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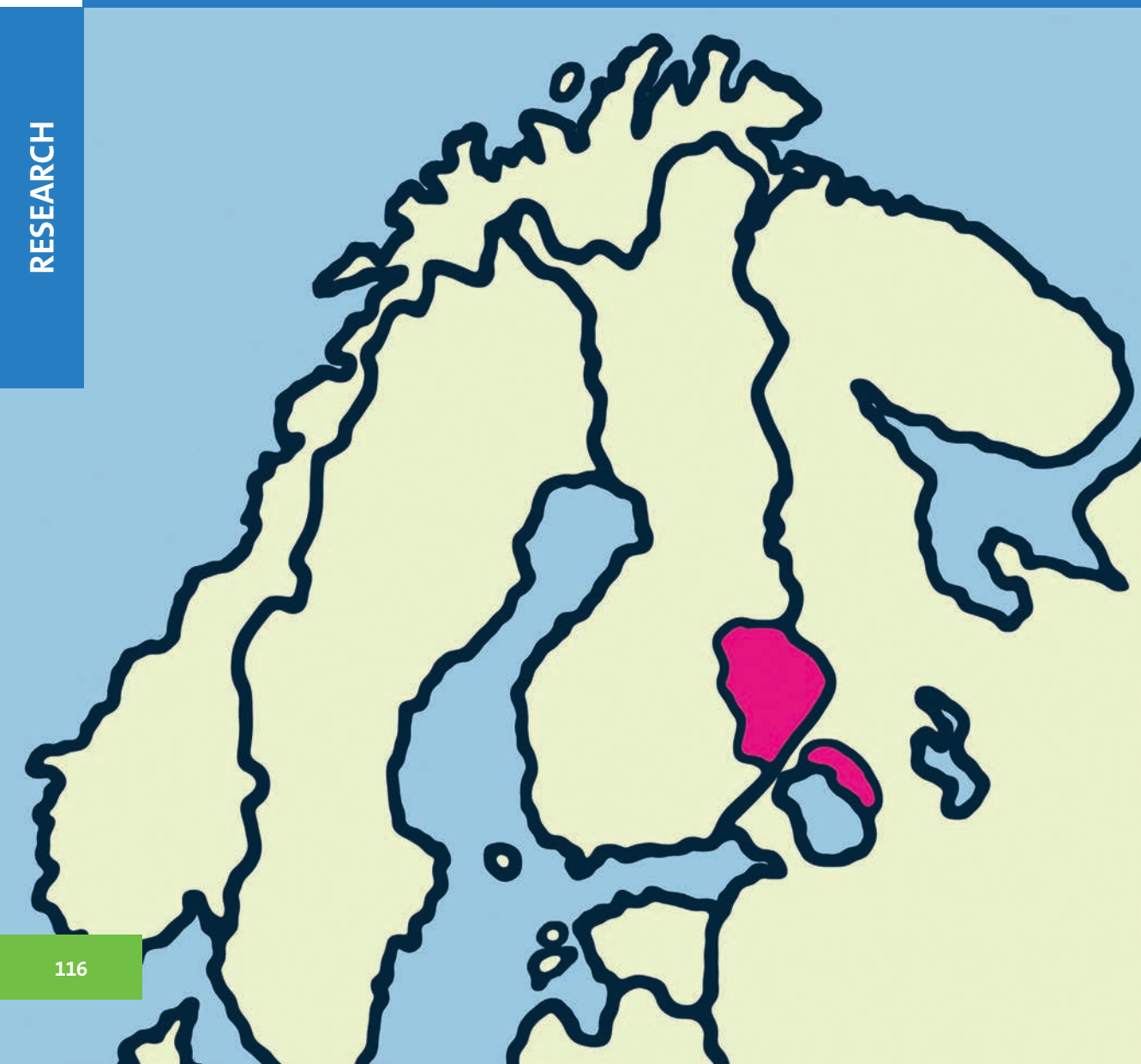
Laura Paalanen

Food habits and related biomarkers in Pitkäranta, Russia, and North Karelia, Finland

Trends and educational differences, 1992–2007

RESEARCH



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RESEARCH 116

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ACADEMIC DISSERTATION

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Abstract

Laura Paalanen. Food habits and related biomarkers in Pitkäranta, Russia, and North Karelia, Finland. Trends and educational differences, 1992–2007. National Institute for Health and Welfare (THL). Research 116/2013. 108 pages. Helsinki, Finland 2013.
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The gap in health behaviours, morbidity and mortality between Russia and Finland is globally one of the largest between neighbouring countries. The Republic of Karelia in north-western Russia and North Karelia in eastern Finland are situated right next to each other. Part of the Republic of Karelia, including the district of Pitkäranta, was part of Finland until the Second World War, when it was annexed to the Soviet Union. Since then the Republic of Karelia and North Karelia have diverged culturally and economically from each other.

The aim of this study was to explore trends and educational differences in food habits and related biomarkers in Pitkäranta, Russia, and North Karelia, Finland, over a 15-year period, which encompasses the early transition years from a centrally planned economy towards a market economy after the dissolution of the Soviet Union in 1991. In addition, the association of food habits and two biomarkers, that of serum total cholesterol and plasma vitamin C concentration, were explored in the two areas.

Two different population-based repeated cross-sectional datasets from the two areas were used: 1) health behaviour surveys from 1994, 1996, 1998, 2000 and 2004 (total n=3599 in Pitkäranta, total n=3652 in North Karelia) and 2) risk factor surveys from 1992, 1997, 2002 and 2007 (total n=2672 in Pitkäranta, total n=5437 in North Karelia). The data were collected by the National Public Health Institute (KTL) (the current National Institute for Health and Welfare, THL) in Finland. In Pitkäranta, the data were collected by the National Public Health Institute in collaboration with the Central Hospital of Pitkäranta and the Ministry of Health and Social Development in the Republic of Karelia. In the health behaviour surveys, self-administered questionnaires were used. The risk factor surveys included a health examination and blood tests in addition to a self-administered questionnaire, which resembled that in the health behaviour survey. Relative education was used as the indicator for socio-economic position. Food habits were assessed with a non-quantitative food frequency questionnaire and additional short questions. Food habits for this study were selected to represent important sources of dairy fat and vitamin C.

The trends and overall prevalence in food habits were very different between Pitkäranta and North Karelia. Food habits changed remarkably in Pitkäranta between 1992 and 2007. The proportion of those who used butter in cooking plunged from 50% to less than 10%. The proportion of those who used butter on

bread decreased as well, although not consistently. The proportion of persons who consumed fat-containing milk fluctuated. The prevalence of daily consumption of fresh vegetables and fruit increased notably. In North Karelia, the changes were smaller. A small decrease in the proportion of those who used butter or consumed fat-containing milk was observed. The prevalence of daily consumption of fresh vegetables and fruit also decreased slightly in North Karelia.

The food habits were in general more favourable among women than men in both areas, but the gender differences were more pronounced in North Karelia than in Pitkäranta. In addition, the educational differences in food habits were somewhat more notable in North Karelia. In general, food habits were less favourable in the lowest compared to the highest education group in both areas. For example, the use of butter in cooking and the consumption of fat-containing milk were more common among subjects in the lowest education group, whereas the daily consumption of vegetables and fruit was more common among their more highly educated counterparts. The education gradient in the quality of spread used on bread was the opposite in the two areas. In Pitkäranta, using butter on bread tended to be more common among men in the highest education group, whereas in North Karelia, men with a low education used butter on bread more often.

The mean serum total cholesterol concentration fluctuated in Pitkäranta between 1992 and 2007, whereas it decreased slightly in North Karelia. The serum total cholesterol did not differ by education in Pitkäranta. In North Karelia, it tended to be higher among subjects in the lowest education group. The food habits that were associated with serum total cholesterol differed between the areas. In Pitkäranta, the consumption of fat-containing milk and in North Karelia, the use of butter in cooking or on bread was associated with the serum total cholesterol concentration.

The mean plasma vitamin C concentration was strikingly low in Pitkäranta throughout the study period. In North Karelia, the overall level of plasma vitamin C was higher. The plasma vitamin C concentration tended to be higher among subjects with a higher education in both areas. The consumption of fruit on a daily basis was most strongly associated with the plasma vitamin C concentration in both areas.

This study gives reason to conclude that simple questions on food habits are reasonably valid measures in comparative settings and are especially useful, when more detailed dietary surveys are not feasible. The limitations of simple indicators and the differences in food cultures between study areas have to be taken into consideration in the interpretation of the results.

The study demonstrated that food habits may change quite rapidly if the local circumstances change. In Pitkäranta, the availability and prices of foods are possible underlying factors that are related to the remarkable changes in food habits. In North Karelia, active health policy and the health consciousness of the population are probably more important in directing food choices nowadays.

As food habits change and the selection of foods in the grocery stores varies over time, the food habit indicators need to be constantly updated. Further, more efforts to validate simple food habit indicators for the use in comparative study settings that include several and more remote countries are needed in the future to ensure the quality of comparative studies.

Keywords: Russia, Finland, food habits, education, butter, vegetables, fruit, cholesterol, vitamin C

Tiivistelmä

Laura Paalanen. Ruokatottumukset ja niihin yhteydessä olevat biomarkkerit Pitkärannassa, Venäjällä, ja Pohjois-Karjalassa, Suomessa. Muutokset ja koulutuserot vuosina 1992–2007. Terveyden ja hyvinvoinnin laitos (THL). Tutkimus 116/2013. 108 sivua. Helsinki 2013.
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Venäjän ja Suomen välinen kuilu terveyskäyttäytymisessä, sairastavuudessa ja kuolleisuudessa on yksi maailman suurimmista. Luoteis-Venäjällä sijaitseva Karjalan tasavalta ja Pohjois-Karjala Suomessa ovat toistensa naapurialueita. Osa Karjalan tasavallasta, Pitkärannan piiri mukaan lukien, oli osa Suomea, kunnes toisen maailmansodan yhteydessä alue liitettiin osaksi Neuvostoliittoa. Tämän jälkeen Karjalan tasavalta ja Pohjois-Karjala ovat eriytyneet toisistaan kulttuurisesti ja taloudellisesti.

Tämän tutkimuksen tavoite oli tutkia ruokatottumusten ja niihin liittyvien biomarkkereiden muutoksia ja koulutuseroja Pitkärannassa, Venäjällä, ja Pohjois-Karjalassa, Suomessa, 15 vuoden aikana. Tähän ajanjaksoon mahtuvat Neuvostoliiton vuoden 1991 hajoamisen jälkeiset varhaisen transition vuodet, jolloin Venäjä siirtyi keskusjohtoisesta suunnitelmataloudesta kohti markkinataloutta. Lisäksi tutkittiin ruokatottumusten yhteyttä valittuihin biomarkkereihin: seerumin kokonaiskolesteroli- ja plasman c-vitamiinipitoisuuksiin.

Aineisto käsitti kaksi erityyppistä väestöpohjaista, toistettua poikkileikkaustutkimusta Pitkärannasta ja Pohjois-Karjalasta: 1) terveyskäyttäytymiskyselyt vuosilta 1994, 1996, 1998, 2000 ja 2004 (tutkimusvuosina yhteensä n=3599 Pitkärannassa, n=3652 Pohjois-Karjalassa) sekä 2) riskitekijätutkimukset vuosilta 1992, 1997, 2002 ja 2007 (tutkimusvuosina yhteensä n=2672 Pitkärannassa, n=5437 Pohjois-Karjalassa). Kansanterveyslaitos (KTL) (nykyinen Terveyden ja hyvinvoinnin laitos, THL) oli vastuussa datankeruusta Suomessa. Pitkärannassa Kansanterveyslaitos keräsi aineistot yhteistyössä Pitkärannan keskussairaalan ja Karjalan tasavallan terveys- ja sosiaalisen kehityksen ministeriön kanssa. Terveyskäyttäytymistutkimuksissa tieto kerättiin lomakkeella, jonka tutkittavat täyttivät itse. Riskitekijätutkimus sisälsi kyselylomakkeen lisäksi terveystarkastuksen ja verikokeita. Terveyskäyttäytymis-tutkimuksessa ja riskitekijätutkimuksessa käytetyt kyselylomakkeet olivat pääpiirteiltään samanlaisia. Sosioekonomisen aseman indikaattorina käytettiin suhteellista koulutusta. Ruokatottumuksia selvitettiin lomakkeeseen sisältyneellä ei-kvantitatiivisella ruoankäytön frekvenssikyselyllä sekä joillakin tarkentavilla kysymyksillä. Tähän tutkimukseen valittiin ruokatottumuksia, jotka edustavat maitorasvan ja c-vitamiinin tärkeimpiä lähteitä.

Ruokatottumukset ja niissä tapahtuneet muutokset olivat hyvin erilaisia Pitkärannassa ja Pohjois-Karjalassa. Ruokatottumukset muuttuivat huomattavan paljon Pitkärannassa vuosien 1992 ja 2007 välillä. Voita ruoanvalmistuksessa

käyttävien osuus putosi 50 prosentista alle kymmeneen prosenttiin. Myös voita leivällä käyttävien osuus pieneni, joskaan ei johdonmukaisesti. Rasvaisen maidon juomisen yleisyys vaihteli tutkimusjakson aikana. Päivittäin tuoreita kasviksia tai hedelmiä syövien osuudet kasvoivat selvästi. Pohjois-Karjalassa muutokset olivat pienempiä. Voita käyttävien ja rasvaista maitoa juovien osuudet vastaajista pienenivät hieman. Myös tuoreita kasviksia ja hedelmiä päivittäin syövien osuudet pienenivät Pohjois-Karjalassa hieman.

Yleisesti ottaen naisten ruokatottumukset olivat miesten ruokatottumuksia terveellisempiä molemmilla tutkimusalueilla, mutta sukupuolten välinen ero oli selvempi Pohjois-Karjalassa kuin Pitkärannassa. Myös ruokatottumusten koulutuserot olivat hieman selvemmät Pohjois-Karjalassa. Ruokatottumukset olivat molemmilla alueilla epäterveellisempiä alimpaan koulutusryhmään kuuluneilla verrattuna korkeimmin koulutettuihin. Esimerkiksi voin käyttö ruoanvalmistuksessa ja rasvaisen maidon juominen oli tavallisempaa alimmassa koulutusryhmässä, kun taas kasvisten ja hedelmien syöminen päivittäin oli tavallisempaa ylimpään koulutusryhmään kuuluneilla. Käytetyn leipärasvan laadun koulutuserojen suunta oli päinvastainen Pitkärannassa ja Pohjois-Karjalassa. Pitkärannassa korkean koulutuksen saaneet miehet käyttivät voita leivällä useammin kuin matalammin koulutetut miehet toisin kuin Pohjois-Karjalassa, jossa voin käyttö leivällä oli tavallisempaa matalammin koulutetuilla miehillä.

Keskimääräinen seerumin kokonaiskolesterolipitoisuus vaihteli Pitkärannassa vuosien 1992 ja 2007 välillä. Pohjois-Karjalassa se pieneni hieman. Pitkärannassa kokonaiskolesterolissa ei ollut koulutusryhmittäisiä eroja, kun taas Pohjois-Karjalassa kokonaiskolesteroli oli hieman korkeampi alimmin koulutetuilla verrattuna korkeimpaan koulutusryhmään. Seerumin kokonaiskolesteroliin yhteydessä olleet ruokatottumukset erosivat alueiden välillä. Pitkärannassa rasvaisen maidon juominen ja Pohjois-Karjalassa voin käyttö ruoanlaitossa ja leipärasvana olivat yhteydessä seerumin kokonaiskolesterolipitoisuuteen.

Plasman keskimääräinen c-vitamiinipitoisuus oli Pitkärannassa äärimmäisen matala koko tutkimusjakson ajan. Pohjois-Karjalassa plasman c-vitamiinipitoisuus oli korkeampi. Korkea koulutus oli yhteydessä korkeampaan plasman c-vitamiini-tasoon molemmilla alueilla. Ruokatottumuksista hedelmien syöminen päivittäin oli vahvimmin yhteydessä plasman c-vitamiinipitoisuuteen molemmilla alueilla.

Tämän tutkimuksen perusteella voidaan todeta, että yksinkertaiset kysymykset ovat kohtuullisen valideja ruokatottumusten mittareita vertailevissa tutkimusasetelmissa ja hyödyllisiä erityisesti silloin, kun tarkempien ruoankäytön tutkimusmenetelmien käyttäminen ei ole mahdollisia. Yksinkertaisten indikaattoreiden rajoitteet sekä erot tutkimusalueiden ruokakulttuureissa tulee huomioida tulosten tulkinnassa.

Tämä tutkimus osoitti, että ruokatottumukset voivat muuttua nopeasti paikallisten olosuhteiden muuttuessa. Pitkärannassa ruokien saatavuus ja hinta ovat taustatekijöitä, jotka ovat mahdollisesti yhteydessä ruokatottumuksissa tapahtuneisiin

huomattaviin muutoksiin. Pohjois-Karjalassa aktiivinen terveyspolitiikka ja väestön terveystietoisuus ovat nykyään todennäköisesti tärkeämpiä tekijöitä ruokavalintojen muutoksissa.

Ruokatottumukset ja elintarvikevalikoima muuttuvat, joten ruokatottumusten indikaattoreita tulisi jatkuvasti päivittää. Lisäksi tulevaisuudessa kannattaa panostaa yksinkertaisten ruokatottumuksia kuvaavien indikaattoreiden validoimiseen sellaisissa tutkimusasetelmissa, jotka sisältävät useampia ja toisistaan maantieteellisesti etäisempiä maita vertailututkimusten laadun varmistamiseksi.

Avainsanat: Venäjä, Suomi, ruokatottumukset, koulutus, voi, kasvikset, hedelmät, kolesteroli, c-vitamiini

Аннотация

Лаура Паланен. Привычки в области питания и связанные с ними биомаркеры в Питкяранте, Российской Федерации, и Северной Карелии, Финляндии. Тенденции и различия в уровне образования 1992–2007. Институт общественного здоровья и благополучия (THL). Исследование 116/2013. 108 страниц. Хельсинки, Финляндия 2013.
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Пропасть в привычках, связанных со здоровьем, заболеваемости и смертности между Россией и Финляндией является в глобальном смысле самой глубокой среди соседних стран. Республика Карелия в Северо-Западной России и Северная Карелия в Восточной Финляндии расположены одна рядом с другой. Часть Республики Карелия, включая Питкярантский район, была до Второй Мировой Войны частью Финляндии, затем аннексирована Советским Союзом. С тех пор Республика Карелия и Северная Карелия культурно и экономически разошлись друг с другом.

Целью данного исследования является выявление тенденций и зависимости уровня образования и привычек, связанных с питанием, а также связанных с ними биомаркеров в Питкяранте, России, и Северной Карелии, Финляндии, в течение 15 летнего периода, который включает в себя ранние переходные годы от централизованно-плановой экономики до рыночной экономики после распада Советского Союза в 1991 году. Дополнительно, связь между пищевыми привычками и двумя биомаркерами, а именно: общего холестерина крови и концентрации витамина С в плазме крови, была исследована в двух регионах исследования.

Были использованы данные двух повторных поперечных популяционных выборочных исследований, проведенных в двух регионах: 1) исследование поведенческих привычек, связанных со здоровьем, в 1994, 1996, 1998, 2000 и 2004 годах (всего участников n=3599 в Питкяранте, всего участников n=3652 в Северной Карелии) и 2) исследование факторов риска в 1992, 1997, 2002 и 2007 годах (всего учасников n=2672 в Питкяранте, всего участников n=5437 в Северной Карелии). Данные были собраны Национальным Институтом Общественного Здоровья (KTL) (в настоящее время Национальный Институт Общественного Здоровья и Благополучия, THL) в Финляндии. В Питкяранте данные были собраны Национальным Институтом Общественного Здоровья в сотрудничестве с Центральной больницей г. Питкяранта и Министерством Здравоохранения и Социального Развития Республики Карелия. В исследовании поведенческих привычек, связанных со здоровьем, был использован анкетный опрос. Исследование факторов риска дополнительно к анкетированию включало медицинское обследование и анализ крови, анкеты использовались те же самые, что и в исследовании поведенческих привычек,

связанных со здоровьем. Данные об уровне образования были использованы как индикатор социо-экономического положения. Привычки в области питания были исследованы с помощью качественного опросника частоты потребления различных пищевых продуктов и ряда дополнительных вопросов. Привычки в области питания в данном исследовании были выбраны для отображения важнейших источников пищевых жиров и витамина С в рационе.

Тенденции и относительные частоты пищевых привычек значительно различались между Питкярантой и Северной Карелией. Произошло существенное изменение пищевых привычек в Питкяранте между 1992 и 2007 годами. Снизился уровень использования масла для приготовления пищи с 50% до менее чем 10% опрошенных. Доля использующих масло для намазывания на хлеб также уменьшилась, хотя и неравномерным образом. Уровень потребления цельного молока колеблется. Особенно возросла относительная частота ежедневного употребления свежих овощей и фруктов . В Северной Карелии изменения были менее выражены. Было зарегистрировано небольшое снижение в употреблении цельного молока и масла. Относительная частота ежедневного употребления свежих овощей и фруктов также слегка снизилась в Северной Карелии.

Пищевые привычки в целом были более благоприятными среди женщин по сравнению с мужчинами в обоих регионах, однако половые различия были более выражены в Северной Карелии, чем в Питкяранте. Также более выраженые различия в уровне образования были связаны с пищевыми привычками в Северной Карелии. В целом, пищевые привычки были более благоприятными в группе с более высоким уровнем образования, чем в группе с более низким, в обоих регионах исследования. Например, использование масла для приготовления пищи и употребление цельного молока встречалось чаще среди лиц в группе с низким уровнем образования, в то время как ежедневное употребление свежих овощей и фруктов чаще встречалось среди более образованных. Зависимость частоты использования спреда с уровнем образования была диаметрально противоположной в регионах исследования. В Питкяранте сливочное масло больше использовали мужчины из группы с более высоким уровнем образования, в то время как в Северной Карелии сливочное масло больше использовали мужчины с более низким уровнем образования.

Наблюдатся колебание уровня среднего значения общего холестерина плазмы крови в Питкяранте между 1992 и 2007 годами, в то время как в Северной Карелии наблюдается небольшое снижение уровня холестерина. Уровень общего холестерина в крови не различается в группах с различным уровнем образования в Питкяранте. В Северной Карелии имеется тенденция к повышению уровня холестерина в группе с низким уровнем образования. Пищевые привычки, связаные с уровнем общего холестерина плазмы крови,

различались в регионах исследования. В Питкяранте употребление цельного молока, а в Северной Карелии использование масла для приготовления пищи или для намазывания на хлеб было связано с концентрацией общего холестерина плазмы крови.

В Питкяранте средняя концентрация витамина С в плазме крови была поразительно низкой во время всего периода исследования. В Северной Карелии общее содержание витамина С в плазме крови было выше. Содержание витамина С в плазме крови имело тенденцию к повышению у лиц с более высоким уровнем образования в обоих регионах. Наиболее строгая ассоциация была установлена между ежедневным употреблением фруктов и концентрацией витамина С в плазме крови в обоих регионах исследования.

Данное исследование дает основание для вывода, что простые вопросы касательно пищевых привычек являются достаточно достоверным инстументом измерения в условиях сравнительного анализа и особенно полезны, когда более детальное исследование диетических факторов невозможно. Для интерпретации результатов исследования необходимо принимать во внимания ограничения простых показателей и различия в культуре питания между регионами исследования.

Ислледование показывает, что пищевые привычки могут изменяться довольно быстро если изменяются местные условия проживания. В Питкяранте доступность и цены на пищевые продукты являются возможной причиной изменения пищевых привычек. В Северной Карелии активная политика здравоохранения и забота населения о собственом здоровье, вероятно, в настоящее время являются более значимыми в направлении выбора пищевых продуктов.

Поскольку пищевые привычки изменяются, и ассортимент пищевых продуктов в магазинах изменяется со временем, показатели пищевого поведения должны обновляться регулярно. В дальнейшем, необходимо прилагать больше усилий по определению простых показателей пищевого поведения, что потребуется в будущем для обеспечения качества сравнительных исследований в условиях многонациональных исследований или более удаленных регионах исследования.

