most prevalent risk factor of acute myocardial infarction (14). High apoB/apoA-1 ratio is also associated with ischemic stroke (15). Some authors have concluded that apoB and apoA-1 and especially the apoB/apoA-1 ratio are better CV risk markers than the conventionally used LDL C and various other lipid ratios (15–17). ApoB is present in very-low density lipoprotein (VLDL), intermediate-density lipoprotein (IDL), large buoyant LDL and small dense LDL (sd-LDL), and the ApoA-1 is the major apo in HDL particles. Total apoB reflects the total number of potentially atherogenic particles and apoA-1 the athero-protective part of the metabolism. No population-based studies on apolipoprotein among Sami have been published.

Other important cardiovascular risk factors are smoking, alcohol consumption, hypertension, diabetes, abdominal obesity, low physical activity and dietary habits.

For Sami men, smoking habits and alcohol consumption have been reported to be similar or lower than in Norwegians (1-3) and the level of physical activity during working hours has been described as higher (18). Several studies reported more obesity in Sami women, but not a higher diabetes mellitus incidence than in other women. Lower frequency of smoking and alcohol consumption is reported among Sami women as compared with Norwegian women (1,2). Former studies have shown that Sami consume more meat, fat, table sugar and boiled coffee and less fruits and vegetables than ethnic Norwegians (19).

The Inuit have gone through a similar lifestyle transition as the Sami, moving from a traditional to a mixed Western diet, in conjunction with reduced physical activity, increased consumption of alcohol and tobacco and increased social stress (20). Bjerregaard et al. reported unfavourable lipid changes as an effect of changing to a Westernized diet among the Inuit (21).

The aims of this study were to evaluate ethnic differences in apoB/apoA-1 ratio and blood lipids in men and women of Sami, Kven and Norwegian ancestry, and to study to what extent these differences could be attributed to differences in other possible covariates.

MATERIAL AND METHODS

Study population

The Centre for Sami Health Research at the University of Tromsø in collaboration with the Norwegian Institute of Public Health carried out a population-based cardiovascular survey in areas with a mixed Sami and Norwegian population, SAMINOR, in 2003–2004. The study covered municipalities where more than 5–10% of the population defined themselves as Sami in the 1970 Census (22); in addition, some selected districts had an overall lower proportion of subjects with Sami ethnicity. Further details on screening procedures and methods have been previously published (23).

All inhabitants in the defined SAMINOR area aged 30 and 36–79 years were invited to participate; out of the 27,987 individuals who responded, 16,968 (60.6%) participated. Analyses were restricted to the 36–79 age group, for a total of 16,538 individuals. The 30-year-old age group was excluded in further analysis because of a small sample size and a low attendance rate. Among the study participants, blood samples from 15,612 were available for analyses. We excluded participants with no information on ethnicity (n=252) and foreigners (n=255). A subgroup of 12,233 participants who were not receiving lipid-lowering medication was selected for the analyses. Total cholesterol, HDL C and triglycerides were successfully measured for all 12,233 participants, while the apoB/apoA-1 ratio was available for 12,015 participants. Multiple regression analyses were done on smaller samples due to missing values of the covariates.

Ethics approval

The study was approved by the Regional Committees for Medical Research Ethics. All the participants gave signed informed consent.

Questionnaires

Two self-administered questionnaires were used to gain information on a set of variables.

We included information on ethnicity, physical activity and smoking habits, consumption of boiled coffee and alcohol, family history of myocardial infarction (MI) and use of cholesterol-lowering medication. Participants answered on their frequency of alcohol consumption (categories: never/not last year, once a month or less, 2 to 4 times a month, 2 or more times per week). Four categories of leisure-time physical activity were used for analyses; low, moderate, high, and very high. A sedentary leisure life-style was defined as low physical activity. Walking or cycling at least 4 hours per week was defined as moderate physical activity. High physical activity included amateur sport activities of at least 4 hours per week, and very high activity included regular physical training several times per week in sport competitions. Family history of myocardial infarction (MI) was defined if one or both parents had a heart attack before the age of 60 (yes/no).

Ethnic classification was based on 11 questions concerning domestic language, ethnic background and self-perceived ethnicity. Four categories were used for analysis:

(1) Sami I: Sami used as home language by all grandparents, parents and respondents (3 generations); (2) Sami II: at least one Sami identity marker (language, self-perceived ethnicity or family background); (3) Kven: at least one Kven identity marker except Sami; and (4) Norwegian.

We selected participants who had never used cholesterol-lowering medication. The category was assessed by combining the question "Do you take cholesterol lowering medication?" with the three categories of "currently," "previously, but not now" and "never used," and by the information on brand names of all medicines taken. Participants that answered "never used" and gave no information on the brand name were defined as "never users" (12,233), representing 81% of the men and 85% of the women. Distribution by ethnic groups was 80.4% of Sami I, 82.1% of Sami II, 79.0% of Kven and 84.4% of Norwegian. This means that 20% of Sami I and 15% of Norwegians were excluded due to having ever used cholesterol-lowering medication.

Laboratory analyses

Non-fasting venous blood samples were drawn. The samples were left to coagulate for a minimum of 30 minutes and were centrifuged within 1.5 hours. Serum was sent by overnight post to the laboratories in Oslo and Tromsø and later stored at -70C°. Serum total cholesterol, HDL C and triglycerides were measured directly by an enzymatic method (Hitachi 917 auto analyser, Roche Diagnostic, Switzerland). Seronorm lipoprotein was used as internal quality control material for the lipid analyses. The control was done at the start and for every 30th sample. The interassay coefficient for variations (CV) for both total cholesterol and triglycerides was 3% and for HDL C 4–5%. These laboratory investigations were performed at the Laboratory of the Department of Clinical Chemistry, University Hospital in Ullevål, Oslo, Norway. Additionally, immunoturbidimetric method assays were used to measure apoB and apoA-1 concentrations (Roche diagnostics, Mannheim). The apolipoprotein methods were standardised against the WHO/IFCC SP-07 standard (24,25). The internal and external quality controls showed values within the established control limits. The interassay CV was 3.7% for apoB and 5,4% for apoA-1. These analyses were performed by the Laboratory of the Department of Clinical Chemistry, University Hospital in Tromsø, Norway.

Physical examinations

Body weight (in kilograms) and height (in cm) were measured with an electronic height and weight scale, with the participants wearing light clothing and no shoes. BMI (body mass index) was calculated as weight in kilogram divided by the height squared in meters.

Waist circumference was measured at the umbilicus, and hip circumference was measured as the maximum circumference over the buttocks. In obese individuals waist circumference was measured as the maximum between the iliac crest and the lower margins of the ribs. Waist- to-hip-ratio (WHR) was calculated as waist circumference divided by hip circumference.

Systolic and diastolic blood pressures were measured with a DINAMAP-R automatic device.

Statistical analyses

SAS statistical software for Windows version 9.1 (SAS Institute Inc., Cary, NC, USA) was used for both data management and statistical analysis. All analyses were age and gender specific. Age-adjusted tests of ethnic differences of sample characteristics were performed using Cochrane Mantel Haenszel test (for categorical variables) and ANCOVA (for continuous variables).

Means and 95% confidence intervals of blood lipids, lipoprotein and apoproteins are presented, separate for each ethnic group. Total cholesterol and HDL C were normally distributed while triglycerides and apoB/apoA-1 ratios were log transformed to correct for skewed distribution. Geometric means and confidence intervals for apoB/apoA-1 ratio values were transformed back to original units when presented. Differences in means between the ethnic groups were tested by ANOVA.

Both simple and multiple linear regression analyses were used to model apoB/apoA-1 ratio and total cholesterol in different ethnic groups. The following independent variables were considered in the multiple linear models: BMI (kg/m^2), physical activity (low, moderate, high, very high), currently smoking (yes/no), frequency of alcohol intake, systolic and diastolic blood pressure (mmHg), family history of MI, WHR and boiled coffee consumption (number of cups per day). WHR was preferred to BMI, since a recent report has suggested that waist-hip-ratio is a better indicator of the risk of myocardial infarction (26).

For apoB/apoA-1 ratio we decided to exclude boiled coffee consumption from the models, because coffee consumption did not influence the association between ethnicity and the lipid ratio. Regression coefficients with 95% confidence intervals are presented. For the apoB/apoA-1 ratio, values are transformed back to original units, producing relative effects.

RESULTS

Characteristics of the study samples are shown for women in Table I and for men in Table II.

Among the women, Sami I and Kvens were older than Sami II and Norwegians. The Sami I group had the highest proportion of women with BMI ≥ 30 kg/m^2, and they also reported lower physical activity than women of Norwegian ancestry. Those currently smoking were more frequent among Kven women while the Sami I women had the lowest rate. The frequency of alcohol consumption showed large differences, with women of the Sami I group having the lowest intake. For men, similar differences were observed, except that Sami I men had the highest frequency of current smoking. The Sami I group had the highest consumption of boiled coffee for both men and women.

Table I. Characteristics of women by ethnic group, The SAMINOR study 2003-2004, (n=6461).