Ключевые слова: Россия, Финляндия, привычки, связанные с питанием, сливочное масло, овощи, фрукты, образоввание, холестерин, витамин С

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List of original papers

I Paalanen L, Prättälä R, Palosuo H, Helakorpi S, Laatikainen T. Socio-economic differences in the use of dairy fat in Russian and Finnish Karelia, 1994–2004. Int J Public Health 2010;55(4):325-37.

II Paalanen L, Prättälä R, Palosuo H, Laatikainen T. Socio-economic differences in the consumption of vegetables, fruit and berries in Russian and Finnish Karelia: 1992–2007. Eur J Public Health 2011;21(1):35-42.

III Paalanen L, Prättälä R, Laatikainen T. Contribution of education level and dairy fat sources to serum cholesterol in Russian and Finnish Karelia: results from four cross-sectional risk factor surveys in 1992–2007. BMC Public Health 2012;12:910.

IV Paalanen L, Prättälä R, Alfthan G, Salminen I, Laatikainen T. Vegetable and fruit consumption, education and plasma vitamin C concentration in Russian and Finnish Karelia, 1992–2002. Public Health Nutr 2013; Aug 30:1-9. [Epub ahead of print].

Abbreviations

CI	Confidence interval
CV	Coefficient of variation
CVD	Cardiovascular disease
EHRM	European Health Risk Monitoring Project
FFQ	Food frequency questionnaire
HAPIEE	Health, Alcohol and Psychosocial factors in Eastern Europe study
HDL-C	High-density lipoprotein cholesterol
HPLC	High-performance liquid chromatography
LDL-C	Low-density lipoprotein cholesterol
LLH	Living conditions, lifestyles and health project
MONICA	Multinational MONItoring of trends and determinants in CArdiovascular disease
MPA	Metaphosphoric acid
OR	Odds ratio
RLMS	Russia Longitudinal Monitoring Survey
SEP	Socio-economic position
TCA	Trichloroacetic acid
WHO	World Health Organization

1 Introduction

Diet is one of the major factors that affect the health of populations. However, comparing food habits between different areas is challenging as food habits vary between and even within countries. Food habits are bound to the local food culture and are adapted to the prevailing circumstances. Thus, in addition to the aspects of healthiness of food habits, foods available in the grocery stores, food prices, possibilities to grow foods and personal and culture-bound food preferences affect food habits. Food habits may change quite rapidly. For example, changes in the availability and price of foods, the advertising of specific food items or the promotion of a new type of diet may bring about marked changes in the food habits of an individual or a population. Further, public discussion in the mass or social media may cause food scares and lead to rapid but usually short-term decreases in the consumption of the foods concerned. Finland and Russia are neighbouring countries that share some common features in their food culture. However, the social and economic circumstances that affect the food habits have been quite different in the two areas in recent decades.

In Finland, food habits have changed considerably during the past fifty years. The consumption of fruit and vegetables has increased whereas the consumption of potatoes, high-fat milk and butter has decreased (Pietinen et al. 1996, Männistö et al. 2010). The diet among the Finnish population has mostly become more beneficial for health. Reasons for the favourable changes in diet include improved variety of healthier foods in grocery stores, increased health consciousness and an active nutrition policy in Finland (Pietinen et al. 2010a).

In Russia, representative surveys on food consumption or even food habits, repeated at regular intervals, do not exist apart from the Russian Longitudinal Monitoring Survey, in which food consumption has been measured with a single 24-hour recall (Stillman and Thomas 2008). Russia is a vast and heterogeneous country, which complicates the gathering of survey data that would be representative for the whole country. Studies concerning trends in the health situation in Russia have mainly concentrated on mortality and life expectancy (Cockerham 1997, McKee and Shkolnikov 2001, Shkolnikov et al. 2001, Murphy et al. 2006), whereas studies on health-related behaviours have for the great part dealt with smoking (McKee et al. 1998, Bobak et al. 2006) and alcohol consumption (McKee 1999, Leon et al. 2007). All the foregoing indicators give an alarming view of the health situation in Russia in recent decades. The studies have shown that large fluctuations in mortality rates have occurred in connection with societal changes.

Concerning food habits, the abundant consumption of fruit and vegetables has been proved to be protective of cardiovascular diseases (Boeing et al. 2012, Larsson et al. 2013). In health behaviour surveys, fruit and vegetable consumption is one of

the most commonly used indicators for healthy food habits. Even though fruit and vegetables represent only one component in the diet, their frequent consumption is related to other healthy food choices and thereby indicates overall healthy food habits. In addition, the measurement of the consumption of fruit and vegetables is more reliable than the consumption of several other foods (Männistö et al. 1996, Paalanen et al. 2006). Because of differences in methodology, data on fruit and vegetable consumption are often not comparable between different studies, though.

The intake of saturated fat is one of the most important health-related aspects of diet as it is positively associated with serum total cholesterol concentration, one of the major risk factors for cardiovascular disease (CVD) (Gordon et al. 1982, Caggiula and Mustad 1997, Clarke et al. 1997, Johansson et al. 2012). Thus, the type of fat used on bread or in cooking is a commonly used indicator in European surveys. Unlike for fruit and vegetable consumption, which is commonly measured in frequencies, the use of fat is often asked more generally as the type of fat usually used. Availability and variety of food products is especially important in relation to saturated fat intake, even more so than for fruit and vegetable consumption. In Finland, for instance, a large variety of fat products are available at present in grocery stores. Thus, consumers can actively choose what kind of fat they want to use on bread or in cooking and whether they want to drink high-fat, medium-fat or skimmed milk. In Russia, this has not been the case until recently. For example, soft margarines became available on the market later in Russia than in Finland and even more so in rural parts. As the selection and availability of food products has widened, the role of active food choice has increased in Russia as well.

Both the consumption of fruit and vegetables and the use of fat vary by socio-economic position. Mostly, the foods considered healthy are more commonly used among the higher socio-economic groups, whereas the lower socio-economic groups favour less healthy foods. However, the socio-economic gradient may differ between countries. For example, in Northern European countries, the consumption of fruit and vegetables is consistently more common in the higher socio-economic groups, whereas the opposite socio-economic pattern has been seen in southern European countries (Roos et al. 2001, Prättälä et al. 2009). The socio-economic differences in food habits in Eastern Europe, especially in Russia, have not been as extensively studied. However, data from the Baltic countries suggest partly parallel and partly opposite socio-economic differences compared to Finland (Petkeviciene et al. 2007).

A part of north-western Russia in the Republic of Karelia was part of Finland until the Second World War. Currently, the Republic of Karelia and the neighbouring Finnish North Karelia are economically, culturally and socio-economically very different. These two areas offer a unique setting to examine health-related behaviours and their changes and socio-economic differences in two neighbouring areas, of which one represents former socialist area in Eastern Europe,

and the other a Western European welfare state. The comparison of food habits, their trends and socio-economic differences in these areas adds knowledge to the factors underlying one of the largest health gaps between neighbouring countries in the world. Furthermore, the comparison of Russian and Finnish Karelia allows exploration of the relevance of the changes in society for food habits and other health behaviours. In the current doctoral study, food habits, related biomarkers and their educational differences will be examined over a 15-year time period since 1992, that is, immediately after the collapse of the Soviet Union in 1991, in the Republic of Karelia, Russia, and North Karelia, Finland.

2 Review of the literature

In this section, the overall trends in food habits and their gender and socio-economic differences in Russia and Finland will be covered. The issues concerning the use of dairy fat products and the consumption of vegetables and fruit will be given special attention. A review of the common dietary assessment methods and a reflection on comparative study settings, which include two or more divergent areas, will also be included.

2.1 Food habits in Russia and Finland

2.1.1 Trends in food habits in Russia

Russia is an enormous country encompassing many different food cultures. No extensive surveys on food habits have been conducted in Russia, and current data are scarce and scattered. Some official statistics based on food balance sheets that cover the whole country do exist. However, food balance sheets only give a rough estimate of the true food consumption in countries such as Russia, where the proportion of self-grown foods is considerable, especially in the case of vegetable, fruit and berry consumption in rural areas of the country. This chapter gives an overview of the data that the author is aware of on food habits in Russia during the past four decades. The Soviet era will be covered briefly, but the emphasis will be on the time since the break-up of the Soviet Union in 1991.

For the Soviet period, mainly data based on food balance sheets are available. The estimates from these data reflect "food disappearance", i.e. food available on the market, rather than actual consumption (Cooper and Schatzkin 1982). The data cover the entire Soviet Union and thus do not allow regional comparisons. However, broad trends in food consumption can be roughly estimated from these data. From 1965 to 1985, the consumption of milk and dairy products and meat increased notably in the Soviet Union (Cooper and Schatzkin 1982, Keep 1995). Furthermore, the consumption of vegetables, fruit and berries increased, whereas potato consumption decreased. A minor increase in the use of vegetable oil occurred, but the increase in the consumption of animal products high in saturated fat and cholesterol outweighed the increases in vegetable oil use.

Data from the Lipid Research Clinic project included a sample of 20–59-year-old men from Moscow and St Petersburg (formerly Leningrad) in 1974–1978 (n=332 for the sample of 20–39-year-old men: n=998 for the sample of 40–59-year-old men) (Ingram et al. 1985, Dennis et al. 1988). Fat intake data calculated on the basis of single 24-hour recalls were in line with calculations from food balance sheet data.

Among men from the two biggest Soviet cities, 38–39% of energy was derived from fat and 16–17% of energy from saturated fat. Furthermore, it has been estimated that the mean intake of vitamin C from diet was 60 mg among the sample of urban men, which was the lower limit of recommended dietary allowances accepted in the Soviet Union in 1968 (Shaternikov et al. 1981).

The "scientific consumption standards", i.e. the recommended dietary allowances of the Ministry of Health of the former Soviet Union, differed greatly from those in other countries. For example, the recommended daily intake of protein in the Soviet Union was twice or even three times higher than that of the World Health Organization (WHO) or other recommendations in Europe or North America (UNICEF 1994, Robertson and Lang 1997). The central planning system enabled the consumption of meat and dairy products in vast quantities by distributing them to the population and by regulating the prices so that they were affordable.

During the early transition period after the break-up of the Soviet Union, diet in the former socialist societies deteriorated. The average calorie, protein and fat intake decreased somewhat (UNICEF 1994). The consumption of milk as well as fresh fruit and vegetables also decreased. Self-production increased as people could no longer afford to buy enough food from the groceries or the supply was poor. As self-production increased, the official statistics based on food balance sheets became even less accurate. However, during subsequent years, the food balance sheet data point to a rise in the availability of several foods. From 1990–1992 to 2005, the consumption of milk, fruit and vegetables increased again, whereas the consumption of meat decreased (Ulijaszek and Koziel 2007).

In 1992, immediately after the break-up of the Soviet Union in 1991, a risk factor survey, including a section on food habits, was performed in the district of Pitkäranta in the Republic of Karelia, Russia. The results pointed to extremely common use of butter on bread in Pitkäranta, whereas the consumption of vegetables, fruit and berries was very low (Matilainen et al. 1994). The strikingly low vegetable and fruit consumption was reflected in alarmingly low plasma ascorbic acid (i.e. vitamin C) concentrations among a sample of men in the same survey (Matilainen et al. 1996). Subsequently, the use of butter on bread in Pitkäranta fell, whereas the consumption of fruit and vegetables has been on the increase (Laatikainen et al. 2006, Vlasoff et al. 2008). Despite the increase in the consumption of fruit and vegetables, the plasma vitamin C concentration was still very low in 1997 (Pussinen et al. 2003).

The Russian Longitudinal Monitoring Survey (RLMS) is a survey that collects data at both the household and individual level in Russia (UNC Carolina Population Center 2013). Food consumption in the RLMS has been assessed with a single 24-hour recall in most cases. The data point to high fat intake in Russia in the 1990s (Stillman 2006). According to the RLMS data, about 40% of energy was derived from fat in 1992. The share of fat in the diet decreased until 1998, after which it

increased again until 2001. Furthermore, according to the data from the RLMS, the intake of vitamin C, β-carotene and vitamin A have also been calculated to be lower than recommended, although the intake varied between study years (Martinchik et al. 2005).

The Health, Alcohol and Psychosocial factors in Eastern Europe (HAPIEE) study, conducted in 2002–2005, included a sample from Novosibirsk, Russia (Boylan et al. 2009). From Novosibirsk, data from about 9,000 subjects (response rate 61%) were used in the analyses. Food consumption was assessed using a quantitative FFQ, which included 147 food or drink items in Russia. The energy intake was higher in Novosibirsk, Russia, than in samples from other Eastern European countries. Furthermore, the total fat intake and more specifically the saturated fat intake were quite high in Novosibirsk. Fat was estimated to be the main source of energy. The mean intake of vitamin C from the diet was surprisingly high: 111 mg and 128 mg per day among men and women, respectively. About half (49% of men and 60% of women) met the recommendation of ≥400g of fruit and vegetables per day. Seasonal variation in fruit and vegetable consumption was observed – the highest percentage of subjects who met the recommendation was among those who completed the FFQ in the autumn. Among the Russian subjects, 75% and 81% of men and women, respectively, who filled in the FFQ in autumn met the recommendation, while only 38% of subjects who filled in the FFQ in the summer did. Results on plasma vitamin C concentrations from Pitkäranta from 1997 point to great seasonal variation in vitamin C containing foods as well (Paalanen et al. 2012) with extremely low plasma vitamin C concentration in spring but about 8-fold and 4-fold mean concentrations in autumn compared to spring among men and women, respectively.

In a case-control study on colorectal cancer in South-East Siberia, the participants were asked several questions on food habits as a part of a general health interview in 2011–2012 (Zhivotovskiy et al. 2012). Here, only the results for the controls (n=210) are summarised. The median consumption frequency of fruit and vegetables was seven times per week, i.e. daily, which is higher than in other studies in Russia. However, the figure is likely to include the consumption of fruit and vegetables in all forms; that is fresh, cooked and pickled. Consumption of dairy products was also queried in the study. The reported prevalence for the consumption of milk, cottage cheese, kefir (sour milk), smetana (sour cream) and cheese ranged between 70% and 80%. Unfortunately, the format of the questions on food habits were not reported in the study and it was not possible to infer what kind of amount, frequency and time period the reported percentages applied to. In any case, the results show that, in addition to milk, the use of other dairy products was equally common among the participants.

2.1.2 Trends in food habits in Finland

Data on trends in food habits are abundant in Finland and include various surveys with diverse dietary assessment methods in addition to food balance sheet data. Considerable changes in food habits have occurred since the 1950s, according to food balance sheets statistics (Männistö et al. 2010). The consumption of cereals and potatoes roughly halved between 1950 and 1975, whereas a notable increase in the consumption of fruit and vegetables took place. The overall consumption of milk has decreased considerably, and a shift from whole milk to low-fat and skimmed milk has taken place. Survey data on an individual level since the 1970's are in line with trends from the food balance sheets and indicate, in addition, a considerable decrease in the use of butter on bread since late 1970s (Lahelma et al. 1997, Helakorpi et al. 2008, Männistö et al. 2010). Thus, the food habits in Finland have mainly become more beneficial for health.

The contribution of fat to the energy intake was high in Finland at the end of 1960s. The results from different studies varied between 37% and 40% of energy from fat on average (Koskinen et al. 1974, Aho and Pekkarinen 1989). The share of energy from fat decreased to 34% in 1992 (Pietinen et al. 1994) and further to 33% and 31% among men and women, respectively, in 2007 (Paturi et al. 2008, Pietinen et al. 2008).

Regional differences in food habits do occur within Finland (Similä et al. 2005), although they may not be as big as in the geographically larger and culturally more diverse Russia. As early as in 1959, differences in food habits between men residing in eastern and western Finland were found (Kromhout et al. 1989). For example, fat intake was considerably higher among men in eastern Finland compared to men in the west. On the other hand, differences in food habits between urban and rural areas of Finland were recorded about ten years later (Koskinen et al. 1974). The results indicated higher use of cereal products and lower consumption of fruit and berries in rural compared to urban areas. Regional differences in food habits have remained, although they did diminish between 1978 and 2006 (Similä et al. 2005, Helakorpi et al. 2007). As examples, the consumption of vegetables, fruit and berries is still more common in urban areas such as southern Finland, whereas cereal products, especially rye bread, are more popular in eastern Finland.

North Karelia in eastern Finland is a specifically interesting area in Finland with regard to the interrelationship of diet, serum cholesterol and health. The serum cholesterol levels were exceptionally high in North Karelia as early as in the 1950s (Keys et al. 1966). In addition, the morbidity and mortality rates have been high in North Karelia. In the 1970s, the food habits were very unfavourable in North Karelia; the intake of saturated fat was high, whereas the consumption of vegetables and fruit was low. During the subsequent decades of active health promotion in connection with the North Karelia Project, the food habits and the overall health situation have improved there (Puska 2009, Puska et al. 2009, Vartiainen et al. 2010).

2.2 Gender and socio-economic differences in food habits

In this section, the literature is limited to studies among adult populations in Europe. The main focus will be on socio-economic differences in dairy fat sources and important sources of vitamin C, that is, vegetable and fruit consumption.

Consistent gender differences in food habits have been widely observed in Europe. Studies reporting dietary patterns or different forms of healthy diet indices show that women's diet is generally healthier than men's (van Lee et al. 2012). More specifically, women eat more fruit and vegetables than men (Baker and Wardle 2003, Krachler et al. 2005, Giskes et al. 2006, Prättälä et al. 2007, Estaquio et al. 2008, Harding et al. 2008, Roos et al. 2008) while eating meat and drinking high-fat milk tends to be more common among men (Pomerleau et al. 2001, Krachler et al. 2005, Petkeviciene et al. 2007, Prättälä et al. 2007, Johansson et al. 2012). Studies reporting nutrient intakes also show differences between the genders. For example, previous studies have shown higher vitamin C and fibre intake and lower fat intake among women than among men (Harding et al. 2008, Pietinen et al. 2008, Johansson et al. 2012). Explanations for more favourable food habits among women compared to men have included women's better nutrition knowledge, stronger beliefs in healthy eating and thereby better motivation to eat healthily among women, the role of women as the household's main responsible person planning the groceries and preparing the meals, and the pursuit of slimness among women (Roos et al. 1998, Jensen and Holm 1999, Oakes and Slotterback 2001, Baker and Wardle 2003, Wardle et al. 2004, Dickson-Spillmann and Siegrist 2011). In addition, it has been suggested that women are trend-setters who adopt new food habits prior to men. For example, in Great Britain a pronounced increase in the consumption of fruit and vegetables seems to have started first among women and somewhat later among men (Rogers and Pryer 2012, Scholes et al. 2012).

Food habits also differ by socio-economic position (SEP). Education is the most common indicator for SEP in studies on socio-economic differences in food habits or nutrient intake (Petkeviciene et al. 2007, Ovaskainen et al. 2010, Kriaucioniene et al. 2012). Other common choices have been occupation (Seiluri et al. 2011) and income (Giskes et al. 2006, Roos et al. 2008). Some studies have found education to be more strongly related to food habits compared to occupation or income (Giskes et al. 2006, Estaquio et al. 2008). In addition, self-reported data on education is regarded as more reliable than that on income, which supports the use of education as the indicator of socio-economic position in studies relying on questionnaire data. Education is most often enquired either as categories of education (e.g. primary, secondary, upper secondary or university) or as total years of education. The distribution of both categories and years of education have changed over time and differs between countries, which may complicate the analyses and interpretation of the results in some studies.

Studies on socio-economic differences in food habits from several European countries show mostly parallel results with higher vegetable and fruit consumption among subjects with a higher SEP (Billson et al. 1999, Irala-Estévez et al. 2000, Vannoni et al. 2003, Giskes et al. 2006, Estaquio et al. 2008, Rogers and Pryer 2012, Scholes et al. 2012) and on the other hand more common use of butter in cooking and on bread among subjects with a lower SEP (Rosell et al. 2006). However, with regard to vegetable consumption, a reverse association with SEP has also been observed in some southern European countries, where the consumption of vegetables is more common in the lower SEP groups compared to the higher ones (Roos et al. 2001, Prättälä et al. 2009).

Interestingly, in the Baltic states, which used to be part of the Soviet Union, contrasting educational differences in the use of foods containing fat have been observed. In a study using cross-sectional health behaviour survey data from 1998, 2000 and 2002 comparing the Baltic states (Estonia, Latvia and Lithuania) and Finland, differences between the countries in the socio-economic gradients in using butter on bread and eating meat and meat products daily were found (Petkeviciene et al. 2007). Using butter on bread was more common among subjects in the lowest education group in Finland and Estonia, while the opposite was true among Latvians and Lithuanians. As for eating meat or meat products, their use was more common among men in the lowest education group in Finland, while among Estonian men, eating meat and meat products daily was more common among subjects with a higher education. Among women the educational differences in meat and meat product consumption were less obvious. On the contrary, educational differences in the use of vegetable oil in cooking, drinking high-fat milk and eating cheese daily were parallel in the three Baltic states and Finland. Using vegetable oil in cooking and eating cheese daily was more common among subjects with higher education compared to a lower one in all four countries, whereas the consumption of high-fat milk seemed to be associated with a low educational level. The data came from the Finbalt Health Monitor project, which aimed at collecting comparative health behaviour survey data from Finland and the Baltic states (Prättälä et al. 2011). The sampling method in all four countries was a nationally representative random sample, with the final number of participants ranging from 1203 to 3198 and response rates between 62% and 80%. A standardised questionnaire was used in all participating countries and all the surveys were carried out according to a common protocol. Yet, education was measured as educational level categories in Latvia and as total years of education in Estonia, Lithuania and Finland, which reduced the comparability of the data from the four countries.

The comparability of the data is a major limiting factor in a large part of the surveys comparing socio-economic differences in food habits across different countries. Often, the issue of comparability has not been taken into account as early as in the planning phase of the survey, but instead, existing data sets collected for

differing purposes are used for comparing different countries. For example, a study using the HAPIEE (Health, Alcohol and Psychosocial factors in Eastern Europe) study data from selected urban areas from Russia, Poland and the Czech Republic (2002–2005) and the Helsinki Health Study data from Finland (2000–2002), compared socio-economic differences food habits in the four countries (Boylan et al. 2011). The areas in the HAPIEE study were Novosibirsk, Russia; Krakow, Poland and six urban centres in the Czech Republic. Firstly, the study populations were quite different in the HAPIEE study and the Helsinki Health Study. In the HAPIEE study, a random sample of the populations in selected cities were recruited, whereas in the Helsinki Health Study only employees of the City of Helsinki were included in the study population. Secondly, the method of assessing food consumption was quite different in the two surveys. In the HAPIEE study, a quantitative FFQ consisting of 136–148 food items was used, whereas the questionnaire used in the Helsinki Health Study only included 22 food and drink items with no specified portion sizes. Thirdly, the information on occupational class was reported by the respondents themselves in the HAPIEE study, whereas in the Helsinki Health Study, the information on occupational class was derived from a register for most participants.

2.2.1 Gender and socio-economic differences in food habits in Russia

Studies on gender and socio-economic differences in food habits in Russia are scarce. The scattered data that the author is aware of are summarised below.

From the time of the former Soviet Union, data from which gender differences in food habits could be examined hardly exist, because the food balance sheet data cannot segregate the consumption of men and women, whereas the Lipid Research Clinic study only included men. However, some information regarding socio-economic differences is available.

Despite a reasonably low income inequality in the former Soviet Union, the amounts of consumed foods varied by income. According to official statistics, the consumption of meat and meat products, milk and dairy products as well as fruit and vegetables were higher among families with higher income in 1986 in the Soviet Union compared to families with lower income (UNICEF 1994). In contrast, the consumption of potatoes, bread and cereals was higher in the lower income families.

Some food consumption and nutrient intake results by education have been published from around 1975 from the Lipid Research Clinics data among men from Moscow and St Petersburg. The results showed higher total fat as well as higher saturated fat intake among subjects with more than a high school education compared to those with less than a high school education (n=1700) (Dennis et al. 1993). Regarding the results on food consumption, they are in line with the data by income from the official statistics. The consumption of dairy products (milk, cheese and yogurt) as well as the consumption of fruit and vegetables was higher among

men with more than a high school education compared to men with less than a high school education. In contrast, bread and cereals were more common in the diet of men with less than a high school education.

Concerning the time after the break-up of the Soviet Union, more data based on surveys are available. Differences by gender, education, income and occupation in the daily vegetable consumption and the daily meat consumption in the three post-Soviet societies of Belarus, Russia and Ukraine were reported on the basis of data gathered with face-to-face interviews in 2001 (response rate 73% in Russia) (Cockerham et al. 2006). The data were part of the Living Conditions, Lifestyles and Health (LLH) project. The data for Russia were combined with the data for Belarus and Ukraine in the analyses. The authors justified this decision with the countries' similar continuing increase in mortality and because each country has maintained autocratic approaches to politics since the downfall of the Soviet Union. Thus, the following results include the three countries. Daily vegetable consumption was more common among women than men, whereas daily meat consumption was more common among men in the survey sample. Education was not significantly associated with either vegetable or food consumption, whereas higher occupation status was positively associated with daily meat consumption, and higher disposable income with both daily meat and daily vegetable consumption.

Data from Novosibirsk (2002–2005) showed that eating fruit at least twice per day was more common among women than men, whereas no gender differences in vegetable consumption were observed (Boylan et al. 2009). The consumption of fruit and the use of vegetable fat in cooking were positively associated with a higher socio-economic position according to all socio-economic measures of the study, i.e. education, occupation and economics. No significant socio-economic differences were seen in the use of vegetables, drinking low-fat milk or using vegetable fat spread.

The association between fish consumption and various socio-economic factors were examined in two populations in Northern Russia: residents in Arkhangelsk city and the rural Nenets autonomous area in 2008–2009 (Petrenya et al. 2011). Fish consumption was queried with a detailed fish questionnaire, which was part of an FFQ, and reported as g/day. Higher monthly household income appeared to be related to higher fish consumption, whereas no significant associations between educational level and fish consumption were seen.

The changes in the share of protein and fat in the diet from 1994 to 2004 have been examined from the data from the RLMS (n=2981) (Rizov et al. 2012). Unfortunately, the results are somewhat hard to interpret. However, they suggest that the share of both fat and protein in the diet increased most among subjects holding a university degree during the ten-year period.

2.2.2 Gender and socio-economic differences in food habits in Finland

A large number of studies have been conducted to explain the gender and socio-economic differences in food habits among adult Finns. The results from Finland are for the greater part in line with studies from Western Europe that were presented in the previous chapter.

Regarding gender differences in food habits, results from Finland are parallel with those from other Western European countries; women eat more vegetables and less meat and drink high-fat milk less often than men in Finland (Prättälä et al. 2007, Roos et al. 2008, Lallukka et al. 2010, Seiluri et al. 2011). Furthermore, the increasing trend in fruit and vegetable consumption was seen among women prior to men in Finland as well (Helakorpi et al. 2007, Roos et al. 2008). The motives in food choice have recently been explored in Finland, and the results point to higher priority of familiarity of foods among men than women (Konttinen et al. 2013). Thus, it may be easier for women to change their food habits, whereas the corresponding changes take longer among men.

Socio-economic differences in food habits also resemble those from other Western European countries. Vegetable and fruit consumption tend to be higher, whereas the use of butter in cooking and on bread tend to be lower among subjects with a higher SEP compared to subjects with a lower SEP (Prättälä et al. 2003, Seiluri et al. 2011, Konttinen et al. 2013).

In Finland, changes in educational differences have also been explored for some foods. The changes in the proportion of subjects using butter on bread and drinking high-fat milk was examined by education from 1978 to 1993 (Lahelma et al. 1997). The proportion of subjects with both of these habits indicating dairy fat use decreased in all education groups, but simultaneously, the educational differences diminished strongly. Furthermore, the changes in the educational differences in daily vegetable consumption between 1979 and 2002 have been examined among adults (aged 25–64 years) using cross-sectional data from national health behaviour surveys (Roos et al. 2008). The daily vegetable consumption was consistently more common among those with a higher educational level or household income compared to those with lower ones during the study period. Consuming vegetables on a daily basis also became more common during the period of around 20 years in all educational and income groups. However, the relative differences between educational and household income groups decreased over the years as the daily vegetable consumption increased significantly more among subjects in the lowest education and income groups compared to their counterparts belonging to the highest groups. A study among a sample of employees of the City of Helsinki examined changes in occupational differences in several food habits, including the frequent consumption of fruit and vegetables, among the same subjects from 2000–2002 to 2007 (Seiluri et al. 2011). The socio-economic differences appeared quite

stable. However, the follow-up period was only five to seven years, which may not have been long enough to demonstrate changes in the socio-economic differences.

To summarise, food habits in Finland tend to be more favourable among women than men and on the other hand in the higher SEP groups compared to lower SEP groups. Further, it can be concluded that some diminishing in socio-economic differences in food habits occurred in Finland until 2002, but thereafter the data are less convincing.

2.3 Dietary assessment in population surveys

No single perfect method exists for measuring food consumption in large population surveys. Trying to gather comparable data from two or more culturally distinct areas brings an extra challenge to the choice of the dietary assessment method. This section gives a brief overview of the common dietary assessment methods, which are used in epidemiological study settings.

2.3.1 Measuring food consumption and nutrient intake

A food record is often considered the golden standard of dietary assessment methods. If the participants fill in the food records thoroughly and according to the instructions, food records give detailed and accurate information on the participants' diet during the recording period. The strength of a food record is that in principle, it does not depend on a person's memory, since the foods consumed should be recorded immediately after consumption. However, a high level of motivation is demanded from the participant as keeping a food record for several days is strenuous and time-consuming and, regrettably, recording affects food consumption. Furthermore, a risk exists in that the subjects do not bother or remember to record all the food they have eaten. Food records are also very demanding from an investigator's point of view, as most often they have to be coded manually, and a food composition database is needed for the conversion of the food consumption data into nutrient intake data. Usually, the length of the food recording period varies between one to seven days. As food consumption varies from day to day and from season to season, one short food record period cannot be considered representative of the individual's diet. The representativeness can be improved by repeating the food recording period during different seasons and including different days of the week (Nelson and Bingham 1997, Willett 1998). Due to the high cost, food records are often not suitable for use in large epidemiological studies. More commonly, they have been used as instruments in validation studies performed among a sub-sample of study participants.

As an alternative to a food record, 24-hour or 48-hour recalls give accurate and quantitative information on food consumption during a short time period, but unlike food records, the recalls rely on the subjects' memory. In a recall, a trained interviewer goes through all foods the subject has consumed during the past 24 or 48

hours. The interviewer can make defining questions and can use food models and a picture booklet, among others, to quantify the amounts consumed. The method is demanding for the subjects, as they have to travel to the study site at a given time to be interviewed. This method also demands notable resources from the investigator in the form of trained interviewers and rooms for the interviews. As for the food record method, a food composition database is needed in the analyses of the data gathered. Data from 24-hour or 48-hour recalls are suitable for calculating mean intakes among the target population, whereas they are not suitable for depicting an individual's habitual diet (Beaton et al. 1979, Nelson and Bingham 1997).

Diet history is an extended version of the 24-hour recall and aims at describing the subjects' habitual diet over a long time period. The diet history is a structured interview, where the frequencies, portion sizes and recipes are most often also specified (Nelson and Bingham 1997). Provided that a food composition database is available and quantitative data are gathered with the diet history interviews, the data allow calculations as amounts of food consumption and nutrient intake. The method, however, depends strongly on the subject's memory as the inquiry covers a longer period of food consumption. The interviews are time-consuming as they often last for one to two hours. As in 24-hour recall, substantial resources are needed from the investigator, because trained interviewers and rooms are needed for the interviews. In addition, the diet history interviews and the processing of the data from them are time- and labour-consuming. The interviews aim to identify day-to-day and seasonal variation. Thus, the data gathered with diet histories represent an individual's usual diet.

Like diet history, a detailed food frequency questionnaire (FFQ) gives information on food habits of an individual during a longer time period. For example, food consumption during the previous 12 months may be inquired. In comparison to diet history interviews, the subjects most often fill in the FFQs themselves. Self-administered questionnaires have advantages compared to interviews in studies with large samples from geographically wide areas, since the questionnaires can be mailed to the subjects as well as returned to the study personnel by mail. In this case, the respondents can complete the questionnaire at a time that is most convenient to them. The questions should be simple enough as the respondents complete the questionnaires without assistance and unclear or missing answers can often not be clarified afterwards. Again, if the study includes a visit to a study site, the subjects can return the questionnaires there, where they can be checked by the study personnel. Fewer resources are needed compared to diet history. To expedite data entry, the forms can even be planned to be optically readable. As a reasonably inexpensive method, FFQ is often used in studies including large population samples.

The level of data varies between FFQs. They can focus on specific food groups (Mohammadifard et al. 2011) or nutrients (Pritchard et al. 2010, Sublette et al. 2011)

or they can aim at measuring the whole diet of the subjects (Pietinen et al. 1988, Paalanen et al. 2006, Haftenberger et al. 2010). Further, FFQs can be divided into quantitative and non-quantitative ones. From the quantitative FFQs, which aim at assessing the whole diet, food consumption and nutrient intake can be calculated as amounts per day using a food composition database. In the case of quantitative questionnaires, the subjects are most often classified according to their calculated food consumption and nutrient intake, whereas for a non-quantitative questionnaire, the classification is only possible according to the frequency of food consumption. Regrettably, even the seemingly accurate quantitative FFQ has serious limitations and has been criticised for the following flaws, among others: 1) The usual frequency of consumption is cognitively difficult to answer, 2) the portion sizes of the same foods vary between occasions, thus "usual portion size" is difficult to determine for many foods, and 3) the details about food preparation methods and recipes of multi-ingredient foods cannot be collected, though they have a large impact on the nutrient values of the foods (Kristal et al. 2005, Brown 2006). All these problems may add to the measurement error of the results.

2.3.2 Measuring food habits

In large population surveys, compromises have to be made in the choice of the dietary assessment method. As interviews are time-consuming and demand substantial resources, the dietary data are often gathered with self-administered questionnaires. Detailed, quantitative FFQs also demand substantial resources, as their conversion to amounts of food consumption and nutrient intake per day is laborious. The quantitative FFQs are also quite strenuous and cognitively demanding for the participants to administer and regardless of the hard work required from both the respondent and the investigator, as described earlier, they may not always result in eminently accurate food consumption and nutrient intake data.

Thus, often a simpler, non-quantitative FFQ may be a more appropriate method. It is less burdensome for the participant and thus does not require so much motivation and cognitive skills from the participant. Its coding also demands fewer resources from the investigator. Food consumption is not calculated as amounts, and therefore no information on nutrient intake level is obtained from the non-quantitative FFQs. The information from non-quantitative FFQs can be complemented with short questions, for instance on the quality of fat used in cooking or on bread, the fat content of milk usually consumed or even the participants' meal pattern and place of eating. Thus, non-quantitative FFQs and short supplementary questions on food choices give more general dietary information about the subjects. The more general level of information has special advantages for the investigator. The data may be more straightforward to interpret, when the original responses of the subjects are managed as such and not converted from food frequency level to nutrient intake

level like from quantitative FFQs. The term referring to the more general dietary information used in this work is "food habits".

Non-quantitative FFQs and short questions have been used in several large surveys (Murphy et al. 2001, Coyne et al. 2005, Lallukka et al. 2007, Seiluri et al. 2011, Zazpe et al. 2011). For example in Finland, a national risk factor survey has been conducted every five years since 1972. General information on the subjects' diet has been gathered as a part of an extensive questionnaire with a non-quantitative FFQ. In addition, short questions on selected food habits, such as questions on the quality of fat used on bread or in cooking, have been included in the questionnaire. Since 1982, more accurate dietary information has been collected among a sub-sample of the study participants as a part of the risk factor survey (Männistö et al. 2010). The methods used have been food records, 24-hour recalls and 48-hour recalls. This kind of thorough dietary assessment would not have been feasible among the entire study population. However, including a simple non-quantitative FFQ and some complementary short questions on diet in the main questionnaire of the risk factor survey has enabled the gathering of information on main dietary indicators from all study participants.

Finally, limitations that apply to practically all dietary assessment methods that rely on self-reported information include measurement error and the subjectivity of the data. One fundamental concern in dietary studies is that the subjects may be prone to giving a more favourable view than what is true of their food habits, either deliberately or unconsciously. Examples of discrepancies in self-reported vs. more objective measures include underreporting of energy intake (Johansson et al. 2001, Poslusna et al. 2009), and related to the former, lower self-reported vs. measured body weight (Niedhammer et al. 2000, Connor Gorber et al. 2007).

2.3.3 Biomarkers in assessing food consumption and nutrient intake

Compared to self-reported food consumption data, biomarkers are considered a more objective means of assessing nutrient intake. The emphasis here is on biomarkers measured from blood, but urine, hair and nails, among others have also been used for some nutrients.

The main limitations regarding the use of biomarkers in surveys are related to practical and resource issues. First of all, the study participants need to be highly motivated, as they have to travel to the study site at a given time to give a blood sample. Secondly, taking and analysing blood samples is resource-heavy. The study personnel must include trained nurses, and the storage of the samples at the study site and the transfer of samples to the analysing laboratory are other issues to be solved. A further limiting factor is that, due to several reasons, biomarkers do not always accurately describe nutrient intakes on an individual level. The absorption of several nutrients may be impaired by diseases and the use of medication (Mullin 2012, Vavricka and Rogler 2012, Samaras et al. 2013). Additionally, the metabolism

of several nutrients varies between individuals because of genetic factors (Humphries et al. 2006, Soutar and Naoumova 2007, Horska et al. 2011). Finally, smoking affects the metabolism of some nutrients (Brubacher et al. 2000, Schleicher et al. 2009, Horska et al. 2011), whereas, physical activity can result in the elevated secretion of nutrients in sweat (Maughan et al. 2004, Henkin et al. 2010). Despite these inaccuracies, biomarkers are a useful tool to supplement food consumption and nutrient intake data on a population level.

Biomarkers can be used as indicators of nutritional status regarding selected nutrients (Garland et al. 1995, Mozaffarian et al. 2011) or they can be used to validate data from questionnaire studies (Bolton-Smith et al. 1991, Männistö et al. 1996, Carlsen et al. 2011, Lin et al. 2013). In validation studies, biomarkers are most often used to validate nutrient intake level data calculated from FFQs, for example. Yet, reliable biomarkers for foods rather than for nutrients have also been studied. Examples include potential biomarkers for fruit and vegetable (Baldrick et al. 2011) and meat and fish (Dragsted 2010, Kuhnle et al. 2013) consumption. In the following paragraphs, biomarkers for two specific food groups will be covered in more detail: 1) serum total cholesterol as a biomarker for dairy fat sources and 2) plasma vitamin C concentration as a biomarker for fruit and vegetable consumption.

No single biomarker for dairy fat intake exists that would be both accurate and practical to use in large population studies. Dairy fat intake can be estimated reliably from the fat composition of the adipose tissue, while the fat composition of serum lipids has been found to be less accurate (Wolk et al. 2001). Unfortunately, taking adipose tissue biopsies is often not feasible in large surveys and does not accomplish the criterion for a good biomarker in being minimally invasive for participants.

Saturated fat intake in diet is positively associated with serum total cholesterol concentration, one of the major risk factors for cardiovascular disease (CVD) (Gordon et al. 1982, Caggiula and Mustad 1997, Clarke et al. 1997, Ramazauskiene et al. 2011, Johansson et al. 2012). The fat in dairy products is mostly saturated – about 70% of the fatty acids in bovine milk are saturated, whereas mono-unsaturated, poly-unsaturated and trans fatty acids account for about 25%, 2.3% and 2.7%, respectively (Månsson 2008). In Finland and other Western European countries, milk and dairy products are a major source of saturated fat among adults (Wolk et al. 2001, Hulshof and Ocké 2005, Paturi et al. 2008). In Finland, other important sources of saturated fat in 2007 were fat spreads and dressings as well as cereal and bakery products. Among men, meat dishes also contributed notably to the saturated fat intake (Paturi et al. 2008).

Serum total cholesterol concentration can be reliably determined (Sundvall et al. 2007), and assuming that the study protocol and the methods used in the analysis laboratories are identical, serum total cholesterol is a reliable measure, even in comparative population surveys (Tolonen et al. 2002a). As dairy products are a major source of saturated fat, serum total cholesterol might be an appropriate

biomarker for the consumption of foods that are important sources of dairy fat. However, the validity of serum total cholesterol as a biomarker for dairy fat sources in the diet has not been studied.

Biomarkers for fruit and vegetable consumption have been searched for, as there is convincing evidence that higher consumption of vitamin C-rich foods such as fruit and vegetables or higher plasma vitamin C concentration are associated with a smaller risk of CVD (Ness et al. 1996, He et al. 2007, Martínez-González et al. 2011, Boeing et al. 2012, Larsson et al. 2013). No similar effect for vitamin C supplements has been proved. A recent meta-analysis found virtually no beneficial effects of vitamin C or other antioxidants in the form of supplements in the prevention of CVD (Myung et al. 2013). Compared to vitamin supplements, fruit and vegetables contain various micronutrients, probably even many advantageous substances that have not been identified so far. Thus, a feasible biomarker for fruit and vegetable consumption rather than for single nutrients would be useful in future studies.

Common biomarkers for fruit and vegetables include plasma vitamin C concentration, total or single carotenoids (van Kappel et al. 2001, Garcia et al. 2010, Baldrick et al. 2011, Carlsen et al. 2011) and flavonoids (Baldrick et al. 2011, Carlsen et al. 2011). Regrettably, the correlations for blood carotenoids and fruit and vegetable consumption have been moderately low (van Kappel et al. 2001, Carlsen et al. 2011). Some studies have found the strongest correlation for serum α-carotene and the consumption of vegetables as well as total fruit and vegetable consumption (Andersen et al. 2005), whereas the results from other studies also support the use of β-carotene as a biomarker for fruit and vegetable consumption (van Kappel et al. 2001, Carlsen et al. 2011, Frankenfeld et al. 2012).

A recent review of biomarkers for fruit and vegetables found plasma vitamin C to be a good biomarker for fruit consumption (Baldrick et al. 2011). The review was based on 96 intervention studies. In contrast, neither plasma vitamin C nor any other single biomarker seemed to be sufficient to describe vegetable consumption. According to the review, with regard to vegetable consumption, a panel of biomarkers should be used instead.

2.4 Comparing food habits between countries

Comparing food habits between countries poses several challenges. Similar to all surveys across different countries, cultural and linguistic differences in responding may hinder the comparison of the results (Laaksonen et al. 2001). The survey methodology should be as identical as possible in all study areas. This, however, is in many cases not possible in surveys regarding food habits. Completely identical questions on food habits cannot be used, because the food culture and the foods available in local grocery stores vary greatly between countries. Thus, perfectly

comparable data on food habits from different countries will hardly ever be achieved.

The level of comparability of data from different countries depends largely on whether issues on comparability have been taken into account as early as in the planning phase of the study. For example, the data may have been collected differently between countries in that in some countries the subjects fill in the questionnaires themselves, whereas in other countries the corresponding data are collected by interviewers (Prättälä et al. 2009, Boylan et al. 2011). Further, the consumption of vegetables may have been enquired about separately for fresh, boiled and preserved vegetables or combined for all vegetables in different countries (Prättälä et al. 2009), which complicates the comparison of absolute frequencies of consumption between countries.

Examples of studies examining food habits in countries from both Eastern and Western Europe with common questionnaires and protocols exist, such as the Finbalt Health Monitor project (Prättälä et al. 2011) and the Bridging the East-West Health Gap project (Laaksonen et al. 2001). The former project was carried out between 1998 and 2008 and included Finland and the three Baltic states (Estonia, Latvia and Lithuania), where a health behaviour survey was conducted among a nationally representative random sample of the population every second year. The latter project included samples from three Eastern European and three Western European countries. The samples were not nationally representative. For example, the sample from Germany only covered the city of Karlsruhe. Nonetheless, the results on food habits did not show consistent east-west differences. Rather, among the six areas included in the study, the food habits seemed to be evidently least favourable in the selected area in Russia, that is, Pitkäranta in the Republic of Karelia. Thus, comparable high quality data from Eastern and Western Europe are scarce. This was identified as a major deficit also in a recent review that included nutritional studies from Eastern, Central and Western Europe (Novaković et al. 2013). Studies from Russia were not included in the review, most probably because of lack of studies that would have fulfilled the inclusion criteria of the review.

Mostly parallel patterns by socio-economic position have been seen in European countries with more common vegetable and fruit consumption and less common use of butter among subjects with a higher SEP, compared to their counterparts with lower SEP. However, contrasting socio-economic patterns have also been observed with examples of higher vegetable consumption in lower SEP groups in some southern European countries (Roos et al. 2001) and more common use of butter on bread among subjects in the lower SEP groups in Latvia and Lithuania (Petkeviciene et al. 2007). Thus, it seems that the reasonably consistent pattern of healthier diet among subjects with a higher SEP in Western and Northern Europe does not necessarily apply to countries in Eastern or Southern Europe regarding all food habits.

Vast societal changes have taken place in Russia in recent decades since the collapse of the Soviet Union in 1991. However, data on trends in food habits in Russia since the early 1990s are scarce and scattered. More specifically, there is currently a gap in the understanding of socio-economic differences in food habits in Russia. Comparative data from Russia and a neighbouring area with more stable societal and economic circumstances would increase the understanding of the underlying societal factors of the changes in food habits in Russia. Comparing data from Russia with an area where the social determinants of food habits have been more extensively studied would allow for a reflection on the factors which predict favourable or unfavourable changes in food habits in Russia. Previous findings from the three Baltic states that seceded from the Soviet Union in 1990–1991 have shown that despite large changes in health behaviours, including food habits, during a time of societal upheaval, the socio-economic differences have remained surprisingly stable (Prättälä et al. 2011, Prättälä and Puska 2012).

From Russia, survey data covering the transition period in the early 1990s are especially limited with regard to the socio-economic variation in food habits. Further, data allowing comparisons on food habits across time within any area in Russia and on the other hand between Russia and other countries are rare. Such data exist for the district of Pitkäranta, the Republic of Karelia, Russia, and North Karelia, Finland, however. Two types of surveys have been conducted in these two areas with common study protocols: 1) health behaviour surveys covering ten years from 1994 to 2004, and 2) risk factor surveys covering 15 years from 1992 to 2007. From these data, the trends in relevant food habits, their socio-economic differences and related biomarkers can be explored in two geographically neighbouring but culturally and socio-economically different areas. Results from the early surveys in the 1990s point to huge overall differences in food habits between these two areas (Puska et al. 1993, Matilainen et al. 1994, Laaksonen et al. 2001). However, the recent trends and socio-economic differences in food habits have not yet been examined.

On the basis of previous findings, assumptions on the direction of trends and socio-demographic differences in food habits in the two areas can be made. It can be expected that the use of butter and the consumption of fat-containing milk are more common, whereas the consumption of fruit and vegetables are less common in Pitkäranta, Russia, than in North Karelia, Finland. The serum cholesterol concentration and plasma vitamin C concentration were lower in Pitkäranta than in North Karelia in the early 1990s, and the same difference between the areas can be expected to have remained. On the basis of recent trends in the Baltic countries, the use of butter can be expected to have decreased and the consumption of vegetables and fruit to have increased in Pitkäranta over recent decades. The food habits can be presumed to be more favourable among women than men in both areas. Further, the socio-economic differences in food habits can be expected to be more notable in

Finland than in Russia. Regarding the changes in socio-economic differences, the previous studies give reason to two alternative expectations: either, the socio-economic differences may have been reasonably stable in both countries, or the socio-economic differences may have started to widen in Russia during the transition towards a market economy.

3 Aims of the study

The main aim was to examine trends and socio-economic differences in food habits and in associated biomarker levels in two geographically close but culturally and economically different areas, the district of Pitkäranta in the Republic of Karelia, Russia and North Karelia, Finland. Two groups of food habits were chosen for the indicators of major dairy fat and vitamin C sources in the diet.

Major sources of dairy fat included

1) the use of butter in cooking,
2) the use of butter on bread,
3) consumption of fat-containing milk, and
4) daily consumption of cheese.

Indicators for vitamin C-rich foods were

1) daily consumption of fresh vegetables,
2) daily consumption of fruit, and
3) regular consumption of berries.

In the specific study aims these are referred to in short as 'food habits'.