	Sami I (n=723)		Sami II (n=1393)		Kven (n=450)		Norwegian (n=3895)		p-value
	n	(%)	n	(%)	n	(%)	n	(%)	
Age									
36-49	297	(41.1)	643	(46.2)	176	(39.1)	1682	(43.2)	
50-64	281	(38.9)	539	(38.7)	169	(37.6)	1595	(40.9)	
65-79	145	(20.1)	211	(15.1)	105	(23.3)	618	(15.9)	<.0001
BMI (kg/m2)									
<18.5	2	(0.3)	6	(0.4)	2	(0.4)	29	(0.7)	
18.5-24.9	199	(27.6)	464	(33.5)	155	(34.4)	1479	(38.1)	
25-29.9	264	(36.7)	541	(39.0)	178	(39.6)	1520	(39.1)	
≥30	255	(35.4)	376	(27.1)	115	(25.6)	857	(22.1)	<.0001[e]
WHR[a] , mean ±SD	0.84	(0.08)	0.83	(0.07)	0.84	(0.07)	0.82	(0.07)	<.0001[f]
SBP [b], mmHg, mean ±SD	127.9	(22.2)	127.8	(20.4)	132.0	(22.1)	128.3	(20.8)	0.025[f]
DBP [c], mmHg, mean ±SD	72.1	(9.8)	72.1	(10.4)	73.6	(10.0)	72.7	(10.3)	0.06[f]
Physical activity									
Low	205	(31.6)	305	(24.0)	84	(20.8)	759	(21.4)	
Moderate	370	(57.0)	828	(65.2)	260	(64.5)	2373	(67.0)	
High	68	(10.5)	129	(10.2)	57	(14.1)	376	(10.6)	
Very high	6	(0.9)	8	(0.6)	2	(0.5)	32	(0.9)	<.0001[e]
Smoking habits									
Never	306	(42.6)	459	(33.2)	129	(28.9)	1443	(37.5)	
Current	223	(31.1)	506	(36.6)	161	(36.0)	1258	(32.6)	
Former	189	(26.3)	419	(30.3)	157	(35.1)	1152	(29.9)	<.0001[e]
Frequency of alcohol intake									
Not last year/ never	283	(40.7)	263	(19.5)	93	(21.4)	589	(15.5)	
Once a month or less	297	(42.7)	552	(41.0)	169	(38.9)	1560	(41.1)	
2-4 times/month	109	(15.7)	453	(33.6)	132	(30.3)	1303	(34.3)	
≥ 2 times /week	6	(0.9)	79	(5.9)	41	(9.4)	346	(9.1)	<.0001[e]
Boiled coffee No of cups pr day, mean ±SD [d]	3.1	(4.0)	1.6	(2.9)	1.6	(2.8)	1.5	(2.7)	<.0001[f]
Family history of MI									
Yes	122	(16.9)	277	(19.9)	75	(16.7)	703	(18.0)	
No	601	(83.1)	1116	(80.1)	375	(83.3)	3192	(82.0)	0.46[e]

[a] WHR, waist / hip ratio
[b] SBP, systolic blood pressure
[c] DBP, diastolic blood pressure
[d] Extreme outliers as more than 20 cups a day are excluded, 4 participants
[e] Cochran-Mantel-Haenszel test, adjusted for age
[f] ANCOVA, adjusted for age

Table II. Characteristics of men by ethnic group, The SAMINOR study 2003-2004, (n=5772)

	Sami I (n=661)		Sami II (n=1320)		Kven (n=425)		Norwegian (n=3366)		p-value
	n	(%)	n	(%)	n	(%)	n	(%)	
Age									
36-49	235	(35.6)	562	(42.6)	162	(38.1)	1390	(41.3)	
50-64	285	(43.1)	553	(41.9)	199	(46.8)	1424	(42.3)	
65-79	141	(21.3)	205	(15.5)	64	(15.1)	552	(16.4)	0.004
BMI (kg/ m^2)									
< 18.5	3	(0.4)	6	(0.5)	2	(0.5)	3	(0.1)	
18.5-24.9	182	(27.5)	322	(24.4)	102	(24.1)	915	(27.2)	
25-29.9	315	(47.7)	697	(52.9)	243	(57.3)	1713	(51.0)	
≥ 30	161	(24.4)	292	(22.2)	77	(18.2)	731	(21.7)	0.0103[e]
WHR [a] mean ±SD	0.93	(0.08)	0.93	(0.07)	0.93	(0.06)	0.93	(0.07)	0.27[f]
SBP [b], mmHg, mean ±SD	133.4	(20.4)	134.3	(18.9)	132.6	(17.5)	133.5	(17.8)	0.023[f]
DBP[c], mmHg, mean ±SD	77.7	(9.7)	78.1	(10.1)	78.3	(9.7)	78.2	(9.9)	0.29[f]
Physical activity									
Low	154	(25.9)	288	(23.8)	103	(25.6)	723	(22.9)	
Moderate	319	(53.6)	655	(54.1)	184	(45.7)	1730	(54.9)	
High	103	(17.3)	233	(19.3)	98	(24.3)	632	(20.1)	
Very high	19	(3.2)	34	(2.8)	18	(4.5)	67	(2.1)	0.0018[e]
Smoking habits									
Never	165	(25.2)	380	(29.1)	108	(25.5)	1058	(31.6)	
Current	250	(38.2)	448	(34.3)	149	(35.1)	1040	(31.1)	
Former	240	(36.6)	479	(36.6)	167	(39.4)	1245	(37.2)	0.0010[e]
Frequency of alcohol intake									
Not last year/ never	115	(18.0)	123	(9.5)	42	(9.9)	257	(7.8)	
Once a month or less	277	(43.3)	464	(36.0)	130	(30.7)	1151	(34.9)	
2-4 times/month	212	(33.2)	543	(42.2)	185	(43.6)	1402	(42.5)	
≥ 2 times /week	35	(5.5)	158	(12.3)	67	(15.8)	487	(14.8)	<.0001e
Boiled coffee									
No of cups pr day mean ±SD [d]	3.6	(4.8)	2.1	(3.5)	1.8	(3.3)	1.8	(3.2)	<.0001[f]
Family history of MI									
Yes	98	(14.8)	230	(17.4)	84	(19.8)	531	(15.8)	
No	563	(85.2)	1090	(82.6)	341	(80.2)	2835	(84.2)	0.15[e]