The specific study aims were as follows:

1) To examine the differences between Pitkäranta and North Karelia in the overall prevalence and trends in food habits, serum total cholesterol concentration and plasma vitamin C concentration using indicators that are measurable in different countries (sub-studies I–IV).
2) To examine how the gender patterns in food habits, serum total cholesterol concentration and plasma vitamin C concentration differ between the two areas (sub-studies I–IV).
3) To examine how the educational patterns in food habits, serum total cholesterol concentration and plasma vitamin C concentration differ between the two areas (sub-studies I–IV).
4) To examine which dairy fat sources and vitamin C-rich foods are associated with the serum total cholesterol and plasma vitamin C concentrations, respectively, in the two areas, and whether the associations are similar or different (sub-studies III and IV).

4 Subjects and methods

4.1 Study sites

The Republic of Karelia in Russia and the province of North Karelia in Finland are neighbouring areas (Figure 1). The Republic of Karelia shares a common history with Finland as a part of it, including the study site, the district of Pitkäranta, was a part of Finnish Karelia before the Second World War. In 1940, the district of Pitkäranta, along with some other areas of Finland, was annexed to the Soviet Union. The majority of the Finnish-speaking population in the district of Pitkäranta moved to North Karelia after the Second World War.

The Republic of Karelia had limited contact with North Karelia or other foreign countries during the Soviet era and currently the two Karelias are politically, economically and culturally very different. The Republic of Karelia and North Karelia have 296 km of common border.

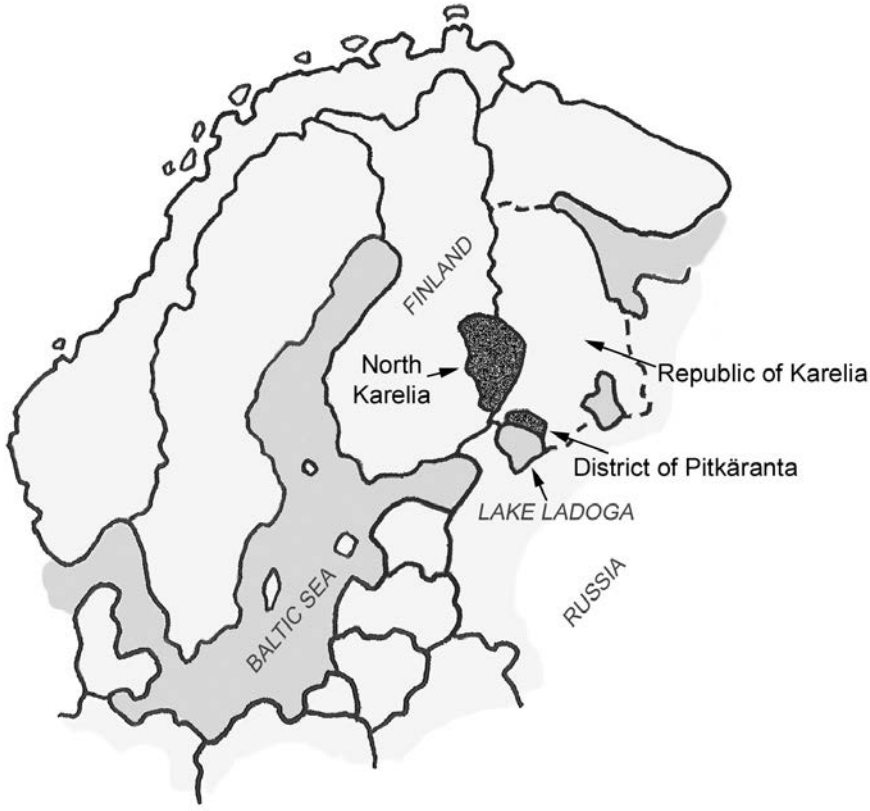


Figure 1. Map of the study areas.

The Republic of Karelia is a part of the Russian Federation. The capital city of the Republic of Karelia is Petrozavodsk, and the republic is divided into 18 districts. When the first risk factor survey in the republic was being planned at the beginning of 1990s, the district of Pitkäranta was chosen to represent the republic. According to prior statistical information it was considered a relatively typical area of the Republic of Karelia with respect to age and nationality distribution, economic structure and urbanisation rate (Kellera 1990, Statistical Office of Karelia 1991).

The district of Pitkäranta is located on the north-western shore of Lake Ladoga. The population of the district was about 22 600 in 2007. About half of the population lives in the district's biggest town Pitkäranta (Federal State Statistics Service 2004). Other municipalities include Harlu, Impilahti, Läskelä and Salmi. The distance from the city of Pitkäranta to the Finnish border is about 100 km. The biggest employers are a pulp factory, the City of Pitkäranta and a quarry. From now on, 'Pitkäranta' will refer to the district of Pitkäranta in the Republic of Karelia in this thesis.

North Karelia is the easternmost province of Finland, with 166 000 inhabitants in 2011 (Statistics Finland 2012). The biggest town in North Karelia is Joensuu, with its 74 000 inhabitants. In 2006, 65% of working population in North Karelia were occupied in the service sector, 26% in secondary production and 8% in agriculture and forestry (Suomen kuntaliitto 2009).

4.2 Surveys in Pitkäranta and North Karelia

4.2.1 Health behaviour surveys (sub-study I)

Cross-sectional health behaviour surveys were carried out in Pitkäranta in 1994, 1996, 1998, 2000 and 2004. In 2002, the health behaviour survey was not conducted in Pitkäranta because a risk factor survey was carried out in the same area that year. Corresponding surveys were conducted in Finland by the National Public Health Institute (KTL) (the current National Institute for Health and Welfare, THL) on an annual basis. In addition, from North Karelia in Finland, data based on a separate special random sample were collected annually until 1996 and every second year thereafter. The original purpose of the extra sample from North Karelia was to serve as a tool for the evaluation of the North Karelia Project. The sample was representative of the adult population of the province of North Karelia. The data from health behaviour surveys from Pitkäranta and from the special sample from North Karelia were analysed in sub-study I. Only study years for which data existed for both study areas were included in the analyses. The number of respondents and the response rates are presented in Table 1.

All surveys were conducted during springtime. The data were gathered by a self-administered questionnaire. In North Karelia, the questionnaires were sent by mail. In Pitkäranta, nurses from the Central Hospital of Pitkäranta took the questionnaires

to the respondents' homes and the respondents were asked to return the questionnaires to their closest hospital or polyclinic.

The subjects were drawn from the National Population Register in Finland. The National Population Register conducted the sample-drawing according to the request of the National Public Health Institute. In Pitkäranta, the subjects were drawn from patient records in 1994 and 1996 and from electoral lists in 1998, 2000 and 2004 using random number lists. The district of Pitkäranta is divided into areas that are responsible for the health care in the specific area. The hospital or polyclinic of the area maintain 'health cards', covering the whole population of the area. The sample was drawn from these health cards. As for the electoral lists, they are maintained by the area's register office and encompass the whole population as well. All surveys, except the 1994 survey in Pitkäranta, were based on a simple random sample. In 1994, the sample in Pitkäranta was stratified with each 10-year age group having an equal number of men and women. Because of a very even population structure in Russia among the working age population, the proper random sampling and age stratified random sampling methods finally resulted in fairly similar age distributions in the original samples.

The age range of the subjects included in the analyses of this study was 25–64 years. In Pitkäranta, the number of 25–64-year-old subjects in the 1994 sample was 1000. In 1996, the sample size was 1500. The samples in the 1998, 2000 and 2004 surveys were again 1000 persons. In 1998, 2000 and 2004, persons who had died or had permanently moved out of the survey area in the period between sampling and survey were excluded from the original sample in calculating the response rates. In addition, persons in prison at the time of the survey were excluded. In 1994 and 1996, there was no possibility to obtain information on non-respondents.

In North Karelia, a random sample of 1200 persons in the age group 15–64 years was drawn in all study years, except in 1996, when the sample size was 1900. The number of persons in the age group 25–64 years ranged from 959 to 973 in all but the 1996 survey, when it was 1585. The response rates for 25–64-year-olds included in this study were calculated from a sample from which persons living abroad were excluded.

4.2.2 Risk factor surveys (sub-studies II–IV)

The National Public Health Institute (KTL) (the current National Institute for Health and Welfare, THL) has carried out cross-sectional risk factor surveys in Finland every five years since 1972. North Karelia has been one of the study areas since the beginning. From 1992, the survey has been called the National FINRISK Study. In Pitkäranta, the first risk factor survey was conducted in 1992 in close collaboration with the National Public Health Institute (KTL). Data from risk factor surveys from years 1992, 1997, 2002 and 2007 were utilised in the analyses of this study.

The samples were stratified with each 10-year age group having an equal number of men and women (stratified random sample). In Pitkäranta, each 10-year age stratum included 125 men and 125 women in all surveys, and the total original sample size was 1000. In North Karelia, each 10-year age stratum of the original sample included 250 men and 250 women in 1992, 1997 and 2002 resulting in an original sample of 2000 persons. In 2007, the size of the stratum was 200, and the original sample thereby 1600 persons. The methodology closely followed the WHO MONICA protocol (WHO MONICA Project Principal Investigators 1988). The protocol was updated in 2002 by the European Health Risk Monitoring Project (EHRM) (Tolonen et al. 2002b) and the updated protocol was used in 2007. The age range of subjects in this study was 25–64 years. The numbers of respondents and the response rates are presented in tables 1 and 2.

All surveys were conducted during springtime. The data collection was conducted first in North Karelia and, after it was finalised in Finland, a Finnish team went to Pitkäranta for data collection. Thus, the samples in Pitkäranta were collected later than in North Karelia. The risk factor surveys were conducted as identically as possible in Pitkäranta and North Karelia. The study protocol included a self-administered questionnaire and a health examination with anthropometric and blood pressure measurements as well as blood sampling.

4.2.3 Ethical issues

Local, prevailing ethical instructions were applied in all studies. The health behaviour surveys only included self-administered questionnaires. In Pitkäranta, the Ministry of Health and Social Development granted permission for the health behaviour surveys. In Finland, the data of the surveys were collected according to the good research practice applied in the National Public Health Institute (KTL).

The risk factor surveys in Pitkäranta were approved by an agreement between the National Public Health Institute (KTL), Finland, the Ministry of Health and Social Development of the Republic of Karelia and the Central Hospital of Pitkäranta. No expert opinions of ethical committees were required in Pitkäranta. Since 2002, written informed consent was obtained from the subjects in Pitkäranta. Regarding data collection in North Karelia, the practices changed during the study period. In 1992, no ethical permission was needed for the risk factor survey, whereas since 1997, the studies were conducted according to the guidelines laid down in the Declaration of Helsinki (World Medical Association 1996). In 1997, the study protocol was approved by the ethical committee of the National Public Health Institute (KTL). The risk factor survey in 2002 was approved by the Ethics Committee of Epidemiology and Public Health, Hospital District of Helsinki and Uusimaa, whereas the risk factor survey in 2007 was approved by the Coordinating Ethics Committee, Hospital District of Helsinki and Uusimaa. Since 1997, written informed consent was obtained from the subjects in North Karelia.

Table 1. Number of participants and response rates in health behaviour surveys 1994–2004 and risk factor surveys 1992–2007 (sub-studies I–III).

	Men, n (response rate)	**Women, n (response rate)**	**Total, n**
Health behaviour surveys			
Pitkäranta			
1994	384 (77%)	412 (82%)	796
1996	317 (43%)	413 (52%)	730
1998	292 (68%)	385 (77%)	677
2000	304 (71%)	430 (80%)	734
2004	288 (69%)	374 (74%)	662
1994–2004	1585	2014	3599
North Karelia			
1994	333 (65%)	355 (77%)	688
1996	514 (62%)	529 (70%)	1043
1998	328 (61%)	330 (76%)	658
2000	298 (61%)	343 (73%)	641
2004	280 (58%)	342 (71%)	622
1994–2004	1753	1899	3652
Risk factor surveys			
Pitkäranta			
1992	380 (77%)	455 (92%)	835
1997	309 (64%)	440 (88%)	749
2002	263 (56%)	342 (71%)	605
2007	192 (45%)	291 (65%)	483
1992–2007	1144	1528	2672
North Karelia			
1992	673 (68%)	803 (81%)	1476
1997	712 (71%)	751 (75%)	1463
2002	664 (67%)	762 (77%)	1426
2007	499 (63%)	573 (72%)	1072
1992–2007	2548	2889	5437

Table 2. Number of participants with plasma vitamin C determinations and response rates for the vitamin C sample in the risk factor surveys 1992–2002 (sub-study IV).

	Men, n (response rate)	**Women, n (response rate)**	**Total, n**
Pitkäranta			
1992	117 (75%)	[1]	117
1997	244 (50%)	338 (68%)	582
2002	218 (46%)	274 (57%)	492
1992–2002	579	612	1191
North Karelia			
1992	224 (67%)	[1]	224
1997	191 (48%)[2]	[1]	191
2002	559 (56%)[3]	642 (65%)[4]	1201
1992–2002	974	642	1616

[1]Plasma vitamin C was not determined among women in Pitkäranta in 1992 and in North Karelia in 1992 and 1997.

[2]Vitamin C could not be measured from all samples from North Karelia in 1997 due to technical difficulties with metaphosphoric acid (MPA) used at the field laboratory.

[3]The plasma samples of 57 men from North Karelia were omitted because of thawing of samples in 2002.

[4]The plasma samples of 61 women from North Karelia were omitted because of thawing of samples in 2002.

4.3 Measurements

The questionnaires in both the health behaviour surveys and the risk factor surveys were designed to be as similar as possible in the two areas. The questionnaires included questions on socio-demographic factors, health behaviours and the use of health services. However, some questions were formatted differently in the two areas, reflecting the local social and cultural environments.

4.3.1 Socio-demographic variables

Gender and education were used as explanatory variables in the analyses. In addition, age was used for adjustment. In sub-studies I and II, results by employment status were presented as well, but the results by employment status are not presented in this thesis.

Education was selected as the main indicator for socio-economic position. In the questionnaires, the number of years of education was inquired. The mean years of

education by gender and age group in the two areas are presented in Table 3. For the analyses in all four sub-studies, a relative education variable based on the subjects' total years of education was created. The years were divided into tertiles (high, intermediate and low) within each 5-year birth cohort (sub-study I) or 10-year birth cohort (sub-studies II, III and IV), separately for men and women.[1] This relative education variable was used because the educational systems differ between Russia and Finland. In addition, the data included persons born between 1928 and 1982, and the distributions of years of education have changed over time.

Table 3. Mean number of years of education by age group in the risk factor surveys 1992–2007 (data for all years combined).

	Men	**Women**
	mean (95% CI)	**mean (95% CI)**
Pitkäranta		
25–34 years	11.8 (11.6–12.1)	12.4 (12.2–12.6)
35–44 years	11.7 (11.4–12.0)	12.2 (12.0–12.5)
45–54 years	11.1 (10.7–11.6)	11.5 (11.3–11.8)
55–64 years	9.4 (9.0–9.8)	9.6 (9.2–10.0)
North Karelia		
25–34 years	13.2 (12.9–13.5)	14.2 (13.9–14.4)
35–44 years	12.1 (11.8–12.3)	12.5 (12.2–12.7)
45–54 years	10.3 (10.0–10.5)	11.1 (10.8–11.3)
55–64 years	9.0 (8.7–9.3)	9.3 (9.1–9.6)

4.3.2 Food habits

The questionnaire in both the health behaviour surveys and the risk factor surveys included an extensive set of questions on food habits. Two sets of variables were selected to indicate important sources of i) dairy fat and ii) vitamin C in the diet. 1) Use of butter in cooking, 2) use of butter on bread, 3) consumption of fat-containing milk, and 4) daily consumption of cheese were selected as indicators for dairy fat. The variable 'daily consumption of cheese' was included only in the analyses of the sub-study III. 1) Daily consumption of fresh vegetables, 2) daily consumption of fruit, and 3) regular consumption of berries were chosen as indicators for vitamin C sources.

[1] Because of a spelling mistake in the Stata syntax, a part of subjects in the lowest education tertile incorrectly ended up as missing data. This mistake only concerned men in Pitkäranta in sub-study II. The corrected values are presented in this thesis.

Fat type used in cooking and on bread was inquired about in multiple choice questions. The questions and options in the health behaviour surveys and the risk factor surveys were very similar. As the selection of fat products expanded during the study period in both study areas, the options in the questionnaires were modified respectively. For example, in Pitkäranta, soft margarine was added to the questionnaire in the health behaviour survey questionnaire in 1998 and in the risk factor survey questionnaire in 2002. The multiple choice options for the questions 'What kind of fat is usually used in your home for food preparation?' and 'What kind of fat do you mostly use on bread?' in the health behaviour surveys 1994–2004 in Pitkäranta and North Karelia are presented in tables 4 and 5. The options were classified on the basis of the quality of fat of the products. Categories from multiple choice questions were combined to construct dichotomous variables: 1) butter (outcome category) and 2) other fat or no fat (reference category). Butter, hard margarine, any mixture of butter and oil consisting mainly of saturated fat and lard were categorised as 'butter'. Using no fat in cooking or on bread, and using vegetable oil or soft margarine were combined as the reference category. The classification of multiple choice options is presented in tables 4 and 5. The questions on fat type used in cooking or on bread in the risk factor surveys closely resembled those in the health behaviour surveys.

The variable 'consumption of fat-containing milk' was constructed to indicate whether or not a subject drank fat-containing milk on a daily basis. Skimmed milk was not available in Pitkäranta during the study period. Thus, all subjects who reported drinking milk daily were categorised as consuming fat-containing milk, and the subjects who did not drink milk daily were categorised in the reference group. In North Karelia, the dichotomisation was performed similarly as in Pitkäranta in other respects, but also the subjects consuming skimmed milk were categorised to the reference group. The mean number of reported glasses of milk per day was 1.2 and 0.8 among men and women in Pitkäranta, respectively, and 2.0 and 1.2 among men and women in North Karelia, respectively.

Consumption of cheese was inquired about in the food frequency section of the questionnaire. For both study areas, the daily consumption of cheese was used in the analyses. The format of the food frequency section of the Finnish questionnaire was revised in the 2007 risk factor survey, but categories comparable with other study years could be constructed from the modified food frequency section for North Karelia. In sub-study III, the trends in the daily consumption of low-fat cheese in North Karelia were also presented. Low-fat cheese was not available in Pitkäranta during the study period. As we do not have corresponding data on low-fat cheese in Pitkäranta, the results are not presented in this thesis. Thus, in this study, cheese refers to cheese with regular fat content.

Table 4. Multiple choice options in the question on the use of fat type in cooking and the classification of the variable in the health behaviour surveys in Pitkäranta and North Karelia, 1994–2004.

	Pitkäranta		North Karelia	
	Options for fat type in cooking	**'Butter in cooking'**	**Options for fat type in cooking**	**'Butter in cooking'**
1994	1. Vegetable oil 2. Margarine 3. Butter 4. None	2, 3	1. Vegetable oil 2. Low-fat spread 3. Soft margarine 4. Hard margarine[1] 5. Mixture of butter and vegetable oil 6. Butter 7. None	4, 5, 6
1996, 1998, 2000	1. Vegetable oil 2. Margarine 3. Butter 4. Lard 5. None	2, 3, 4	1. Vegetable oil 2. Low-fat spread 3. Plant sterol margarine 4. Soft margarine 5. Hard margarine[1] 6. Mixture of butter and vegetable oil 7. Butter 8. None	5, 6, 7
2004	1. Vegetable oil 2. Margarine 3. Butter 4. Lard 5. None	2, 3, 4	1. Vegetable oil 2. Liquid vegetable oil product 3. Spread with about 60% fat 4. Plant stanol margarine 5. Margarine 6. Hard margarine[1] 7. Mixture of butter and vegetable oil 8. Butter 9. None	6, 7, 8

[1]Hard margarine refers to margarine which is intended mainly for cooking or baking (in Finnish 'talousmargariini').

Table 5. Multiple choice options in the question on the use of fat type on bread and the classification of the variable in the health behaviour surveys in Pitkäranta and North Karelia, 1994–2004.

	Pitkäranta		North Karelia	
	Options for fat type on bread	**'Butter on bread'**	**Options for fat type on bread**	**'Butter on bread'**
1994	1. None 2. Margarine 3. Butter	2, 3	1. None 2. Low-fat spread 3. Soft margarine 4. Hard margarine[1] 5. Mixture of butter and vegetable oil 6. Butter	4, 5, 6
1996	1. None 2. Margarine 3. Butter	2, 3	1. None 2. Low-fat spread 3. Plant sterol margarine 4. Soft margarine 5. Mixture of butter and vegetable oil 6. Butter	5, 6
1998, 2000	1. None 2. Vegetable margarine 3. Other margarine 4. Lard 5. Butter	3, 4, 5	1. None 2. Low-fat spread 3. Plant sterol margarine 4. Soft margarine 5. Mixture of butter and vegetable oil 6. Butter	5, 6
2004	1. None 2. Vegetable margarine 3. Other margarine 4. Lard 5. Butter	3, 4, 5	1. None 2. Low-fat spread 3. Plant stanol margarine 4. Plant sterol margarine 5. Margarine 6. Mixture of butter and vegetable oil 7. Butter	6,7

[1]Hard margarine refers to margarine which is intended mainly for cooking or baking (in Finnish 'talousmargariini').

The consumption of fresh vegetables, fruit and berries was inquired about in the food frequency section of the risk factor survey questionnaire. In the food frequency section, the subjects were asked to report on their food consumption during the preceding half-year period in 1992, and after 1997 the question was changed to concern the previous 12 months. The food frequency section did not measure food consumption quantitatively. Instead, it aimed at giving an overall picture of the subjects' food habits.

Fresh vegetables were specified in the questionnaire as "fresh vegetables and salads". For fruit, the respondents may have counted both fresh and for example canned fruit in their answers, as fruit were not specified in any way. Berries included "fresh or frozen berries".

The food frequency section included six frequency options: 1) less than once a month or never, 2) a couple of times per month, 3) once a week, 4) a couple of times per week, 5) almost every day, and 6) once a day or more often. Options 5 and 6 were combined to represent daily consumption in the case of fresh vegetables and fruit, and the remaining options were combined as the reference category. Thus, 'daily consumption' included daily and almost daily consumption. As the daily consumption of berries was very uncommon, options 4, 5 and 6 were combined to represent 'regular consumption' which included the consumption of berries at least a couple of times a week. The results for berries are presented only if the results were statistically significant or otherwise relevant. The detailed results can be found in the sub-studies.

New foods and frequency categories were added to the food frequency section in the Finnish questionnaire in 2007. Subsequently, the data for fresh vegetables, fruit and berries in 2007 in North Karelia were not comparable with earlier surveys. Thus, the data for North Karelia in 2007 was omitted from the analyses on the consumption of fresh vegetables, fruit and berries (sub-study II).

4.3.3 Serum total cholesterol (sub-study III)

Serum total cholesterol was chosen as the biomarker for the consumption of foods containing dairy fat. In North Karelia, venous blood samples were taken in a sitting position into siliconised glass vacuum blood collection tubes following at least four hours of fasting. The venous blood samples were centrifuged at the survey site in 1992, 1997 and 2002, and the sera were mailed daily for cholesterol measurements to the laboratory of the National Public Health Institute (KTL) (the current National Institute for Health and Welfare, THL), Helsinki, Finland. The laboratory is accredited and standardised against national and international reference laboratories. In 2007, the sera were frozen immediately after separation and transferred in dry ice to the laboratory once a week for analyses. In Pitkäranta, the methodology was as identical as possible, and the analyses were made from fresh serum samples in 1992–2002. The samples were transferred once or twice a week to the laboratory of

the National Public Health Institute, Helsinki, Finland. In 2007, the sera were frozen and transferred about every other week to the laboratory. The serum total cholesterol was analysed using an enzymatic method in 1992–2002 (CHOD-PAP, Boehringer-Mannheim, Monotest). More information on the cholesterol measurement methods in 1992–2002 can be found in a previous publication (Sundvall et al. 2007). In 2007, serum total cholesterol was measured by an enzymatic assay (Abbott Diagnostics Europe, Wiesbaden, Germany) using an Abbott Architect c8000 clinical chemistry analyser.

4.3.4 Plasma vitamin C concentration (sub-study IV)

Plasma vitamin C concentrations were determined from either a sub-sample or the total sample of survey participants in the two areas in 1992, 1997 and 2002. The number of subjects with vitamin C measurements is presented in Table 2. More detailed information can be obtained from sub-study IV. The blood samples for vitamin C determination were collected during January–April in North Karelia and March–April in Pitkäranta. All vitamin C determinations were performed in the same laboratory at the National Public Health Institute (KTL), Helsinki, Finland. From Pitkäranta, the data only included men in 1992 and both sexes thereafter. From North Karelia, the data for 1992 and 1997 included men only, and the data for 2002 included both sexes.