[a] WHR, waist / hip ratio
[b] SBP, systolic blood pressure
[c] DBP, diastolic blood pressure
[d] Extreme outliers as more than 20 cups a day are excluded, 12 participants
[e] Cochran-Mantel-Haenszel test, adjusted for age
[f] ANCOVA, adjusted for age

Table III. Means and 95 % CI for total cholesterol, HDL C and geometric means and 95 % CI for the apoB/apoA-1 ratio and triglycerides by the ethnic groups among 5772 men and 6461 women not using lipid reducing medications, (The SAMINOR study 2003-2004).

Gender	Age	Sami I mean	95% CI	Sami II mean	95% CI	Kven mean	95% CI	Norwegian mean	95% CI	p-value
Total cholesterol										
Men	36-49	6.15	(6.01,6.30)	6.10	(6.01,6.18)	5.94	(5.75,6.12)	5.92	(5.87,5.98)	0.0007
	50-64	6.22	(6.09,6.35)	6.19	(6.10,6.28)	6.23	(6.09,6.37)	6.11	(6.06,6.16)	0.14
	65-79	5.84	(5.66,6.01)	6.09	(5.94,6.23)	6.21	(5.94,6.48)	6.05	(5.96,6.13)	0.0498
Women	36-49	5.76	(5.65,5.88)	5.65	(5.57,5.72)	5.52	(5.39,5.65)	5.50	(5.45,5.54)	<.0001
	50-64	6.35	(6.22,6.49)	6.34	(6.25,6.42)	6.60	(6.44,6.76)	6.35	(6.30,6.40)	0.03
	65-79	6.37	(6.21,6.54)	6.37	(6.24,6.50)	6.72	(6.49,6.94)	6.65	(6.56,6.74)	0.0007
HDL cholesterol										
Men	36-49	1.23	(1.18,1.27)	1.21	(1.18,1.23)	1.20	(1.16,1.25)	1.20	(1.19,1.22)	0.81
	50-64	1.29	(1.25,1.33)	1.31	(1.28,1.34)	1.34	(1.29,1.38)	1.28	(1.26,1.30)	0.09
	65-79	1.44	(1.37,1.51)	1.37	(1.32,1.42)	1.42	(1.32,1.52)	1.34	(1.31,1.37)	0.037
Women	36-49	1.39	(1.35,1.43)	1.43	(1.41,1.46)	1.40	(1.35,1.46)	1.44	(1.43,1.46)	0.055
	50-64	1.45	(1.41,1.50)	1.48	(1.45,1.51)	1.56	(1.50,1.62)	1.53	(1.51,1.55)	0.0009
	65-79	1.54	(1.47,1.60)	1.51	(1.46,1.57)	1.59	(1.49,1.68)	1.56	(1.53,1.59)	0.41
Apo B										
Men	36-49	1.10	(1.07,1.14)	1.07	(1.05,1.09)	1.02	(0.98,1.06)	1.01	(0.99,1.02)	<.0001
	50-64	1.13	(1.10,1.16)	1.08	(1.06,1.11)	1.07	(1.04,1.11)	1.04	(1.03,1.05)	<.0001
	65-79	1.02	(0.98,1.07)	1.05	(1.02,1.08)	1.06	(1.01,1.12)	1.02	(1.01,1.04)	0.26
Women	36-49	1.01	(0.98,1.03)	0.93	(0.91,0.94)	0.90	(0.86,0.93)	0.88	(0.86,0.89)	<.0001
	50-64	1.11	(1.08,1.15)	1.08	(1.06,1.10)	1.09	(1.06,1.13)	1.03	(1.02,1.04)	<.0001
	65-79	1.10	(1.06,1.15)	1.07	(1.04,1.10)	1.12	(1.07,1.16)	1.08	(1.07,1.10)	0.31
Apo A-1										
Men	36-49	1.29	(1.26,1.32)	1.30	(1.28,1.32)	1.29	(1.26,1.32)	1.31	(1.30,1.32)	0.41
	50-64	1.32	(1.29,1.34)	1.35	(1.33,1.37)	1.39	(1.35,1.42)	1.36	(1.35,1.37)	0.003
	65-79	1.36	(1.32,1.40)	1.37	(1.33,1.40)	1.38	(1.32,1.45)	1.37	(1.35,1.39)	0.95
Women	36-49	1.33	(1.31,1.36)	1.41	(1.39,1.42)	1.37	(1.33,1.40)	1.42	(1.41,1.43)	<.0001
	50-64	1.41	(1.38,1.44)	1.47	(1.45,1.49)	1.52	(1.48,1.56)	1.51	(1.50,1.52)	<.0001
	65-79	1.46	(1.42,1.50)	1.46	(1.43,1.50)	1.53	(1.48,1.58)	1.53	(1.51,1.54)	0.001
ApoB/apoA-1 ratio[a]										
Men	36-49	0.84	(0.80,0.88)	0.81	(0.79,0.83)	0.77	(0.74,0.81)	0.76	(0.74,0.77)	<.0001
	50-64	0.84	(0.81,0.87)	0.79	(0.77,0.81)	0.76	(0.73,0.79)	0.76	(0.75,0.77)	<.0001
	65-79	0.73	(0.70,0.78)	0.76	(0.73,0.80)	0.76	(0.71,0.83)	0.74	(0.73,0.76)	0.50
Women	36-49	0.74	(0.71,0.77)	0.65	(0.63,0.66)	0.64	(0.61,0.68)	0.61	(0.59,0.61)	<.0001
	50-64	0.78	(0.75,0.81)	0.73	(0.70,0.74)	0.71	(0.68,0.75)	0.67	(0.66,0.68)	<.0001
	65-79	0.75	(0.70,0.79)	0.73	(0.69,0.76)	0.72	(0.68,0.76)	0.70	(0.69,0.72)	0.12
Triglycerides[a]										
Men	36-49	1.73	(1.61,1.87)	1.71	(1.63,1.79)	1.69	(1.55,1.84)	1.67	(1.62,1.72)	0.71
	50-64	1.53	(1.43,1.63)	1.55	(1.48,1.62)	1.58	(1.47,1.69)	1.58	(1.54,1.62)	0.72
	65-79	1.37	(1.26,1.49)	1.35	(1.26,1.44)	1.31	(1.18,1.46)	1.45	(1.39,1.51)	0.17
Women	36-49	1.30	(1.23,1.38)	1.21	(1.16,1.25)	1.25	(1.16,1.35)	1.16	(1.13,1.19)	0.0008
	50-64	1.45	(1.36,1.53)	1.42	(1.36,1.47)	1.36	(1.28,1.46)	1.39	(1.35,1.42)	0.45
	65-79	1.46	(1.35,1.57)	1.38	(1.30,1.47)	1.56	(1.41,1.72)	1.49	(1.45,1.55)	0.08

[a]Geometric means

Age- and sex-stratified distributions of total cholesterol, HDL C, triglycerides, apoB, apoA-1 and apoB/apoA-1 ratio for the 4 ethnic groups are shown in Table III. Standard deviation (SD) of each of these variables was almost equal between the ethnic groups (data not shown).

In the 36–49 age group, mean cholesterol concentration was significantly different in the 4 ethnic groups for both men ($p=0.0007$) and women ($p<.0001$). Sami I had the highest concentration and Norwegians the lowest. However, for women in the oldest age group (≥65 years), the lowest concentrations were found among Sami I and the highest among Kvens. A similar pattern was seen in men.

Differences in HDL C in the ethnic groups were only significant for women aged 50–64 years ($p=0.0009$), where Kven women had the highest level and Sami I the lowest. No significant differences in the triglycerides level were found, except for women ($p=0.0008$) aged 36–49 years with Sami I having the highest mean level.

The correlation coefficient between apoA-1 and HDL C cholesterol is 0.88, and for apoB and total cholesterol 0.87, with almost no differences between gender, age and the ethnic groups (not shown).

The apoB and apoB/apoA-1 ratio was significantly different in the 4 ethnic groups for men and women under 65 years of age, but no significant difference was observed in those above 65 years of age. Simple regression analyses in Table IV confirm the results from Table III for the apoB/apoA-1 ratio. Multiple regressions analyses, controlling for currently smoking, physical activity, WHR, family history of MI, systolic and diastolic blood pressure and alcohol consumptions only slightly reduced the differences between the ethnic groups.

Table IV. Relative effect of ethnicity on apoB/apoA-1 ratio, by age and gender from both univariate and multivariate regression analyses. The SAMINOR study 2003-2004.