In 1992 and 1997, venous blood specimens were taken into 10 ml evacuated heparin tubes after at least four hours of fasting. Within one hour plasma was separated by centrifugation and 0.5 ml plasma was transferred to a tube containing 4.5 ml 5% metaphosphoric acid (MPA) supplied by the analysing laboratory in Helsinki and frozen immediately to -70°C with dry ice. The samples were transported in dry ice in batches to Helsinki, Finland, where they were stored at -20°C for less than six months before analysis. Plasma total vitamin C (ascorbic acid + dehydroascorbic acid) was determined from MPA extracts with an automated fluorimetric method using ortho-phenylenediamine (Brubacher and Vuillemier 1978) in the 1992 and 1997 surveys. The precision of the method between series was determined on pooled aliquots of stabilised plasma samples stored at -20ºC. In 1992, the precision was 4.7 CV% (10 series, n=22) and in 1997 4.5 CV% (35 series, n=75). The detection limit of the method for plasma vitamin C was 0.6 µmol/l. Vitamin C could not be measured in North Karelia in 1997 from all samples due to technical difficulties with the MPA used at the field laboratory. The reason remained unknown, but was linked to stabilised sample tubes, which did not precipitate the plasma proteins. The methods used in the surveys in 1992 and 1997 have previously been described in more detail (Matilainen et al. 1996, Pussinen et al. 2003).

In 2002, instead of the MPA used in 1992 and 1997, trichloroacetic acid (TCA) was used for heparin plasma stabilisation. In addition, the method was changed to an HPLC method using electrochemical detection (Salminen and Alfthan 2008), which

measured only ascorbic acid. The plasma samples were stored at -20°C at a field laboratory until transfer in dry ice to Helsinki, Finland, where the samples were stored at -70°C until plasma vitamin C determination in 2003–2005. The samples were stored at -20°C for about two weeks before final storage at -70°C. The precision of the method was 5.4 CV% (11 series, n=33). The detection limit for the method was 2 µmol/l. Since the overall plasma vitamin C level was lower than in the earlier measurements, a validation study on vitamin C determination using TCA at different temperatures was conducted (Salminen and Alfthan 2008).

The plasma vitamin C concentrations are comparable between Pitkäranta and North Karelia at all study points. However, as the method of plasma vitamin C determination changed over the study period, the absolute levels of plasma vitamin C concentrations cannot be directly compared across study years. In 1992 and 1997, the concentration of plasma total vitamin C was determined (both ascorbic acid and dehydroascorbic acid). In 2002, as a result of a change in method, only the concentration of ascorbic acid was determined. As the absolute levels of plasma vitamin C were not comparable over time, the plasma vitamin C concentrations were divided into tertiles within each study, separately for men and women (Figure 2). The tertile variable was used in the statistical analyses. Henceforth, the term 'vitamin C' will be used for all years.

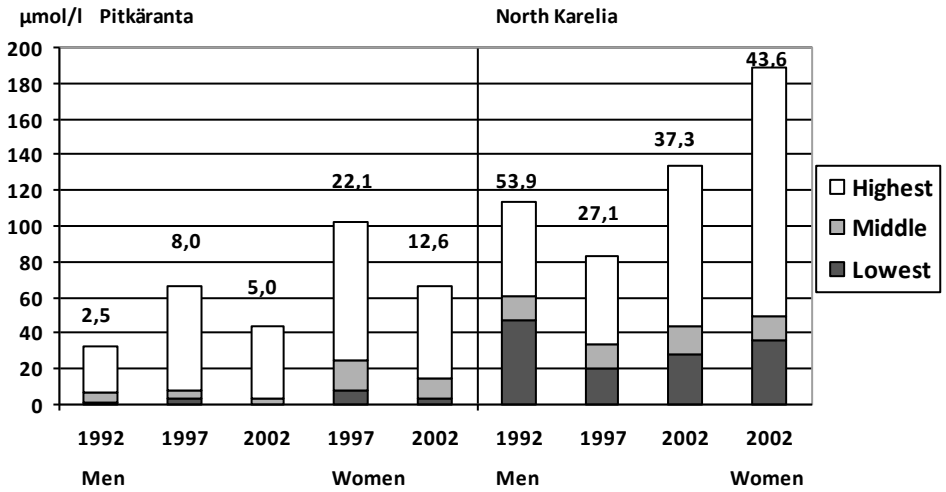


Figure 2. The mean plasma vitamin C concentrations (above the columns) and plasma vitamin C tertiles in Pitkäranta and North Karelia, 1992, 1997 and 2002. Because of methodological changes, the means are not directly comparable across study years.

Because of the instability of vitamin C, the plasma samples are extremely susceptible to deterioration from, for example, temperature changes and freezing conditions. Transferring plasma samples from study sites to the laboratory in Helsinki, Finland, brought an extra challenge to the study protocol. One tube box from North Karelia, 2002, with samples from 45 men and 41 women in the age groups of this study had thawed during transport. An additional 32 samples (12 men, 20 women) were identified in quality control as damaged or destroyed, most likely as a result of thawing. These 118 samples were omitted from the analyses.

4.4 Statistical methods

A summary of the data sets, important variables and the statistical methods used in the four sub-studies are presented in Table 6. All analyses were performed separately for Pitkäranta and North Karelia. The data were stratified for sex in sub-studies I, II and IV, whereas the data were analysed for men and women combined in sub-study III.

The basic results are presented as proportions (%), means and their 95% confidence intervals (CI). Logistic regression analysis was applied for dichotomous outcome variables in sub-studies I, II and IV. The results for logistic regression are presented as odds ratios (OR) and 95% CI. In some cases, p values are also presented to demonstrate the statistical significance of the associations. In sub-study III, linear regression analysis was applied as the outcome variable was continuous. The results for linear regression analysis are presented as regression coefficients (β) and 95% CI. In addition, the interaction terms for the interaction between education and study year (sub-studies I and II) or the interaction between education and selected foods (sub-studies III and IV) were tested adjusting for age.

In sub-study I, the samples for the health behaviour surveys in 1996, 1998, 2000 and 2004 in Pitkäranta were simple random samples, whereas the sample in 1994 was a stratified random sample with each 10-year age group having an equal number of men and women. To check whether the dissimilar sampling method affected the results, the data from 1994 were adjusted by weighting the data according to the age distribution in Pitkäranta in 1996, separately for men and women, and the distributions of food habits were compared with those calculated with the unadjusted data. The adjustment had practically no effect. Therefore, the data for 1994 were not adjusted in the final analyses. All samples in North Karelia were simple random samples. Logistic regression analysis was used to examine educational differences in the use of foods selected as indicators of important dairy fat sources. The analyses were adjusted for age using a 10-year age group variable. No statistically significant interactions for education and study year in explaining the use of selected dairy fat sources were found. Thus, the effect of education was stable over the study period in both areas.

In sub-study II, logistic regression analysis was used to examine educational differences in the consumption of fresh vegetables, fruit and berries using data from risk factor surveys from the two areas. Age adjustment was performed using age as a continuous variable. In addition, the changes in vegetable, fruit and berry consumption during the study period were examined by calculating time trend indices for each education group. The time trend indices were calculated using logistic regression analysis with food variables as dependent variables and the study year as the independent variable. The continuous study year variable was coded as 1–4 (in North Karelia 1–3). The time trend index analyses were adjusted for age. No statistically significant interactions for education and study year were found. Thus, the effect of education on the consumption of fresh vegetables, fruit and berries was stable in both areas.

In sub-study III, the data for men and women were combined in the analyses in order to increase statistical power, and because the preliminary analyses showed that the results were very similar for men and women. The educational variation in serum total cholesterol was examined by calculating the means and 95% CI in each education group for each study year. The role of selected foods in explaining serum total cholesterol was examined using multivariate linear regression analysis. The linear regression analysis was performed for all study years combined. In this thesis, the results adjusted for sex, age, study year and education are presented (full model). Only one food variable was included in the analyses at a time. The interactions between the food variables and education were tested to check whether the effect of the selected food habits on cholesterol levels varied depending on educational level. The interaction term was significant only in the case of daily consumption of cheese in North Karelia ($p=0.03$), and it was not taken into account in the analyses.

In sub-study IV, logistic regression analysis was used to examine educational differences in plasma vitamin C concentration adjusting for age. The middle and lowest plasma vitamin C tertiles were combined and used as the reference category. The data from Pitkäranta in 1992 were omitted from the logistic regression analyses as the distribution was highly skewed; 95 out of 117 observations (81%) only reached the detection limit (0.6 µmol/l), and were classified into the lowest plasma vitamin C tertile. The association of selected vitamin C sources and plasma vitamin C concentration was also examined with logistic regression analysis. The results adjusted for age, education and the remaining food variables are presented in this thesis. No significant interactions between education and fresh vegetable, fruit or berry consumption were found in explaining plasma vitamin C concentration.

The analyses were carried out with the Stata statistical software package, version 9.2 (sub-studies I and II) and version 11.2 (sub-studies III and IV) (StataCorp., College Station, TX, USA).

Table 6. Data sets, statistical methods and variables used in sub-studies.

Sub-study	Data set	Variables	Statistical method
I	**Pitkäranta and North Karelia:** Health behaviour surveys 1994, 1996, 1998, 2000 and 2004	**Independent variables:** Study year, gender, age, education, employment status **Dependent variables:** Use of butter in cooking, use of butter on bread, consumption of fat-containing milk	Logistic regression; data stratified for study area and gender
II	**Pitkäranta:** Risk factor surveys 1992, 1997, 2002 and 2007 **North Karelia:** Risk factor surveys 1992, 1997 and 2002	**Independent variables:** Study year, gender, age, education, employment status **Dependent variables:** Daily consumption of fresh vegetables, daily consumption of fruit, regular consumption of berries	Logistic regression; data stratified for study area and gender
III	**Pitkäranta and North Karelia:** Risk factor surveys 1992, 1997, 2002 and 2007	**Independent variables:** Study year, gender, age, education, use of butter in cooking, use of butter on bread, consumption of fat-containing milk, daily consumption of cheese **Dependent variable:** Serum total cholesterol	Linear regression; data stratified for study area
IV	**Pitkäranta and North Karelia:** Risk factor surveys 1992, 1997, and 2002	**Independent variables:** Study year, gender, age, education, daily consumption of fresh vegetables, daily consumption of fruit, regular consumption of berries **Dependent variable:** Plasma vitamin C concentration	Logistic regression; data stratified for study area and gender

5 Results

In the following chapters, the main findings from the four sub-studies will be presented. Only the statistically significant and borderline significant results will be commented on in the text.

5.1 Trends in and differences between Pitkäranta and North Karelia

5.1.1 Food habits (sub-studies I–III)

Food habits changed tremendously in Pitkäranta during the study period. According to health behaviour surveys conducted in 1994, 1996, 1998, 2000 and 2004 in Pitkäranta, the proportion of the respondents who used butter in cooking decreased from about 50% to less than 10% in the ten years (Table 7). Approximately 90% of subjects in Pitkäranta used butter on bread in 1994 and 1996. The proportion of those who used butter on bread plummeted to about 30% in Pitkäranta in 1998, when the option soft margarine was added to the questionnaire. Thereafter, the use of butter increased again, reaching a prevalence of about 60% of subjects in 2004. During the ten years from 1994 to 2004, the prevalence of consuming of fat-containing milk fluctuated in Pitkäranta.

The data from risk factor surveys in 1992, 1997, 2002 and 2007 also showed parallel trends in the prevalence of using butter in cooking or on bread, as well as in the prevalence of consuming fat-containing milk in sub-study III. The risk factor survey data encompassed a longer time period of 15 years and pointed to an even more dramatic decrease in the prevalence of using butter in cooking; from 65% in 1992 to 11% in 2007. Daily consumption of cheese was almost non-existent in Pitkäranta in 1992 (3% among men and women combined, 95% CI 2–4%), but the proportion of those who used cheese daily increased systematically to 40% (95% CI 35–44%) in 2007.

The proportion of respondents who consumed fresh vegetables and fruit daily increased consistently in Pitkäranta (Table 8). From 1992 to 2007, the proportion of those who consumed fresh vegetables daily nearly tripled (men: 9% in 1992 and 24% in 2007, women: 11% in 1992 and 35% in 2007). Daily consumption of fruit was almost non-existent in Pitkäranta in 1992 (2% among men and 4% among women). The proportion of respondents who consumed fruit daily increased steeply to 31% among men and 50% among women in 2007.

In North Karelia, the changes during the study period were smaller. The proportion of respondents who used butter in cooking or consumed fat-containing

milk decreased slightly from 1994 to 2004, but the change was significant only among women (Table 7). The prevalence of using butter on bread was quite stable, at about 25% among both genders during the health behaviour study period 1994–2004. In comparison, the risk factor surveys from 1992 to 2007 showed a more obvious decrease, resulting from a high prevalence of using butter on bread at the beginning of the risk factor study period in 1992 (results only shown in sub-study III). The proportion of respondents who consumed cheese daily decreased from 50% (95% CI 47–52%) to 30% (95% CI 27–33%) from 1992 to 2007 in North Karelia (men and women combined).

In North Karelia, the proportion of respondents who consumed fresh vegetables daily decreased among men and was stable among women. A marked decrease from 1992 to 2002 in North Karelia was seen in the prevalence of consuming fruit daily and in consuming berries regularly (Table 8).

The comparison between the two study areas revealed that the use of butter in cooking was more common in Pitkäranta than in North Karelia in 1992 (results only shown in sub-study III) and among men in 1994 (Table 7). Thereafter, however, the proportion of respondents who used butter in cooking or on bread decreased steeply in Pitkäranta and was smaller than in North Karelia in the subsequent studies. The habits of using butter on bread and that of consuming fat-containing milk were prone to be more common in Pitkäranta than in North Karelia (Table 7). The proportion of respondents who consumed cheese daily was higher in North Karelia than in Pitkäranta in 1992, but decreased in North Karelia and increased in Pitkäranta, resulting in a higher proportion of daily cheese consumers in Pitkäranta in 2007 compared to North Karelia (results only shown in sub-study III).

Daily consumption of vegetables and fruit were notably more common in North Karelia than in Pitkäranta throughout the study period (Table 8).

Table 7. Trends in the proportions of men and women who used butter in cooking or on bread or consumed fat-containing milk daily (Pitkäranta: n=1478 for men, n=1998 for women; North Karelia: n=1702 for men, n=1842 for women)[1,2].

	1994	1996	1998	2000	2004
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Pitkäranta					
Men					
Butter in cooking	53 (48–58)	**39 (33–45)**	**17 (12–21)**	**14 (10–18)**	**8 (5–12)**
Butter on bread	91 (87–94)	93 (90–96)	**28 (23–33)**	**48 (42–53)**	**61 (55–66)**
Fat-containing milk	60 (55–65)	**44 (38–50)**	59 (53–65)	**49 (43–54)**	59 (53–65)
Women					
Butter in cooking	49 (43–54)	**29 (25–32)**	**14 (10–17)**	**11 (8–13)**	**7 (4–9)**
Butter on bread	91 (88–94)	92 (90–94)	**29 (25–34)**	**45 (40–49)**	**60 (55-65)**
Fat-containing milk	56 (51–61)	**38 (34–42)**	52 (47–57)	**46 (41–51)**	55 (49–60)
North Karelia					
Men					
Butter in cooking	41 (36–47)	44 (40–48)	37 (31–42)	32 (27–38)	33 (28–39)
Butter on bread	24 (20–29)	29 (25–33)	24 (19–28)	26 (21–31)	27 (22–33)
Fat-containing milk	49 (44–54)	54 (49–58)	42 (37–48)	**38 (32–43)**	41 (35–47)
Women					
Butter in cooking	46 (40–51)	39 (35–43)	39 (34–45)	37 (32–42)	**29 (24–34)**
Butter on bread	25 (20–29)	22 (18–26)	24 (19–29)	21 (17–26)	25 (20–30)
Fat-containing milk	36 (31–41)	30 (26–34)	**25 (20–30)**	**26 (21–30)**	**22 (17–26)**

[1]Data from health behaviour surveys.

[2]Statistically significant differences based on 95% CIs compared to 1994 are shown in bold.

Table 8. Trends in the proportions of those who consumed vegetables or fruit daily or berries at least a couple of times weekly (Pitkäranta: n=1134 for men, n=1522 for women; North Karelia: n=2032 for men, n=2304 for women)[1–3].

	1992	1997	2002	2007
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Pitkäranta				
Men				
Fresh vegetables daily	9 (7–12)	11 (7–14)	15 (11–20)	**24 (18–31)**
Fruit daily	2 (0–3)	**7 (5–10)**	**16 (12–21)**	**31 (24–37)**
Berries regularly[3]	14 (11–18)	**6 (3–8)**	**8 (5–11)**	15 (10–20)
Women				
Fresh vegetables daily	11 (8–14)	**18 (14–21)**	**25 (20–29)**	**35 (29–40)**
Fruit daily	4 (2–5)	**18 (14–22)**	**32 (27–37)**	**50 (44–56)**
Berries regularly[3]	17 (14–21)	12 (9–15)	17 (13–21)	22 (17–27)
North Karelia				
Men				
Fresh vegetables daily	54 (51–58)	48 (45–52)	**44 (41–48)**	[4]
Fruit daily	61 (57–65)	**53 (49–56)**	**43 (39–47)**	[4]
Berries regularly[3]	48 (44–52)	**39 (36–43)**	**38 (34–42)**	[4]
Women				
Fresh vegetables daily	71 (68–74)	72 (68–75)	69 (65–72)	[4]
Fruit daily	82 (79–84)	**72 (69–75)**	**66 (63–70)**	[4]
Berries regularly[3]	69 (66–72)	**59 (55–62)**	**58 (55–62)**	[4]

[1]Data from risk factor surveys.

[2]Statistically significant differences based on 95% CIs compared to 1994 are shown in bold.

[3]Regular consumption of berries included consumption at least a couple of times weekly.

[4]Data for North Karelia in 2007 were excluded because the food frequency questions were not comparable with other years.

5.1.2 Serum total cholesterol and plasma vitamin C concentration (sub-studies III, IV)

In Pitkäranta, the mean serum total cholesterol concentration fluctuated between 1992 and 2007. From 1992 to 1997 the mean cholesterol concentration decreased from 5.26 mmol/l (95% CI 5.19–5.33 mmol/l) to 5.10 mmol/l (95% CI 5.02–5.18 mmol/l) (data combined for men and women). Until 2002, the mean cholesterol had increased to 5.42 mmol/l (95% CI 5.33–5.51 mmol/l) and was stable from 2002 to 2007.

In contrast, the mean cholesterol concentration decreased steadily in North Karelia from 5.72 mmol/l (95% CI 5.66–5.78 mmol/l) in 1992 to 5.28 mmol/l (95% CI 5.21–5.34 mmol/l) in 2007.

Overall, the mean serum cholesterol concentration was lower in Pitkäranta than in North Karelia in 1992–2002, but rose above the levels of North Karelia's in 2007.

Because of methodological changes in the vitamin C analytics, plasma vitamin C concentrations are not directly comparable across study years. However, the mean plasma vitamin C concentration was very low in Pitkäranta at all study points (1992, 1997 and 2002) and among both sexes (Figure 2). Among men in Pitkäranta, the mean plasma vitamin C concentration was lower than 10 µmol/l in all measurements. Among women in Pitkäranta, the plasma vitamin C concentration was only determined in 1997 and 2002. The mean concentration was low among women as well: 22 µmol/l in 1997 and 13 µmol/l in 2002.

The mean plasma vitamin C concentrations were many times higher in North Karelia compared to Pitkäranta (Figure 2). Among North Karelian men, the mean concentration ranged from 27 to 54 µmol/l in 1992–2002. Among North Karelian women, plasma vitamin C was only determined in 2002, when it was 44 µmol/l; more than three times as high as among women in Pitkäranta in the same year.

5.2 Gender differences

5.2.1 Food habits (sub-studies I–II)

Only small gender differences in the proportions of respondents who used butter in cooking or on bread were observed (Table 7). The consumption of fat-containing milk was consistently more common among men than women in North Karelia.

The daily consumption of fresh vegetables and the regular consumption of berries were significantly more common among women than men in 1997 and 2002 in Pitkäranta. The same was true for the daily consumption of fruit in 1997, 2002 and 2007 (Table 8). In North Karelia, all three selected food habits representing important vitamin C sources, daily consumption of fresh vegetables, daily consumption of fruit and regular consumption of berries were more common among women than among men throughout the study period.

5.2.2 Serum total cholesterol and plasma vitamin C concentration (sub-study IV)

In sub-study III, the results for cholesterol were presented for men and women combined. Here, the serum total cholesterol concentrations are shown stratified by sex.

In Pitkäranta, the differences between men and women in the mean cholesterol concentration were not statistically significant (Table 9, Paalanen L, unpublished results). In North Karelia, the mean total cholesterol was higher among men than among women in 1992 and 2002.

The gender differences in plasma vitamin C concentration cannot be expressed with certainty, since vitamin C determinations were not available for women at all study points. However, the results from 1997 and 2002 from Pitkäranta, and from 2002 from North Karelia point to higher mean plasma vitamin C concentrations among women than men (Figure 2).

Table 9. Mean cholesterol concentration (mmol/l) and 95% CI in Pitkäranta (n=1109 for men, n=1496 for women) and North Karelia (n=2466 for men, n=2785 for women), 1992–2007[1].

	1992	1997	2002	2007
	mean (95% CI)	mean (95% CI)	mean (95% CI)	mean (95% CI)
Pitkäranta				
Men	5.19 (5.09–5.28)	5.09 (4.97–5.22)	5.34 (5.21–5.47)	5.28 (5.11–5.46)
Women	5.43 (5.21–5.42)	5.10 (5.01–5.20)	5.48 (5.35–5.60)	5.52 (5.33–5.71)
North Karelia				
Men	5.84 (5.76–5.93)	5.55 (5.47–5.63)	5.68 (5.59–5.77)	5.32 (5.22–5.41)
Women	5.62 (5.54–5.69)	5.56 (5.48–5.64)	5.46 (5.39–5.54)	5.24 (5.15–5.33)

[1]Data from risk factor surveys.

5.3 Educational differences

5.3.1 Food habits (sub-studies I–III)

The educational differences in the prevalence of using butter in cooking were more obvious in North Karelia than in Pitkäranta (figures 3–4). For example, the educational differences in the use of butter in cooking were not statistically significant among men in Pitkäranta, whereas among North Karelian men, significant and consistent educational differences were seen. In both areas, these habits tended to be more common among subjects with a lower education compared to their more educated counterparts.

For the use of butter on bread, the direction of the educational gradient was the opposite in Pitkäranta and North Karelia, especially among men (Figures 5–6). In

Pitkäranta, the use of butter on bread was more common among men with a high education compared to men with a low education in 1998 and 2004. In contrast, in North Karelia, using butter on bread tended to be more common among men with low education. The difference was statistically significant in 1996 and 2000. Among women, the educational differences in the use of butter on bread did not quite reach statistical significance.

The consumption of fat-containing milk tended to be more common among subjects with a low educational level compared to their counterparts with a higher education in both study areas (results only shown in sub-study I). The educational differences in the consumption of fat-containing milk seemed to level off slightly over the study years.

The daily consumption of cheese was more common among subjects with a high education in Pitkäranta compared to subjects with a low education (results only shown in sub-study III). In North Karelia, the educational difference was not significant.

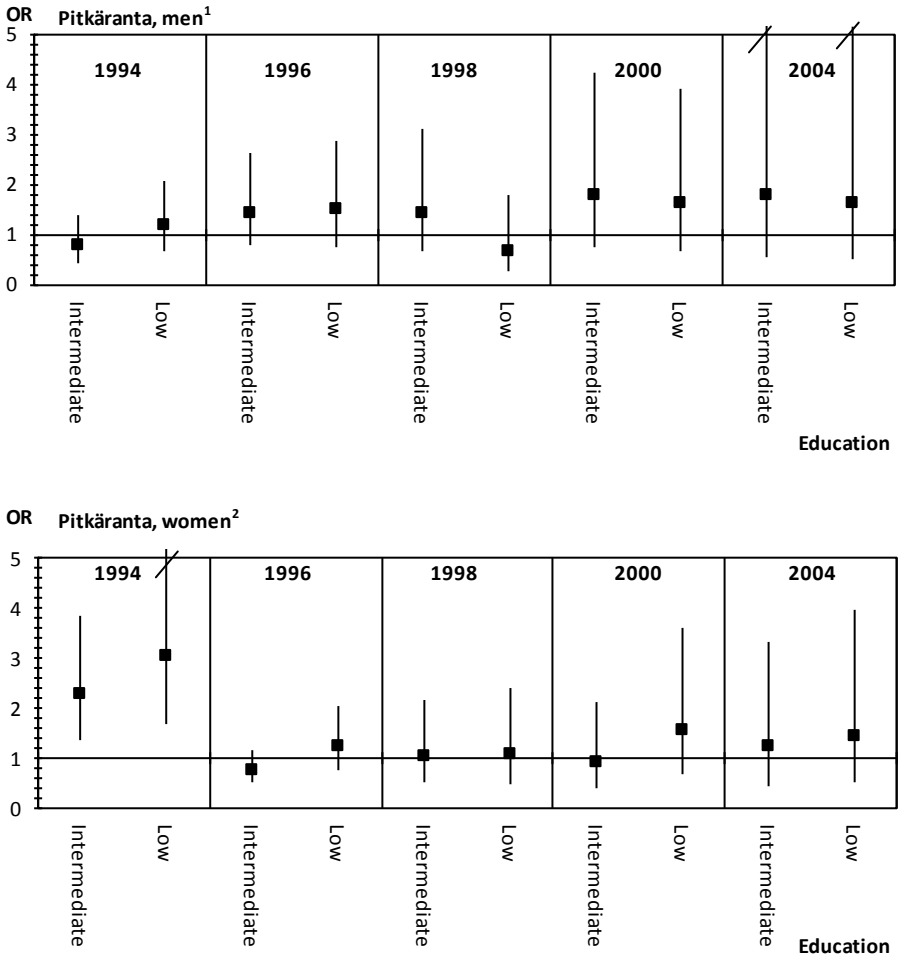


Figure 3. The association of education and the use of butter in cooking in Pitkäranta, 1994–2004 (n=1421 for men; n=1988 for women). Odds ratios (OR) and 95% confidence intervals from logistic regression analysis are presented. OR=1.0 in the highest education tertile.

[1]Among men in Pitkäranta, the upper confidence interval limit was 5.80 in the intermediate education group and 5.18 in the low education group in 2004.

[2]Among women in Pitkäranta, the upper confidence interval limit was 5.49 in the low education group in 1994.

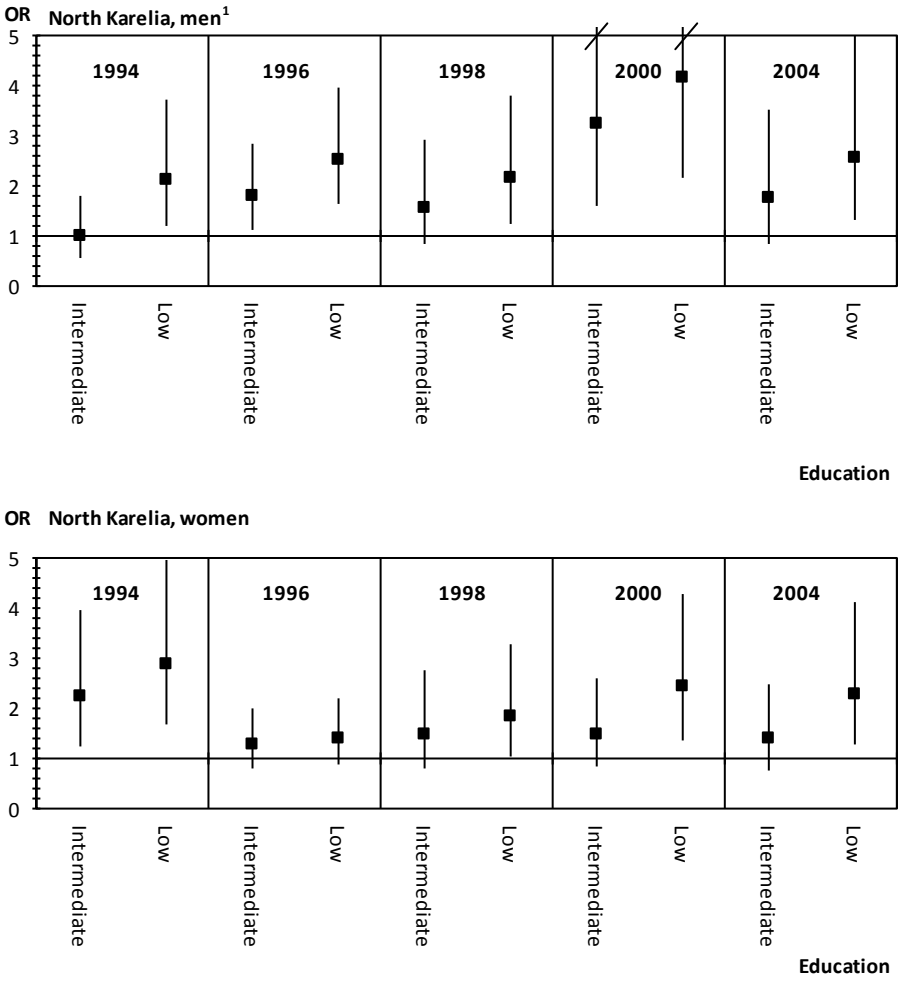


Figure 4. The association of education and the use of butter in cooking in North Karelia, 1994–2004 (n=1690 for men; n=1802 for women). Odds ratios (OR) and 95% confidence intervals from logistic regression analysis are presented. OR=1.0 in the highest education tertile.

[1]Among men in North Karelia, the upper confidence interval limit was 6.44 in the intermediate education group and 8.07 in the low education group in 2000.

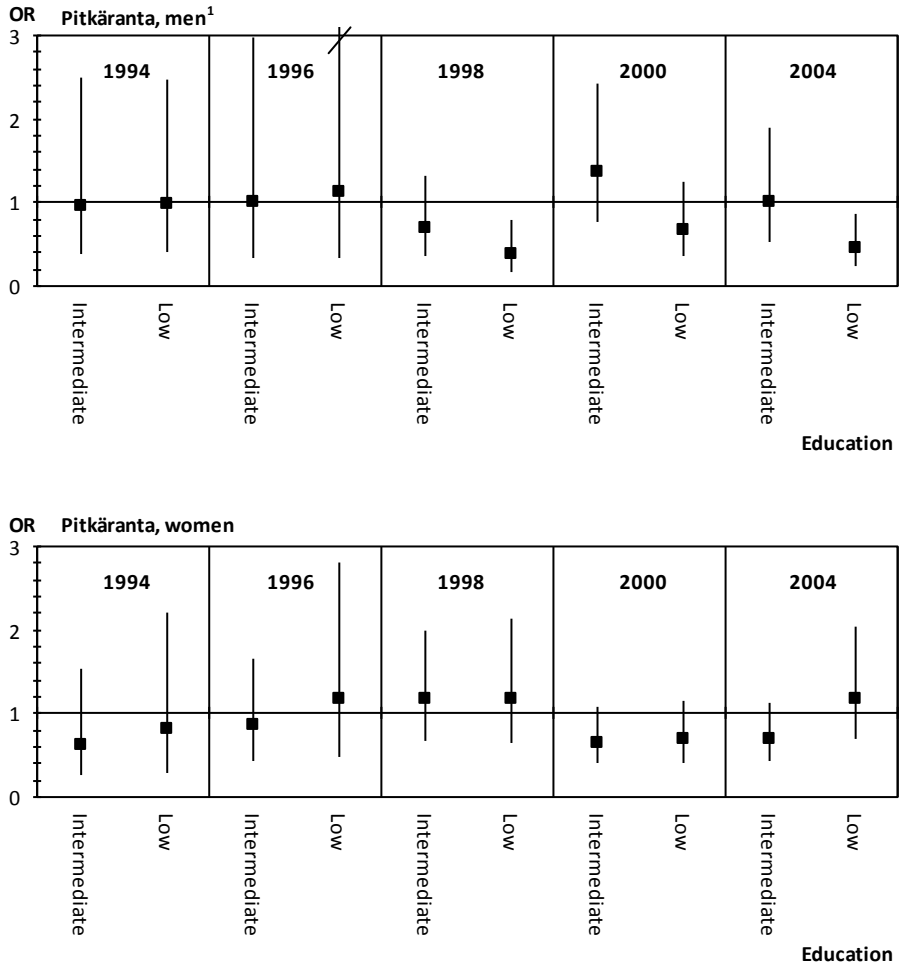


Figure 5. The association of education and the use of butter on bread in Pitkäranta, 1994–2004 (n=1431 for men; n=1990 for women). Odds ratios (OR) and 95% confidence intervals from logistic regression analysis are presented. OR=1.0 in the highest education tertile.

[1]Among men in Pitkäranta, the upper confidence interval limit was 3.78 in the low education group in 1996.

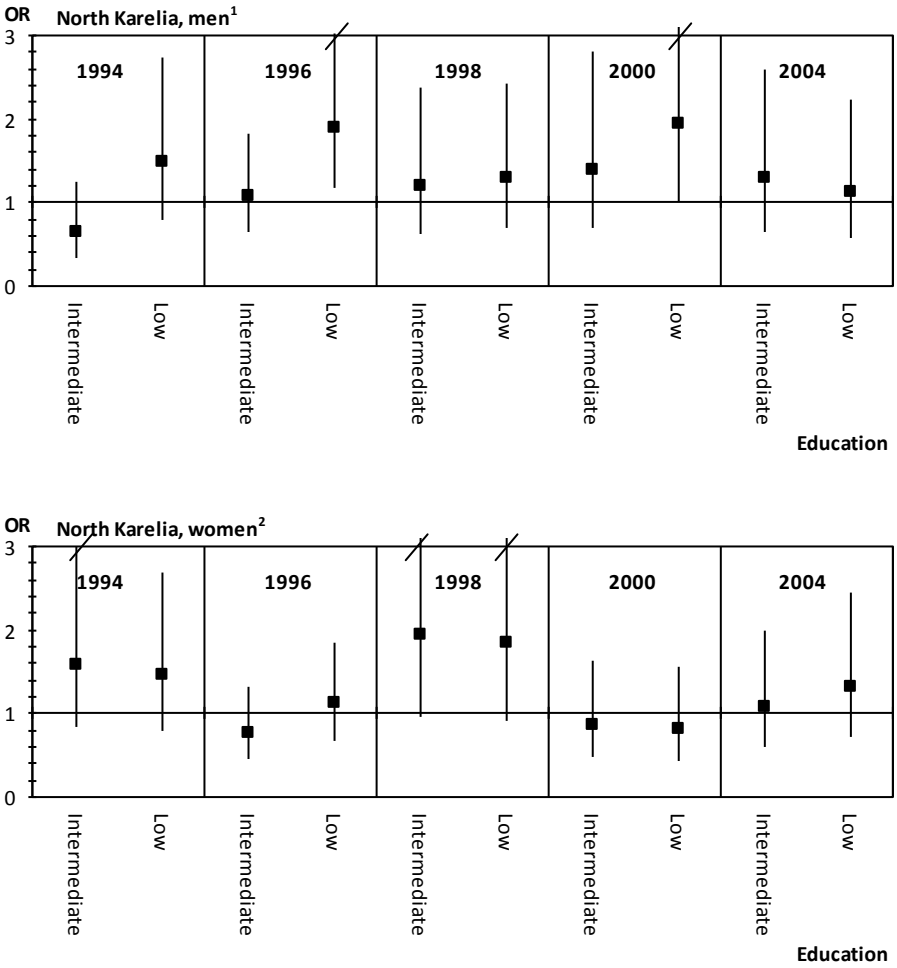


Figure 6. The association of education and the use of butter on bread in North Karelia, 1994–2004 (n=1708 for men; n=1834 for women). Odds ratios (OR) and 95% confidence intervals from logistic regression analysis are presented. OR=1.0 in the highest education tertile.

[1]Among men in North Karelia, the upper confidence interval limit in the low education group was 3.03 in 1996 and 3.72 in 2000.

[2]Among women in North Karelia, the upper confidence interval limit in the intermediate education group was 3.01 in 1994. In 1998, it was 3.95 in the intermediate and 3.66 in the low education group.

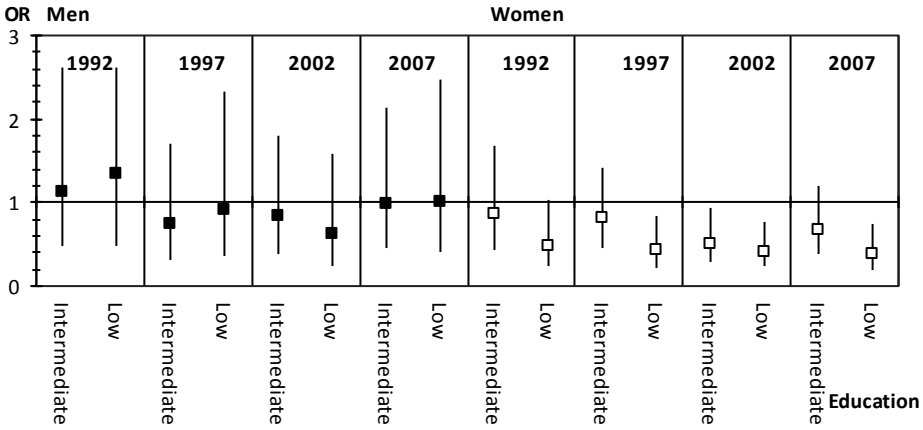
Among men in Pitkäranta, no educational differences in the prevalence of consuming fresh vegetables daily were seen (Figure 7). Among women in Pitkäranta and among both sexes in North Karelia, the daily consumption of fresh vegetables was more common among subjects with a higher education. The results for the time trend index showed that the proportion of respondents who consumed fresh vegetables daily increased significantly in all education groups among both sexes in Pitkäranta between 1992 and 2007 (Table 10). In contrast, the proportion of those who consumed fresh vegetables daily decreased significantly in North Karelia between 1992 and 2002 among men in the high and intermediate education groups and among women in the intermediate education group.

Educational differences in the prevalence of consuming fruit daily did not reach statistical significance among men in Pitkäranta, with the exception in 2007 (Figure 8). Among women in Pitkäranta, educational differences were more obvious with more common daily fruit consumption in the high education group. In North Karelia, educational differences in the daily consumption of fruit were parallel, and significant differences were seen in 1992 and 1997 among men and in 1992 and 2002 among women.

The proportion of those who consumed fruit daily increased during the study period 1992–2007 in all education groups among both sexes in Pitkäranta (Table 10). On the contrary, in North Karelia, daily consumption of fruit became less common between 1992 and 2002 among both sexes with the low education group among men as an exception.

Regarding educational differences in the prevalence of consuming berries regularly, minor educational differences were seen only among the North Karelians. The results for berry consumption by education can be found in a supplementary table in sub-study II.

Pitkäranta:



North Karelia:

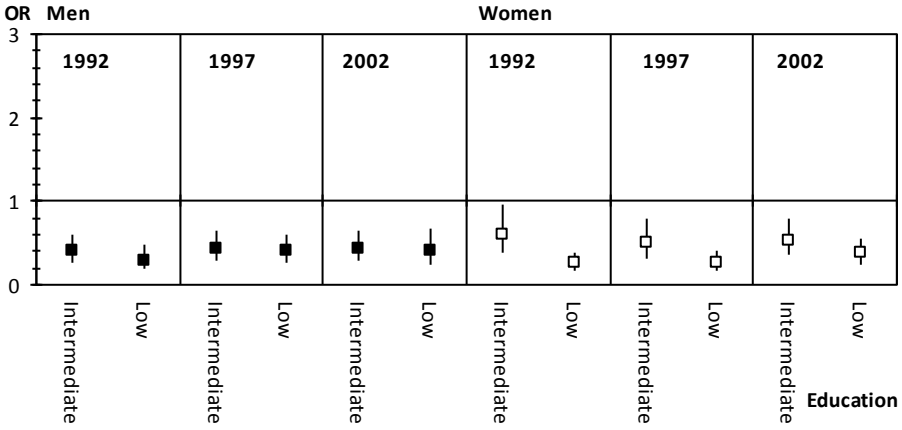


Figure 7. The association of education and the daily consumption of fresh vegetables in Pitkäranta (1992, 1997, 2002 and 2007) (n=1140 for men, n=1526 for women) and North Karelia (1992, 1997 and 2002) (n=1767 for men, n=2283 for women). Odds ratios (OR) and 95% confidence intervals from logistic regression analysis are presented. OR=1.0 in the highest education tertile.

Table 10. The change in the proportion of respondents who consumed fresh vegetables or fruit daily in Pitkäranta between 1992 and 2007 (n=1139 for men; n=1526 for women) and in North Karelia between 1992 and 2002 (n=1762 for men; n=2280 for women) by education (age-adjusted time trend index)[1–3].

	Men	**Women**
	OR (CI 95%)	**OR (CI 95%)**
Pitkäranta (1992–2007)		
Fresh vegetables daily		
Education		
High	**1.54 (1.17–2.02)**	**1.65 (1.37–1.99)**
Intermediate	**1.51 (1.18–1.94)**	**1.52 (1.24–1.86)**
Low[4]	**1.40 (1.02–1.92)**	**1.55 (1.22–1.99)**
Fruit daily		
Education		
High	**3.05 (2.21–4.20)**	**2.65 (2.15–3.27)**
Intermediate	**2.05 (1.51–2.78)**	**2.36 (1.90–2.94)**
Low[4]	**4.04 (2.35–6.96)**	**2.94 (2.22–3.90)**
North Karelia (1992–2002)		
Fresh vegetables daily		
Education		
High	**0.76 (0.63–0.93)**	0.89 (0.71–1.12)
Intermediate	**0.78 (0.64–0.96)**	**0.81 (0.66–1.00)**
Low	0.84 (0.66–1.07)	1.09 (0.92–1.29)
Fruit daily		
Education		
High	**0.63 (0.52–0.76)**	**0.72 (0.58–0.89)**
Intermediate	**0.63 (0.51–0.76)**	**0.61 (0.49–0.76)**
Low	0.92 (0.73–1.17)	**0.69 (0.58–0.83)**

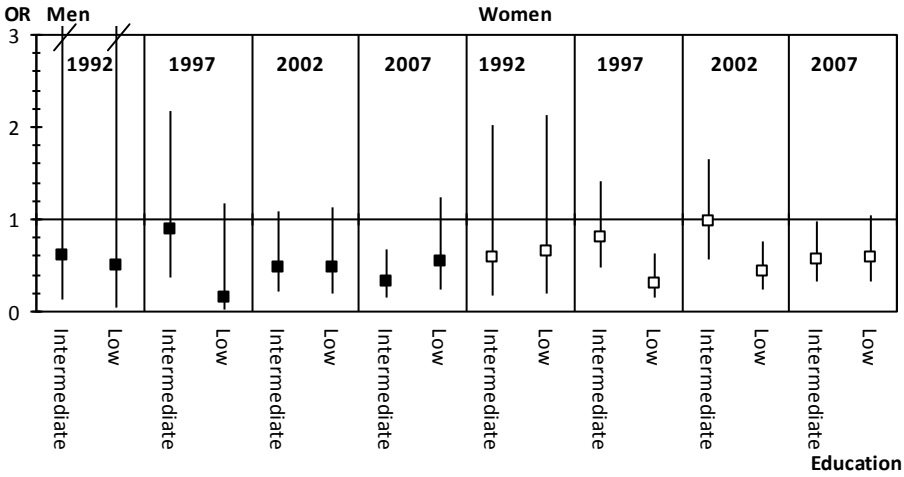
[1]Data from risk factor surveys.

[2]Data for 2007 North Karelia was omitted because of change in the food frequency section of the questionnaire in 2007.

[3]Statistically significant changes during the study period in food habits based on 95% CIs are written in bold.

[4]In the lowest education group among men in Pitkäranta, the figures differ slightly from the figures in sub-study II because of a typo in the Stata syntax of the analyses of the original article.

Pitkäranta[1]:



North Karelia:

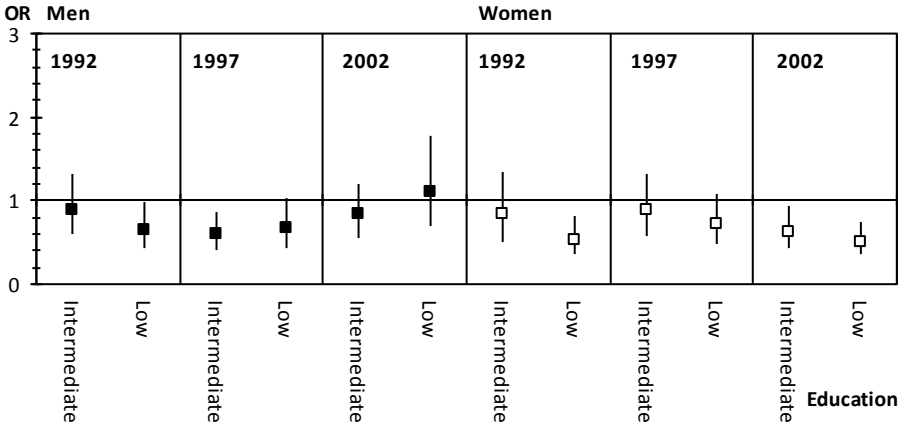


Figure 8. The association of education and the daily consumption of fruit in Pitkäranta (1992, 1997, 2002 and 2007) (n=1139 for men, n=1526 for women) and North Karelia (1992, 1997 and 2002) (n=1762 for men, n=2280 for women). Odds ratios (OR) and 95% confidence intervals from logistic regression analysis are presented. OR=1.0 in the highest education tertile.

[1]In Pitkäranta, the upper confidence interval limit was 3.18 in the intermediate education group and 5.12 in the low education group among men in 1992.

5.3.2 Serum total cholesterol and plasma vitamin C concentration (sub-studies III and IV)

The mean serum total cholesterol did not differ by education in Pitkäranta (Table 11). In North Karelia, the mean serum total cholesterol was higher in the lowest education group in 1992 and 2002. In 1997 the difference in cholesterol did not quite reach statistical significance, and by 2007, educational differences had levelled off.

Table 11. The mean serum total cholesterol concentration by education (Pitkäranta: n=2522; North Karelia: n=4885)[1,2,3].

	1992	1997	2002	2007
	mean (95% CI)	mean (95% CI)	mean (95% CI)	mean (95% CI)
Pitkäranta				
Education				
High	5.27 (5.15–5.40)	5.14 (5.01–5.26)	5.53 (5.37–5.69)	5.34 (5.15–5.53)
Intermediate	5.21 (5.09–5.34)	5.16 (5.04–5.28)	5.41 (5.25–5.56)	5.54 (5.35–5.74)
Low	5.32 (5.19–5.46)	5.02 (4.85–5.19)	5.36 (5.19–5.54)	5.48 (5.08–5.88)
North Karelia				
Education				
High	5.61 (5.52–5.71)	5.47 (5.37–5.57)	5.45 (5.37–5.54)	5.26 (5.16–5.37)
Intermediate	5.68 (5.57–5.78)	5.59 (5.49–5.69)	5.56 (5.45–5.68)	5.27 (5.14–5.39)
Low	**5.91 (5.81–6.02)**	5.64 (5.53–5.74)	**5.70 (5.58–5.81)**	5.29 (5.16–5.42)

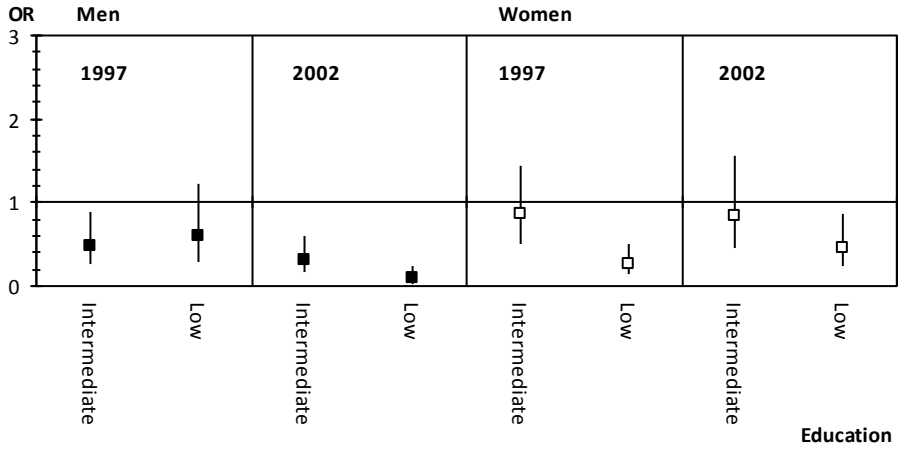
[1]Data from risk factor surveys.