		Men				Women			
		Univariate n=5683		Multivariate[a] n=5631		Univariate n=6332		Multivariate[a] n=6245	
Age	Ethnicity	e^{β}	95% CI	e^{β}	95% CI	e^{β}	95% CI	e^{β}	95% CI
36-49									
	Norwegian	1.0 (Ref)		1.0 (Ref)		1.0 (Ref)		1.0 (Ref)	
	Kven	1.02	(0.97,1.08)	1.03	(0.98,1.08)	1.06	(1.01,1.11)	1.05	(1.00,1.09)
	Sami II	1.07[b]	(1.04,1.11)	1.07[b]	(1.04,1.10)	1.07[b]	(1.04,1.10)	1.05	(1.02,1.08)
	Sami I	1.11[b]	(1.06,1.16)	1.09	(1.04,1.13)	1.22[b]	(1.18,1.27)	1.18[b]	(1.13,1.22)
50-64									
	Norwegian	1.0 (Ref)		1.0 (Ref)		1.0 (Ref)		1.0 (Ref)	
	Kven	1.0	(1.02,1.05)	1.01	(0.96,1.05)	1.06	(1.01,1.11)	1.04	(0.99,1.09)
	Sami II	1.04	(1.02,1.07)	1.04	(1.01,1.07)	1.07[b]	(1.04,1.11)	1.05	(1.02,1.08)
	Sami I	1.11[b]	(1.02,1.15)	1.11[b]	(1.07,1.15)	1.15[b]	(1.11,1.20)	1.11[b]	(1.07,1.16)
65-79									
	Norwegian	1.0 (Ref)		1.0 (Ref)		1.0 (ref)		1.0 (ref)	
	Kven	1.03	(0.95,1.08)	1.03	(0.95,1.11)	1.04	(0.95,1.11)	1.02	(0.96,1.08)
	Sami II	1.02	(0.97,1.05)	1.03	(0.98,1.08)	1.03	(0.97,1.07)	1.02	(0.97,1.06)
	Sami I	0.99	(0.94,1.06)	0.97	(0.92,1.03)	1.07	(0.98,1.10)	1.02	(0.96,1.07)

[a] Adjusted for physical activity, smoking habits, alcohol consumptions, systolic and diastolic blood pressures, family history of myocardial infarction and waist /hip ratio.
[b] $p<0.0001$

Compared with Norwegian women, the estimated apoB/apoA-1 ratio level was 18% higher in Sami I women aged 36–49 and 11% higher for those aged 50–64 years. For the Sami I men, the levels were 9% higher in the 36–49 age group and 11% higher in the 50–64 age group. The apoB/apoA-1 ratio was also significantly higher in Sami II men and women (<64 years) compared with the Norwegians; however, the results were less obvious.

For total cholesterol, Sami I had significantly lower levels than Norwegians in the oldest age group, for both men and women, in both unadjusted and adjusted analyses (Table V). The result is also significant for Sami II women. In the youngest age group (<50 years) the opposite results appeared for both genders, with higher levels for Sami I and Sami II. For the 50–64 age group, no significant differences were found between the Sami groups and the Norwegian group, although for women the Kvens had higher levels than the Norwegians.

DISCUSSION

The main result of the present study was a higher apoB/apoA-1 ratio and cholesterol level in middle-aged Sami men and women than in Norwegians. The strongest ethnic effect was found in women. In the oldest group there was no ethnic difference in apoB/apoA-1 ratio, and total cholesterol was even lower in Sami than in Norwegians.

To our knowledge, this is the first large population-based study in which apoB/apoA-1 ratio distribution among different ethnic groups in Scandinavia has been described.

Table V. Effect of ethnicity on total cholesterol (mmol/l), by age and gender from both univariate and multivariate regression. The SAMINOR study 2003-2004.

		Men				Women			
		Univariate n=5772		Multivariate[a] n=5488		Univariate n=6461		Multivariate[a] n=6120	
Age	Ethnicity	β	95% CI	β	95% CI	β	95% CI	β	95% CI
36-49	Intercept	5.92	(5.87,5.98)			5.50	(5.54,5.54)		
	Norwegian	0 (Ref)		0 (Ref)		0 (Ref)		0 (Ref)	
	Kven	0.01	(-0.16,0.18)	0.03	(-0.15,0.20)	0.02	(-0.13,0.17)	0.01	(-0.14,0.16)
	Sami II	0.17	(0.07,0.28)	0.16	(0.06,0.27)	0.15	(0.06,0.24)	0.10	(0.01,0.19)
	Sami I	0.23	(0.08,0.38)	0.19	(0.04,0.34)	0.26 [b]	(0.14,0.38)	0.21	(0.09,0.34)
50-64	Intercept	6.11	(6.06,6.16)			6.35	(6.30,6.40)		
	Norwegian	0 (Ref)		0 (Ref)		0 (Ref)		0 (Ref)	
	Kven	0.12	(-0.03,0.27)	0.13	(-0.02,0.29)	0.25	(0.08,0.42)	0.24	(0.07,0.41)
	Sami II	0.08	(-0.02,0.18)	0.07	(-0.03,0.18)	-0.01	(-0.12,0.09)	-0.02	(-0.13,0.09)
	Sami I	0.11	(-0.02,0.24)	0.06	(-0.08,0.19)	0.01	(-0.13,0.14)	-0.02	(-0.17,0.12)
65-79	Intercept	6.05	(5.96,6.13)			6.65	(6.57,6.74)		
	Norwegian	0 (Ref)		0 (Ref)		0 (Ref)		0 (Ref)	
	Kven	0.17	(-0.10,0.43)	0.19	(-0.08,0.46)	0.07	(-0.16,0.29)	0.08	(-0.16,0.31)
	Sami II	0.04	(-0.12,0.20)	0.05	(-0.12,0.22)	-0.28	(-0.24,-0.11)	-0.22	(-0.41,-0.04)
	Sami I	-0.21	(-0.40,-0.02)	-0.21	(-0.41,0.00)	-0.28	(-0.47,-0.08)	-0.34	(-0.55,-0.12)

[a] Adjusted for physical activity, smoking habits, alcohol consumptions, systolic and diastolic blood pressures, family history of myocardial infarction, waist /hip ratio and cups of boiled coffee.
[b] p <0.0001

The strengths of this study are the large sample size and physical measurements of anthropometries and blood pressure. The ethnic definitions in our study include more homogenous ethnic groups, where the Sami I group confirmed a strong self-perceived Sami ethnicity and feelings of belonging to the Sami culture. The Sami II group was more mixed, with both Kven and Norwegian ancestry. These definitions lead to less misclassification of the groups. As a consequence, the differences of the apoB/apoA-1 ratio became smaller between Sami II when compared with Norwegians than for the Sami I group when compared with the reference group.

The attendance rate of 60% was rather low, but it is similar to many other population-based studies (27–30). The low attendance rate could imply a problem with selection bias. The study covered the population in municipalities where more than 5–10% of the population reported to be Sami in the 1970 Census (22), and all inhabitants in the predefined birth cohorts were invited to participate. We do not know the attendance rate in each ethnic group, as information about ethnicity was collected at the screening site. Among the non-respondents the frequency of men and the youngest age group was higher when compared with the respondents. The study was announced as a cardiovascular screening study. However, it seems unlikely that the unfavourable lipid levels could be the result of a selectively higher attendance of Sami with high cardiovascular risk. The NOWAC study about external validity showed no differences in life-style factors between respondents and non-respondents. Lack of time and concern about privacy were the main reasons for not attending (28). We also excluded participants who used cholesterol-lowering medication: 20% of Sami I participants were excluded as compared with 15% of Norwegians. This may have influenced the comparison of lipids in the ethnic groups, particularly for the oldest aged group where no ethnic differences in lipid levels were found, and, if anything, it underestimated the ethnic differences in the younger age groups. The fact that lipids and the other risk factors for CVD are measured at the same time is a limiting factor in the cross-sectional design model. The causal relation between the risk factors and lipids cannot be assessed, and the adjustments may be imperfect.

The ethnic differences in lipoprotein levels observed for those aged 36–64 years were not in the oldest age group. For total cholesterol the association was even reversed. Two recent studies indicate a higher mortality rate of cardiovascular disease in Sami and particularly in Sami women (4,5). Selective survival of individuals with low or moderate lipid levels may have influenced ethnic differences in the oldest age group. But these 2 mortality studies are register studies and no risk factors were measured. Therefore, we do not know whether Sami men and women with unfavourable lipids had higher mortality rates in middle age as compared with Norwegians with the same lipid levels.

Abnormal lipids, smoking, hypertension, diabetes, abdominal obesity, psychosocial factors, low consumption of fruits, vegetables and alcohol intake and low physical activity account for most of the risks related to myocardial infarction. Abnormal lipids and smoking are the 2 most important risk factors (26). Levels of total cholesterol have shown a remarkable decline since the 1970s, not least in Finnmark (7). One explanation of this decline is attributed to changes in dietary habits and life-style, which may have influenced the ethnic groups differently.

Smoking frequency has declined for Norwegian men, from the 50% to 30% (6). Smoking habits in Sami women have changed from a lower frequency to being similar with Norwegian women. The Sami I in our study are represented by subjects with 3 generations of Sami language and they included most of the reindeer breeders. Participants in this group have the most traditional Sami life-style. They have higher prevalence of risk factors, which might influence lipoproteins, than the Norwegians. Compared with the Norwegian women, the Sami women were more obese, less physically active, had slightly higher systolic blood pressure, a greater family history of MI and drank more boiled coffee. Obesity might be a result of excess food in a setting of reduced activity. Obesity affects lipoprotein metabolism through higher LDL cholesterol, increased triglycerides and lower levels of HDL cholesterol (31). The Sami I women had both higher levels of apoB, the atherogenic part of the metabolisms, and lower levels of apoA-1. For men, the risk factor differences between the ethnic groups were less obvious. Sami men reported being less physically active in leisure time, the family history of MI was slightly higher and they drank more boiled coffee than Norwegians. Consumption of boiled coffee has been shown to increase total cholesterol and may be a causal factor of the differences between ethnic groups. But adjustment for consumption of boiled coffee and for all the other risk factors did not change the ethnic differences in lipid levels substantially.