[2]Data for men and women were combined.

[3]Statistically significant differences based on 95% CIs compared to the highest education group are written in bold.

A clear educational gradient was seen for plasma vitamin C concentration in Pitkäranta for men and women in 1997 and 2002 (Figure 9). Plasma vitamin C concentration tended to be lower among respondents in the middle and low education tertiles compared to the highest tertile among both genders. Educational differences in plasma vitamin C concentration were not examined in Pitkäranta in 1992 because of a skewed distribution and consequent impossibility of forming a practical tertile variable. In North Karelia, plasma vitamin C concentration was lower in the lowest education tertile compared to the highest tertile among men in 1992 and 1997 (borderline significance). Among North Karelian women, no educational differences were seen in 2002, which was the only year that plasma vitamin C was measured in this sub-group.

Pitkäranta:



North Karelia:

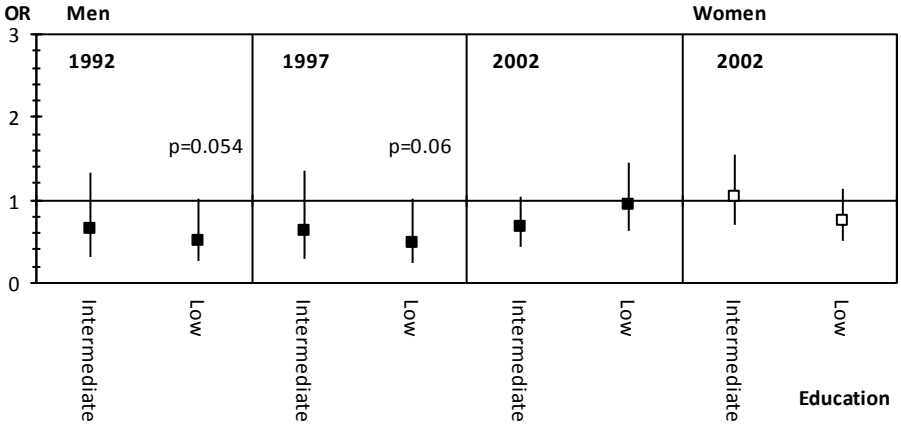


Figure 9. The association of education and high plasma vitamin C concentration in Pitkäranta (1997 and 2002) (n=462 for men, n=612 for women) and North Karelia (1992, 1997 and 2002) (n=959 for men, n=630 for women). Odds ratios (OR) and 95% confidence intervals from logistic regression analysis are presented. OR=1.0 in the highest education tertile.

5.4 Associations between food habits and biomarkers

5.4.1 Foods containing dairy fat vs. serum total cholesterol concentration (sub-study III)

The association of serum total cholesterol concentration with 1) use of butter in cooking, 2) use of butter on bread, 3) consumption of fat-containing milk and 4) daily consumption of cheese was examined using linear regression analysis. The data comprised the years 1992, 1997, 2002 and 2007 in both study areas. Men and women and all the four study years were combined in the analyses.

After adjusting for sex, age, study year and education, only the consumption of fat-containing milk was significantly associated with serum total cholesterol in Pitkäranta (β=0.19, 95% CI 0.10–0.28). In North Karelia, using butter in cooking (β=0.09, 95% CI 0.04–0.15) and butter on bread (β=0.09, 95% CI 0.02–0.15) were significantly associated with cholesterol. The daily consumption of cheese was not significantly associated with serum total cholesterol in either area.

5.4.2 Vegetables, fruit and berries vs. plasma vitamin C concentration (sub-study IV)

The association of plasma vitamin C concentration with 1) daily consumption of fresh vegetables, 2) daily consumption of fruit and 3) regular consumption of berries was examined using logistic regression analysis in 1997 and 2002 for Pitkäranta and 1992, 1997 and 2002 for North Karelia. For Pitkäranta, the association of plasma vitamin C concentration with food habits was not analysed in 1992 because of the skewed distribution of the vitamin C concentration and consequent impossibility of forming a practical vitamin C tertile variable.

Adjusting for age, education and the other two food variables, only daily consumption of fruit had a significant association with plasma vitamin C in 1997 (OR 3.03, 95% CI 1.14–8.05) and 2002 (OR 4.10, 95% CI 1.78–9.45) among men in Pitkäranta. The same was true for women in Pitkäranta in 2002 (OR 2.08, 95% CI 1.19–3.66), whereas in 1997, in addition to the consumption of fruit, daily consumption of fresh vegetables was also significantly associated with plasma vitamin C among women (OR 3.89, 95% CI 2.05–7.40 for fruit, OR 2.03, 95% CI 1.09–3.77 for fresh vegetables).

Daily consumption of fruit was most strongly associated with plasma vitamin C concentration in North Karelia as well. Among men in 1992 (OR 2.03, 95% CI 1.07–3.86) and 1997 (OR 2.27, 95% CI 1.19–4.35) and among women in 2002 (OR 1.49, 95% CI 1.01–2.19), daily consumption of fruit was significantly associated with plasma vitamin C concentration. In 2002, the association had ceased to be statistically significant among men.

5.5 Summary of main findings

Differences in overall levels between Pitkäranta and North Karelia

- In 1992, the use of butter in cooking was more common in Pitkäranta than in North Karelia, but these positions reversed due to people in Pitkäranta switching to other alternatives over the study years.
- The use of butter on bread and the consumption of fat-containing milk were more common in Pitkäranta than in North Karelia.
- The consumption of fresh vegetables and fruit was more common in North Karelia than in Pitkäranta throughout the study period.
- The mean serum total cholesterol concentration was higher in North Karelia than in Pitkäranta in 1992, but the difference levelled off over the study years.
- The mean plasma vitamin C concentration was higher in North Karelia than in Pitkäranta.

Diverging trends in Pitkäranta and North Karelia

- No truly parallel overall trends in the two areas were observed.
- The use of butter in cooking plunged in Pitkäranta, while a small, steady decrease was seen in North Karelia.
- The use of butter on bread plummeted in 1998, when soft margarine was added as an option to the questionnaire in Pitkäranta. Thereafter, the use of butter on bread became more common again. In North Karelia, the use of butter decreased slightly after 1992.
- The consumption of fat-containing milk fluctuated in Pitkäranta, whereas a small, steady decrease was seen in North Karelia.
- In Pitkäranta, the daily consumption of fresh vegetables and fruit became substantially more common from 1992 to 2007, whereas a small decrease was seen in North Karelia between 1992 and 2002.
- The mean serum total cholesterol concentration fluctuated in Pitkäranta; a decrease from 1992 to 1997 with a following subsequent increase was observed. In North Karelia, a decrease in serum total cholesterol was seen.

Similarities and differences in gender patterns in Pitkäranta and North Karelia

- Practically no gender differences in the use of butter were found.
- In Pitkäranta, no gender differences in the prevalence of consuming fat-containing milk were seen, whereas in Finland, drinking fat-containing milk was more common among men than women.

- The daily consumption of fresh vegetables and fruit was more common among women than men in both study areas, but the gender differences were more consistent in North Karelia than in Pitkäranta.
- The mean serum total cholesterol concentration did not differ by gender in Pitkäranta, whereas in North Karelia, the mean serum total cholesterol was higher among men than women in 1992 and 2002.
- The results suggest that plasma vitamin C concentration is prone to be higher among women than among men in both areas.

Similarities and differences in educational patterns in Pitkäranta and North Karelia

- The use of butter in cooking and the consumption of fat-containing milk were more common among subjects with a lower education compared to subjects with a higher education in both areas.
- The use of butter on bread was more common among men with a higher education compared to their counterparts with lower education in Pitkäranta, whereas the opposite was true for North Karelia. No significant educational differences in the use of butter on bread were seen among women.
- The consumption of fresh vegetables and fruit on a daily basis was more common in high education groups than in lower ones among women in Pitkäranta and among both genders in North Karelia. Among men in Pitkäranta, no educational differences in the consumption of fresh vegetables and fruit were seen.
- The mean serum total cholesterol did not differ by education in Pitkäranta, whereas in North Karelia, subjects in the lowest education group had a higher mean cholesterol concentration compared to the highest education group in 1992 and 2002.
- Plasma vitamin C concentration was prone to be higher among subjects with a high education in both areas, yet this pattern could not be confirmed among North Karelian women.

Food habits associated with serum total cholesterol and plasma vitamin C concentration

- In Pitkäranta, the consumption of fat-containing milk, whereas in North Karelia, the use of butter in cooking or on bread were associated with the serum total cholesterol concentration.
- Of the food habits representing important vitamin C sources in this study, daily consumption of fruit was most strongly associated with the plasma vitamin C concentration in both areas.

6 Discussion

This study of two geographically neighbouring but culturally and socio-economically very different areas, the district of Pitkäranta in the Republic of Karelia, Russia, and North Karelia, Finland, shows both remarkable differences and some similarities in food habits and their trends between these areas. The study period encompasses the early years of market economy in Russia after the collapse of the Soviet Union. Economically, the period around the mid-1990s was extremely challenging for the Russian population, especially in rural and remote areas. In Finland, the economic and social circumstances were more stable during the study years, regardless of the economic depression at the beginning of the 1990s.

Considerable changes in food habits were observed in Pitkäranta, whereas the magnitude of the changes was smaller in North Karelia. As expected, educational differences were more obvious in North Karelia than in Pitkäranta. Educational differences were rather stable in both areas. The changes in the serum total cholesterol concentration were mostly in line with the changes observed in the consumption of dairy fat. As would be expected on the basis of previous literature, the consumption of fruit, rather than that of fresh vegetables or berries, was more strongly associated with plasma vitamin C concentration in both areas.

6.1 Similarities between Pitkäranta and North Karelia

The educational differences in the use of butter in cooking, the consumption of fat-containing milk and the consumption of fresh vegetables and fruit were similar in Pitkäranta and North Karelia. That is, the subjects with lower education used butter in cooking and consumed fat-containing milk more often, whereas subjects with higher education consumed fresh vegetables and fruit more frequently in both areas. Previous studies from Finland and the Baltic states (Petkeviciene et al. 2007, Prättälä et al. 2011) as well as from several other Western European countries have shown parallel educational patterns in these food habits with more favourable habits among subjects with a higher SEP (Vannoni et al. 2003, Giskes et al. 2006, Rosell et al. 2006, Rogers and Pryer 2012). Similar to this study, the consumption of fruit was more common among subjects with a high education in Novosibirsk, Russia, in 2002–2005 (Boylan et al. 2011). In Novosibirsk, the consumption of vegetables did not differ by education. In this study, significant educational differences in the consumption of vegetables were found among both genders in North Karelia, whereas in Pitkäranta, educational differences were significant only among women. The results from Novosibirsk resemble the current findings in that, albeit not statistically significant, the educational pattern was more evident among women

than men in that sample as well. One possible explanation for the weak educational gradient in vegetable consumption in Novosibirsk was the popularity of home-grown vegetables, which may result in reasonably equal consumption.

The educational differences in the consumption of fresh vegetables and fruit were quite stable in both areas, as proved by the time trend analyses. Although the overall prevalence of these healthy habits changed, educational differences in favour of subjects with a higher education remained. Similarly to our study, quite persistent socio-economic differences in vegetable and fruit consumption as well as other food habits have been observed in other studies from Europe as well (Prättälä et al. 2011, Seiluri et al. 2011, Rogers and Pryer 2012). In Lithuania (1994–2010) and in Glasgow, Scotland (1986–1995), the socio-economic differences in the daily consumption of fresh vegetables seem to have widened, because of larger increases in their consumption in the higher socio-economic groups (Wrieden et al. 2004, Kriaucioniene et al. 2012). The reasons for higher vegetable consumption in higher socio-economic groups include the fact that high SEP is related to greater health consciousness (Inglis et al. 2005) and better nutrition knowledge (Turrell and Kavanagh 2006, Hendrie et al. 2008). Further, in Finland, food habits tend to be healthier among adults who eat lunch at a worksite canteen (Raulio et al. 2010) and in general, the availability of worksite canteens is better in occupations that are related to higher education. Healthy foods are often claimed to be expensive, and the high prices of healthy foods act as a barrier to eating healthily, especially in lower socio-economic groups (Inglis et al. 2005, Turrell and Kavanagh 2006, Kettings et al. 2009, Rydén and Hagfors 2011). Price definitely has an influence on consumers' food choices, and the state can direct food habits through subsidies. However, a study from Finland has demonstrated that adopting a diet in line with nutrition recommendations did not increase food costs (Ottelin et al. 2007). Not all healthy foods are expensive, but choosing affordable healthy foods such as root vegetables may demand more effort in the preparation phase.

Similar to the daily consumption of fresh vegetables and fruit, plasma vitamin C concentration was also positively associated with education among women in Pitkäranta and among both genders in North Karelia. Previous studies have shown similar socio-economic patterns in both vegetable and fruit consumption and plasma vitamin C concentration (Wrieden et al. 2000, Harding et al. 2008).

Daily consumption of fruit, rather than the consumption of vegetables, was associated with plasma vitamin C concentration in both areas. Among British men (aged 60–79) a positive association for both vegetable and fruit consumption with plasma vitamin C was found (Wannamethee et al. 2006). In the current study, the association between the consumption of vegetables and plasma vitamin C concentration was not as apparent, although among women in Pitkäranta, an exceptional significant association in 1997 was observed. Furthermore, the current data are also suggestive of a higher mean plasma vitamin C concentration among

women than men in both areas, which is in line with findings from previous studies (Babinská et al. 1995, Wrieden et al. 2000, Harding et al. 2008, Mosdøl et al. 2008).

6.2 Differences between Pitkäranta and North Karelia

The use of butter in cooking and on bread decreased in both areas, but the drop was much greater in Pitkäranta than in North Karelia. In Finland, a notable decrease in the use of butter had occurred before the period of this study (Pietinen et al. 1996, Lahelma et al. 1997, Helakorpi et al. 2008, Männistö et al. 2010). Thus, it seems that the decreasing trend in the use of butter in Pitkäranta follows that of Finland with a time lag. Furthermore, although the changes in the quality of fat used in everyday cooking or on bread are parallel in the two areas, the reasons for the changes can be assumed to differ between the areas. The favourable changes in Pitkäranta are supposedly related to the widening of the range available and improvements in both availability and affordability of foods in grocery stores in Pitkäranta. When affordable vegetable oil and soft margarine became available, their use overtook that of butter. In Russia, a tradition of using vegetable oil in cooking existed, and it was easy to change the fat used in cooking once vegetable oil was available at a sufficiently low price. In North Karelia, however, an active nutrition policy pursued in Finland and health information related to the North Karelia Project have probably had a major impact on the food habits (Puska 2009, Pietinen et al. 2010a).

Similar trends in food habits have been observed in Lithuania, a Baltic state which seceded from the Soviet Union in 1990 and in Poland, a former socialist society. Like in Pitkäranta, the availability and variety of foods increased in Lithuania and Poland in the 1990s (Zatonski et al. 1998, Kriaucioniene et al. 2012). As a result, the proportion of persons using vegetable oil in cooking roughly doubled and the proportion of persons spreading butter on bread nearly halved between 1994 and 2000 in Lithuania (Kriaucioniene et al. 2012). Also in Poland, a striking shift from animal to vegetable fat use was seen in the early 1990s in line with the transition towards a market economy, which included reductions in subsidies for dairy and other animal fat products (Zatonski et al. 1998, Zatonski and Willett 2005).

In Pitkäranta, the consumption of fresh vegetables, fruit and berries became substantially more common during the study period, whereas these healthy habits decreased slightly in North Karelia. Even so, these favourable food habits remained notably more common in North Karelia compared to Pitkäranta throughout the study period. In Pitkäranta, the availability of fresh vegetables out of season was very poor in the early 1990s (unpublished data from personal communication during qualitative interviews from Pitkäranta, 2006). During the study period, the availability and affordability of fresh vegetables and imported fruit improved. A notable increase in the availability of imported fruit took place in a few other former socialist societies as well in the early 1990s in connection with market liberalisation (Zatonski et al. 1998, Poledne and Škodová 2000, Zatonski and Willett 2005). In

North Karelia, a pronounced increase in the consumption of fresh vegetables and fruit preceded the study period of the current study (Helakorpi et al. 1993, Pietinen et al. 1996, Männistö et al. 2010). In this study, a decrease in daily consumption of fresh vegetables and fruit was observed following 1992 in North Karelia. A similar steady decrease occurred in three other Finnish risk factor survey areas as well (Vartiainen et al. 1993, Vartiainen et al. 1998, Laatikainen et al. 2003). One must bear in mind that firstly, we did not measure the consumed amounts but only the frequencies of use. Secondly, younger birth cohorts participated in the study at each study round as the age range was 25–64 years each time. It might be that frequent consumption of fresh vegetables and fruit is less common in younger Finnish birth cohorts and thereby, as younger birth cohorts joined the study and older ones no longer belonged to the age group of this study, the overall prevalence in the study population decreased. In reality, the frequent consumption of vegetables and fruit seems to be less common among younger adults than older adults (Helakorpi et al. 2008, Peltonen et al. 2008, Rogers and Pryer 2012). Finally, it must be pointed out that data from health behaviour surveys among Finnish adults covering the whole of Finland differed from the current results, in that they point to an increasing trend in the daily fresh vegetable consumption until 2002 (Roos et al. 2008). However, the sample in the health behaviour survey was a random sample of Finnish adults. Therefore, the populations of big cities and towns, particularly those in southern Finland where the average educational level, for example, is higher, are strongly represented in the health behaviour data. Food habits in Finland show regional variation (Similä et al. 2005, Similä et al. 2006, Helakorpi et al. 2007), and thus it is not surprising that the current results from the rather rural North Karelia do not fully correspond to the results from a random sample of all Finns.

The mean serum total cholesterol concentration did not differ by education in Pitkäranta, whereas in North Karelia, the serum total cholesterol concentration tended to be higher among subjects in the lowest education group compared to the highest education group. From Russia, previous data on socio-economic variation in serum cholesterol that could be compared with the sample from Pitkäranta in this study are scarce. Data from the Lipid Research Clinic study from Moscow and St Petersburg from around 1975 showed differences by education among men (n=1920) with higher serum total cholesterol among men with more than a high school education (mean concentration 6.39 mmol/l) compared to men with less than a high school education (mean concentration 6.11 mmol/l) (Dennis et al. 1993). The educational gradient was parallel for LDL cholesterol concentration. The results are in line with the education differences in food habits among the same sample, considering that the total fat intake, the saturated fat intake and the consumption of dairy products (milk, cheese, yogurt, dairy desserts and creams) was higher among subjects with a higher education. However, Moscow and St Petersburg are very different from the district of Pitkäranta, and the results from the Lipid Research

Clinic are from the Soviet time and a couple of decades older than the data in the current study. Data from 2006–2009 from the Survey on Stress, Aging and Health in Russia (n=1495), however, were in line with the current results from Pitkäranta in that no differences in serum total cholesterol by education were seen (Glei et al. 2013). The data only included residents of Moscow who were 55 or older. The results from North Karelia are in line with previous findings from Finland and other Western European countries, where the serum total cholesterol concentration has generally been either higher in the lower socio-economic groups (Osler et al. 2000, Aromaa and Koskinen 2002, Eliasson et al. 2006, Ernstsen et al. 2012) or similar in all socio-economic groups (Yarnell et al. 2005). Finally, it must be noted that the mean serum total cholesterol concentration was higher than recommended in all education groups in both study areas, as the recommendation on population level is <5.0 mmol/l (Graham et al. 2007). Again, North Karelia is not representative of the whole of Finland as the cholesterol concentration has tended to be higher in North Karelia than in most other areas in Finland (Vartiainen et al. 2003).

The mean plasma vitamin C concentration was considerably higher in North Karelia than in Pitkäranta at all study points. The mean concentrations in Pitkäranta were strikingly low and indicate that vitamin C deficiency was relatively common during the spring in the study period in Pitkäranta. Unfortunately, the determinations were only available from 1992 to 2002, and no up-to-date data on plasma vitamin C concentration are available. Further, plasma vitamin C concentration was prone to be positively associated with education, although in North Karelia, the educational differences were less pronounced.

As discussed earlier, the use of butter in cooking was more common among subjects with a lower education in both areas. Interestingly, the same did not apply to butter used on bread. As expected, the use of butter on bread was more common among subjects with lower education in North Karelia. However, the opposite was true in Pitkäranta. An educational gradient similar to Pitkäranta has been observed in two Baltic states, Latvia and Lithuania, where subjects with a higher education used butter on bread more often than subjects with a lower education (Petkeviciene et al. 2007). The more frequent use of butter on bread in the higher education groups in Pitkäranta in the current study might be related to the custom of eating bread without any spread in Russia. Using spread on bread might be considered proof of higher status.

6.3 Methodological considerations

6.3.1 Non-response

Non-response is a growing problem in population health surveys everywhere in Europe, regrettably in the current work as well. In this study, the response rates declined in both health behaviour surveys and risk factor surveys in both areas over

the study years. Still, in this study, the response rates were mostly in the same range as in other corresponding studies (Laaksonen et al. 2001, Wolf et al. 2005, Petkeviciene et al. 2007, Boylan et al. 2009). Survey non-respondents differ from respondents, as non-response is more common among men than women, in younger age groups than older ones and among persons with low education (Lallukka et al. 2002, Tolonen et al. 2005, Tolonen et al. 2006, Martikainen et al. 2007, Rönmark et al. 2009, Christensen et al. 2012). Differences in health behaviours have also been seen; the response rate is prone to be lower among smokers than non-smokers (Tolonen et al. 2005, Rönmark et al. 2009). All these factors decrease the representativeness of the results. In Finland, analyses on trends in non-participation from 1978 to 2002 showed that the response rates declined among both men and women in all age groups (Tolonen et al. 2006). The data came from health behaviour surveys covering the whole of Finland. Non-response was more common among men than women and among subjects with a lower education than a higher one. Further, the decline in the response rate was faster among men than women and among subjects with a lower education level compared to those with a higher education level. Thus, the comparison between men and women has become more unreliable over time, and the accuracy of various estimates for health indicators may have diminished. There is no reason to expect that the current data from the special sample from North Karelia would be free from the aforementioned problems related to declining response rates.

In Pitkäranta, the response rates were exceptionally low in the health behaviour survey in 1996 among men and women (43% among men and 52% among women) and in the risk factor survey in 2007 among men (45%). The economic situation was very difficult around 1996, which complicated the data collection. In addition, after the risk factor survey in 1992 and health behaviour survey in 1994 that had been conducted in close collaboration with the National Public Health Institute (KTL), local staff were responsible for data collection for the first time in 1996, and several adversities occurred.

Unfortunately, no non-participation analyses have been conducted for the data from Pitkäranta. The author is also not aware of non-participation analyses for data from any area in Russia that would be comparable with Pitkäranta. In connection to the WHO MONICA Project, non-respondent characteristics were examined in 27 populations including a sample from Novosibirsk, Russia (Tolonen et al. 2005). The analyses showed that unlike in most studied populations, non-response seemed to be more common among persons with a higher education in the sample from Novosibirsk. However, these results cannot be directly applied to the sample from Pitkäranta. Novosibirsk is a city that had a population of almost 1 500 000 in 2010 (Federal State Statistics Service 2011), whereas the Pitkäranta area is quite rural. In addition, although both Novosibirsk and Pitkäranta are both parts of Russia, the distance between them is about 3000 kilometres.