The measurement of physical activity could be imprecise due to the lack of validated instruments, plus the questionnaire focused only on physical activity during leisure time. Physical activity studies on Norwegian and Sami populations have indicated that both Sami women and men were more active during work (18). However, in traditional reindeer-herder activity, mechanized transportation has eliminated a lot of the physical activity needed for moving from place to place. The result has been a gradually more sedentary life-style.

The atherosclerotic-related diseases are associated with affluent life-styles. Foods containing products with high levels of animal fat lead directly to elevated blood lipids. Surplus food in addition to a reduction in habitual physical activity can result in obesity, which also encourages hyperlipidaemia (31).

The traditional diet among Sami differed from the general population, with a higher consumption of lean reindeer meat, which was prepared by boiling. In recent years, boiling has increasingly been replaced by frying in butter and so the fat intake has increased. The association of dietary fat with coronary heart disease is predominately through the effects of saturated fats and cholesterol (31). Fruits and vegetables are high in fiber content and an increased fiber intake is associated with lower cholesterol levels (32). The intake of fruits and vegetables is low among the Sàmi (19). The limitation of this survey is the lack of information on fat intake.

Comparison with other indigenous populations, like the Inuit, showed similar patterns. Total cholesterol and LDL was higher among Inuit women and participants with 3 or more Inuit grandparents had higher levels of LDL C and total cholesterol when compared with 1 or 2 Inuit grandparents (21). In our study, levels of apoB/apoA-1 ratio were higher in Sami I than in Norwegians. Among the Inuit, the cholesterol and triglycerides varied according to alcohol consumption and smoking (21). In our study, these 2 factors were not associated with lipid differences. The frequency of alcohol consumption showed huge differences among the Sami when compared with the Norwegians, particularly for the highest consumptions. This difference could be real, fewer Sami drink more than 2 times a week, or it could be inaccurate reporting by the participants. The measurement of alcohol consumption has not been validated. The conclusion from the Inuit study was that Westernization had an effect on blood lipids and the effect was to some extent due to dietary changes (21).

There is limited data on apoB/apoA-1 ratio distributions among indigenous populations. Ethnic variations in lipid levels have been reported and explained by interplay between genetic and environmental factors. ApoB, HDL, TC/HDL-C ratio and apoB/apoA-1 ratio in migrant South Asian Indians in Canada were found to be significantly higher than among native Caucasians (33). Higher apoA-1 and lower apoB levels were reported in native Greenland Inuits compared with the Danes (low study sample size). The anti-atherogen pattern has been explained by a high consumption of marine mammals and fish (34). High frequency of CVD has been reported in Aboriginals from Canada and in American Indians, while total cholesterol, LDL, triglycerides and HDL levels were similar and even lower compared with the general population (35). No data on apolipoprotein were reported.

All analyses were based on non-fasting samples. Total cholesterol and HDL C varied little, while triglycerides decreased according to time since the last meal. There was no ethnic difference in time since the last meal. It is not likely that use of non-fasting samples influenced the comparison between ethnic groups. The significant differences between the ethnic groups were most consistent for apoB/apoA-1 ratio. ApoB and apoA-1 measurements have several methodological advantages. As for total cholesterol and HDL C, fasting samples are not necessary. The measurements are internationally standardized, easily automated, accurate and precise, and neither difficult nor expensive to do (13).

Prospective studies collaboration (PSC) showed that total cholesterol was positively associated with ischemic heart disease (IHD) mortality and the ratio of total/HDL cholesterol was more than twice as informative as total cholesterol (36). The correlations between total cholesterol and apoB and between apoA-1 and HDL C were both close to 0.90 in our study, indicating a similar association with IHD mortality if we use the apoB/apoA-1 ratio. Some have argued that the apoB/apoA-1 ratio might be an even better risk marker for CVD, and a higher apoB/apoA-1 ratio in Sami compared with Norwegians might indicate a higher risk of cardiovascular disease among the Sami. Further longitudinally studies are necessary.

Conclusions

Our conclusion is that middle-aged Sami have higher values of apoB/apoA-1 ratio and total cholesterol when compared with Norwegians. An increase in the apoB/apoA-1 levels is related to life-style factors, of which we have included only a few. Further studies to investigate the relationship between lipids and the dietary pattern and fat intake among the Sami are warranted.

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