6.3.2 Validity of the non-quantitative method in assessing food habits

The dietary assessment method used in this study did not allow analyses on a nutrient intake level. Instead, the method aimed at examining the overall food habits of the study subjects. The food habits of the study subjects were enquired as part of an extensive self-administered questionnaire. The questionnaire covered the general health status, physical activity, the use of health services, physical activity, smoking and alcohol consumption, among others. Therefore, an extensive quantitative FFQ could not be included in the questionnaire. The food habit section of the questionnaire included a non-quantitative food frequency questionnaire and simple multiple choice questions. The questions were as similar as possible in Pitkäranta and North Karelia.

In connection to the risk factor surveys in Finland, food consumption has been investigated in detail with food records and 24- or 48-hour recalls among a sub-sample of subjects (Männistö et al. 2003, Männistö et al. 2010, Pietinen et al. 2010b). Unfortunately, this kind of detailed dietary survey was not possible in Pitkäranta due to several reasons. As an example, firstly, a comprehensive food composition data base is needed to manage the data from detailed food records and recalls. Such a data base was not available for the analyses of Russian foods and dishes in this study. Secondly, the interviewers who conduct 24-hour recalls have to be trained extensively, they need to master the local language and be acquainted with the local food culture. For these reasons, conducting an extensive dietary survey was not feasible in Pitkäranta and using a simpler method was the only choice.

The use of simple questions on food habits also has certain advantages. In a self-administered questionnaire, simple questions can be expected to be easier for the respondent to answer and thereby the information they bring about can be expected to be comparatively reliable. The method is also inexpensive compared to more detailed methods, and can yield valuable information on the overall food habits in a population. In the Helsinki Health Study – a questionnaire study among employees of the City of Helsinki – a method comparable to the one in this study was used (Lallukka et al. 2007, Seiluri et al. 2011). A short, non-quantitative FFQ (22 food items) and two additional questions on fat used on bread and in cooking proved to be suitable for estimating food habits by SEP in relation to the Finnish national dietary guidelines.

To gather comparable data on trend estimates, the questionnaires should be modified with moderation. In this study, the questions remained as similar as possible from year to year with one exception. The food frequency section in the questionnaire in Finland was modified in 2007 in order to gather more accurate information on food habits. The number of frequency categories was increased, resulting in changes in the distribution of the responses. Because the responses were

not considered comparable with earlier surveys, the data for North Karelia in 2007 had to be omitted from the analyses in sub-study II.

6.3.3 Serum total cholesterol and plasma vitamin C as biomarkers

In this study, serum total cholesterol was used as the biomarker for dairy fat intake, because it was considered the most feasible one of the available options. The systematic error of the cholesterol measurement methods in the risk factor surveys in Finland has been examined previously with the conclusion that the systematic error has only a minor effect on estimating and interpreting changes in serum total cholesterol (Sundvall et al. 2007). Different methods of high-density lipoprotein cholesterol (HDL-C) measurement have been used in the risk factor surveys, and unlike for serum total cholesterol, the measurements have been found to include bias that might even lead to misclassification of subjects according to their HDL-C concentration (Leiviskä et al. 2013). The low-density lipoprotein cholesterol (LDL-C), on the other hand, is commonly calculated using the Friedewald equation on the grounds of total cholesterol, HDL-C and triglyceride values (Friedewald et al. 1972) and thereby the values of LDL-C are not any more accurate than the values of HDL-C. Thus, as a reliable indicator in trend analyses serum total cholesterol was chosen as the biomarker in this study.

The pattern of fluctuation in the mean serum total cholesterol seemed to follow the fluctuation in using butter on bread and consuming fat-containing milk in Pitkäranta. The analyses on the association of major dairy fat sources and serum total cholesterol concentrations confirmed that the consumption of high-fat milk was strongly associated with serum cholesterol in Pitkäranta. In North Karelia, a similar steady decrease in the use of all the selected dairy fat sources and the mean serum total cholesterol were seen. In North Karelia, the dairy fat sources that were significantly associated with serum total cholesterol concentration were butter used in cooking and butter on bread.

The Czech Republic is a former socialist society, where trends in food habits and serum total cholesterol resembled those in Pitkäranta in the early 1990s. After the abolition of subsidies to e.g. meat and meat products as well as dairy products in 1991, the use of butter dropped and the use of vegetable oil and soft margarine increased (Poledne and Škodová 2000). Simultaneously (from 1992 to 1997), the total cholesterol decreased significantly among both genders.

Of all the biomarkers for the intake of vitamins, the correlation of plasma vitamin C and the intake of vitamin C is possibly the strongest (Bates and Thurnham 1997). As a water-soluble compound, vitamin C concentration in plasma reflects the short-term dietary intake of vitamin C. The best temporal correlation is achieved when the intake during the seven days preceding the blood sample is estimated (Bates and Thurnham 1997). In comparison, food consumption during the past six or twelve months was enquired in the food frequency section of the self-administered

questionnaire in this study, which may well have weakened the associations of food consumption data with the measured plasma vitamin C concentrations.

In this study, vitamin C was most strongly associated with the consumption of fruit in both areas, which is not surprising given the results from Finland, indicating that fruit and berries together accounted for 56% and 60% of vitamin C intake among Finnish men and women in 2002, respectively (Männistö et al. 2003). The corresponding proportions for fresh vegetable consumption were only 10% and 14%. Furthermore, as the supply of fruit is good year-round in Finland, it can be assumed that the consumption of fruit in Finland is more constant compared especially to the consumption of berries, which may vary more by season. Our results also support the findings of earlier literature in that plasma vitamin C is strongly associated with fruit consumption (Wrieden et al. 2000, Baldrick et al. 2011, Frankenfeld et al. 2012). As a matter of fact, the conclusion of a recent review on biomarkers for fruit and vegetables was that vitamin C may be a single sufficient biomarker for fruit consumption, whereas a single sufficient biomarker for vegetable consumption seems not to be available at present (Baldrick et al. 2011). The authors wished for further research on novel biomarker approaches with regard to biomarkers for vegetable consumption. Thus, it is not surprising that in the current study, the association of vitamin C and vegetables was not strong. Consequently, the weak association between reported fresh vegetable consumption and plasma vitamin C concentration does not necessarily mean that the measurement of vegetable consumption would have been unreliable.

Not all vitamin C sources were included in this study. For example, the association between the consumption of fruit juices and plasma vitamin C was not analysed. In addition, vitamin supplements may be an important vitamin C source among some people. However, the aim of this study was not to capture all vitamin C sources but to examine the association of a few main sources, which simultaneously serve as indicators of an overall healthy diet.

The mean plasma vitamin C concentration was strikingly low at each study point in Pitkäranta. All surveys were conducted in spring, when the supply of vegetables and fruit depends primarily on imported products, and the consumption of berries is at its lowest. However, we have recently demonstrated that the mean plasma vitamin C concentration in Pitkäranta was about 8-and 4-fold during autumn compared with spring among men and women, respectively (Paalanen et al. 2012). Thus, the concentration is not alarmingly low year-round. Parallel results are available from the Belarus, which was part of the former Soviet Union, where about 55% of 17–20-year-old subjects (n=250) were classified as deficient in vitamin C in spring, while the respective proportion was only 20% in autumn (Filippova et al. 2001). Parallel seasonal variation in plasma vitamin C concentrations has been reported from other countries as well (Harding et al. 2008).

Vitamin C is a very labile compound and its determination involves many challenges. In this study, part of the plasma vitamin C samples were omitted from the analyses because of probable thawing of the samples in question. All vitamin C determinations were performed in the laboratory of the National Public Health Institute (KTL) (currently the National Institute for Health and Welfare, THL) in Helsinki, Finland, and the samples had to be transferred in ice from North Karelia in eastern Finland and Pitkäranta in north-west Russia to the analysing laboratory. Unfortunately, a small proportion of the samples were damaged before final storage and determinations. The damage to the samples occurred randomly, and therefore, it should not disrupt the analyses by education, for instance.

6.3.4 Challenges in comparing two areas

The data in this study are unique. The data include health behaviour surveys covering 10 years since 1994 and risk factor surveys that cover 15 years since 1992 from two geographically similar but socio-economically very different areas, the district of Pitkäranta in Russia and North Karelia in Finland. Our data are comparable across the two study areas. The samples from both areas were simple random samples or stratified random samples and they were drawn from the National Population Register (North Karelia) or patient records or electoral lists (Pitkäranta), in order to achieve a representative sample of the target population. However, limitations related to the number of participants may have diminished the statistical power. It is possible that all existing differences by educational groups or changes over time did not reach statistical significance or could not be observed in this study because of restrictions in the sample sizes.

The methodology in both health behaviour surveys and risk factor surveys were as similar as possible in the two areas in order to achieve comparable data. Because the methods were kept as similar as possible, the results are also for the most part comparable from year to year. Standardised protocols were used in the risk factor surveys to ascertain high quality of the data (WHO MONICA Project Principal Investigators 1988, Tolonen et al. 2002b). The field workers in the risk factor survey underwent a thorough training period. Furthermore, the key persons, such as the persons responsible for drawing the blood samples, were basically the same in both areas each study year. All surveys were conducted during the spring to avoid a possible effect of seasonal variation.

No detailed dietary data were gathered in this study. As discussed earlier, a food composition data base is needed to process quantitative food consumption and nutrient intake data, and such a data base was not at the disposal of this study in the case of local foods in Pitkäranta. As a matter of fact, one of the major problems in nutritional studies comparing several countries is that the food composition data bases from different countries do often not yield comparable results (Kohlmeier et al. 1998, Vaask et al. 2004, Boylan et al. 2009). For example, considerable

discrepancies have been reported in the energy and nutrient content of basic foodstuffs between an adapted Finnish food composition data base and a Russian food composition data (Vaask et al. 2004). Similarly, the food composition databases of the Russian Institute of Nutrition, the US Department of Agriculture and the German Federal Food code have been found to be non-comparable (Kohlmeier et al. 1998).

The questionnaires were very similar in the two study areas. However, they had to be adapted to the local circumstances. New multiple choice options were added to the questionnaire in the course of time in both areas to match the widening assortment of bread spreads in the grocery stores. In Pitkäranta, the use of butter plunged simultaneously with the addition of soft margarine to the questionnaire in the health behaviour survey in 1998. The changes in the type of spread used on bread certainly show an actual change in the habits in the population. However, the dramatic change might be partly due to misinterpretation of the new options by the study subjects.

The methodology surrounding the blood samples was very similar in Pitkäranta and North Karelia. The blood samples for the serum cholesterol and plasma vitamin C determinations were collected following the same protocol from both areas and analysed in the same laboratory at the National Public Health Institute (KTL) (the current National Institute for Health and Welfare, THL), Helsinki, Finland. The laboratory in the National Public Health Institute has taken part in both national and international quality assurance systems (Sundvall et al. 2007).

North Karelia and Pitkäranta differ greatly from each other socio-economically, which complicated the choice of the SEP indicator in this study. Relative education was found to be the most suitable SEP indicator in this comparative setting. The relative education in this study describes the length of the subjects' education in relation to their peers from the same area and of the same sex and birth cohort. As the educational systems differ between countries, the years of education were not directly comparable. Including other aspects of SEP like occupation or income would possibly have resulted in a more in-depth understanding of the relationship between social circumstances and food habits in the areas, especially as a previous study has suggested occupation and income, rather than education, to be more strongly associated with food habits in Russia (Cockerham et al. 2006). Unfortunately, no reliable information on income was available and forming comparable categories for occupation for the two areas was not possible. Forming comparable categories for SEP indicators has been problematic in other comparative settings as well (López-Azpiazu et al. 2003, Boylan et al. 2011). For example, in a meta-analysis comparing fat intake by SEP in Europe, the lack of accurate and homogenous information was solved by presenting data only for the extreme categories of education and occupation (López-Azpiazu et al. 2003).

The local food cultures in Pitkäranta and North Karelia are different, which complicated the selection of indicators for saturated fat in this study. Dairy products are the most important sources of saturated fat in Finland (Paturi et al. 2008), although there are other comparatively important sources as well, such as bakery and meat products. In Lithuania, meat products are a more important source of saturated fat than dairy products among both genders (Petkeviciene et al. 2012). It is possible that the saturated fat sources in Pitkäranta resemble those found in Lithuania more than those in Finland, although this assertion has not been confirmed by research. Compared to dairy products, bakery and meat products may vary even more between the two areas. Thus, the indicators were limited to dairy fat sources, that is, the use of butter in cooking or on bread, the consumption of fat-containing milk and the consumption of cheese, which are probably more comparable across the study areas. A further shortcoming of this study is that fat-containing milk was the only liquid dairy product in this study, although other liquid dairy products are commonly used in both study areas. In Russia, for instance, other frequently consumed liquid dairy products include smetana (sour cream) and kefir (sour milk) (Zhivotovskiy et al. 2012), which can be presumed to be important dairy fat sources in Russia. Actually, according to unpublished data from qualitative interviews that were conducted among seven key persons in the Pitkäranta area in 2006, smetana is frequently consumed as a drink. Unfortunately, the questions on the use of smetana and kefir were not specified in enough detail in the questionnaire. On the whole, it was not possible to include all types of dairy products in the analyses. As a result, the association of the consumption of selected dairy fat sources and serum total cholesterol seen in this study may be weaker than the true association of fatty dairy products and total cholesterol, particularly so for the sample from Pitkäranta.

This study brought about understanding of the recent trends in food habits and their socio-economic differences in the Republic of Karelia, Russia, and North Karelia, Finland. The data on this topic from Russia were very limited prior to this study. These results emphasise that food habits can change quite rapidly in connection to the changes in society and people's immediate surroundings. In addition, this study examined the usefulness of simple methods in assessing food habits in two very different areas. As a whole, the observed associations between the simple survey questions on food habits and the measured biomarkers indicate that the selected food habits can be assessed relatively validly with simple questions in large, comparative population-based surveys.

7 Conclusions

There was a clear difference in the prevalence and trends in food habits between the district of Pitkäranta in the Republic of Karelia, Russia, and North Karelia, Finland, between 1992 and 2007. With regard to the use of butter on bread, the consumption of fat-containing milk, and the consumption of fresh vegetables, fruit and berries, the food habits were more favourable for health in North Karelia than in Pitkäranta. However, the use of butter in cooking was more common in North Karelia than in Pitkäranta.

Food habits changed dramatically in Pitkäranta during the study period, whereas they remained more stable in North Karelia. In Pitkäranta, food habits have mainly become more beneficial for health after the break-up of the Soviet Union. The changes were presumably related to the improvements in the availability and affordability of healthier foods in the local grocery shops. In North Karelia, the more notable changes in food habits had occurred prior to the time period of this study. In general, these results give reason to expect that in the future, food habits in Pitkäranta and North Karelia may converge, at least concerning the consumption of vegetables and fruit. Furthermore, the favourable changes in food habits in Pitkäranta hold a promise of favourable changes in the overall health situation in the area.

The food habits were in general healthier among women than men in both areas. The gender differences were more evident in North Karelia than in Pitkäranta. The educational differences in food habits were somewhat more evident in North Karelia than in Pitkäranta and were quite stable in both areas. The food habits were mainly more favourable among subjects with a high compared to a low educational level in both areas, with the exception of the use of butter on bread in Pitkäranta, where it was more common among men with a high education. The pattern of a more favourable situation in the high education group also applied to the biomarkers. In the future, the selection and year-round availability of foods can be assumed to improve further in Pitkäranta. Thus, as the role of active food choice presumably increases, the socio-economic differences in food habits may start to widen.

The dairy fat sources that were associated with serum total cholesterol concentration were quite different in Pitkäranta and North Karelia. In Pitkäranta, the consumption of fat-containing milk was associated with serum total cholesterol, whereas in North Karelia, an association with the use of butter in cooking or on bread was seen. Clearly there is room for improving the selection and availability of affordable skimmed and low-fat dairy products in Pitkäranta.

In both areas, the consumption of fruit was most strongly associated with plasma vitamin C concentration. This study supports earlier suggestions of plasma vitamin C

concentration as a useful biomarker for fruit consumption (Baldrick et al. 2011). To improve the poor vitamin C status observed in Pitkäranta, the best approach might be to promote the consumption of fruit by increasing their ready availability and affordability year-round.

These results emphasise that food habits can change quite rapidly as a result of several reasons. Changes in availability, prices and marketing messages in the media are just a few examples of the possible underlying factors. Positive examples in this study include the notable increase in fruit and vegetable consumption in Pitkäranta. In contrast, the use of fresh vegetables seems to have started to decrease in North Karelia after a long increasing trend. Outside this study, a topical example of a rapid unfavourable change in food habits is the increase in the share of energy from saturated fat according to the latest dietary survey in 2012 in Finland after a steady decrease (Vartiainen et al. 2012a). Simultaneously, the mean total cholesterol has risen after decades of a decreasing trend in Finland (Vartiainen et al. 2012b). Very similar trends in the use of butter and serum cholesterol have been observed in Northern Sweden, where after a decrease, the use of mainly saturated fats, especially butter-based spread for bread and butter in cooking, increased between 2004 and 2010 (Johansson et al. 2012). The authors connected the increased use of saturated fat to the supportive opinions for high-fat diets in the media. The changes in the use of saturated fat were associated with the changes in serum total cholesterol concentrations which started to increase after 2007. The causal effects of changes in the use of butter on changes in serum total cholesterol could not be evaluated, however.

As a whole, the results of this study give reason to conclude that short questions on food habits are reasonably valid measures in comparative settings, when more detailed dietary surveys are not feasible. Food consumption and nutrient intake cannot be quantitatively assessed with short questions. However, assuming that the indicators on food habits are thoroughly selected, they can yield relevant data on the diet of the study population. In this study, the use of butter in cooking and on bread and the consumption of fat-containing milk all showed different trends in Pitkäranta. Thus, they give information on slightly different aspects of food habits related to fat. The consumption of fresh vegetables and fruit were found to be more straightforward indicators of food habits.

8 Implications for future research

In the future, collecting follow-up data from Pitkäranta would be essential for adding up-to-date knowledge on the trends in food habits, serum total cholesterol and plasma vitamin C concentration as well as their socio-economic differences. New risk factor survey data was gathered from North Karelia in 2012 but not from Pitkäranta. Thus, at present, no more up-to-date data than reported in this study, i.e. until 2007, are available from Pitkäranta. Furthermore, collecting similar data from other areas in Russia would expand understanding of food habits in Russia, as the current results are by no means representative of the whole of Russia.

This study was a start in identifying food habit indicators that would feasibly yield comparable data from two very different areas. A few simple indicators on food habits cannot extensively describe the whole diet of a population, and the important indicators vary between countries and even within such enormous countries with several distinct food cultures as Russia. Regretfully, in many countries, including Russia, carrying out large population-based health examination surveys is extremely challenging, because of economic as well as practical reasons, and including a detailed dietary assessment section is a prominent extra burden. In future studies, compromises have to be prepared for in the choice of dietary assessment methods, as was the case in this study. Furthermore, if the aim is to achieve representative data that gives a picture of the habitual diet of a population, it may be more useful and cost-effective to collect data on at least some key indicators from a larger sample than very detailed data from a small sample of individuals.

In this study, the selected indicators were useful in highlighting the overall trends and their remarkable differences between Pitkäranta and North Karelia. However, the indicators most certainly need further development in the future. Furthermore, studies with a focus on the association of the selected food habit indicators and morbidity and mortality are needed. As seen in this study, food habits can change quite rapidly. The selection of foods in the grocery stores changes continuously in both areas. Thus, the indicators also need to be updated accordingly.

Furthermore, efforts aiming at validating simple food habit indicators for use in studies that compare several countries are needed to ensure the quality of comparative studies. This study only included two neighbouring areas from Northern Europe, and still several issues regarding the comparability of the selected indicators arose. Including more areas or even two areas that lie further apart in possible future studies will probably bring about new challenges.

Regarding the plasma vitamin C measurements, the need for new measurements is great, as the latest plasma vitamin C determinations are from 2002. The mean plasma vitamin C concentration was extremely low in Pitkäranta in spring 2002. As

the consumption of fruit and vegetables increased considerably from 2002 to 2007, and possibly the upward trend may have continued, it would be of major public health importance if there had been an improvement in the extremely low plasma vitamin C concentration. In addition, new plasma vitamin C measurements might give more evidence for the gender differences in plasma vitamin C concentration. Furthermore, as the plasma vitamin C has previously shown considerable seasonal variation (Paalanen et al. 2012), the measurements should, if possible, be repeated during a different season.

Repeated cross-sectional surveys like the health behaviour and the risk factor surveys employed in this study add knowledge to the changes of food habits and other health behaviours and in the societal factors that underlie the changes. Provided that the sample size is sufficient, the trends can be explored in selected socio-economic groups to increase the understanding on trends in health inequalities. However, to maintain the comparability of the possible future surveys, the methods should remain similar enough. Concerning the questionnaires and other methodological issues, finding a balance between maintaining the comparability while updating the methods according to the changes in the prevailing circumstances and topical research interests is a challenge that does not only apply to studies on food habits but all research relating to the behaviour of human beings.

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References

Aho, K. and Pekkarinen, M. (1989) Diet and physical activity of men in east and west Finland in 1969. *Ann Med* **21**, 241-243.

Andersen, L. F., Veierød, M. B., Johansson, L., Sakhi, A., Solvoll, K. and Drevon, C. A. (2005) Evaluation of three dietary assessment methods and serum biomarkers as measures of fruit and vegetable intake, using the method of triads. *Br J Nutr* **93**, 519-527.

Aromaa, A. and Koskinen, S. (2002) *Terveys ja toimintakyky Suomessa. Terveys 2000 -tutkimuksen perustulokset.* Publications of the National Public Health Institute, B3/2002, National Public Health Institute (KTL), Helsinki.

Babinská, K., Béderová, A., Grancicová, E., Magálová, T. and Brtková, A. (1995) Serum levels of vitamins A, C and E in the population of Slovakia. [In Slovak]. *Bratislavske lekarske listy* **96**, 430-434.

Baker, A. H. and Wardle, J. (2003) Sex differences in fruit and vegetable intake in older adults. *Appetite* **40**, 269-275.

Baldrick, F. R., Woodside, J. V., Elborn, J. S., Young, I. S. and McKinley, M. C. (2011) Biomarkers of fruit and vegetable intake in human intervention studies: a systematic review. *Crit Rev Food Sci Nutr* **51**, 795-815.

Bates, C. J. and Thurnham, D. I. (1997) Biochemical markers of nutrient intake. In *Design Concepts in Nutritional Epidemiology,* Margetts, B. and Nelson, M. eds, pp. 170-240. Oxford University Press, New York.

Beaton, G. H., Milner, J., Corey, P., McGuire, V., Cousins, M., Stewart, E., de Ramos, M., Hewitt, D., Grambsch, P. V., Kassim, N. and Little, J. A. (1979) Sources of variance in 24-hour dietary recall data: implications for nutrition study design and interpretation. *Am J Clin Nutr* **32**, 2546-2559.

Billson, H., Pryer, J. A. and Nichols, R. (1999) Variation in fruit and vegetable consumption among adults in Britain. An analysis from the dietary and nutritional survey of British adults. *Eur J Clin Nutr* **53**, 946-952.

Bobak, M., Gilmore, A., McKee, M., Rose, R. and Marmot, M. (2006) Changes in smoking prevalence in Russia, 1996-2004. *Tob Control* **15**, 131-135.

Boeing, H., Bechthold, A., Bub, A., Ellinger, S., Haller, D., Kroke, A., Leschik-Bonnet, E., Müller, M. J., Oberritter, H., Schulze, M., Stehle, P. and Watzl, B. (2012) Critical review: vegetables and fruit in the prevention of chronic diseases. *Eur J Nutr* **51**, 637-663.

Bolton-Smith, C., Casey, C. E., Gey, K. F., Smith, W. C. and Tunstall-Pedoe, H. (1991) Antioxidant vitamin intakes assessed using a food-frequency questionnaire: correlation with biochemical status in smokers and non-smokers. *Br J Nutr* **65**, 337-346.

Boylan, S., Lallukka, T., Lahelma, E., Pikhart, H., Malyutina, S., Pajak, A., Kubinova, R., Bragina, O., Stepaniak, U., Gillis-Januszewska, A., Simonova, G., Peasey, A. and Bobak, M. (2011) Socio-economic circumstances and food habits in Eastern, Central and Western European populations. *Public Health Nutr* **14**, 678-687.

Boylan, S., Welch, A., Pikhart, H., Malyutina, S., Pajak, A., Kubinova, R., Bragina, O., Simonova, G., Stepaniak, U., Gilis-Januszewska, A., Milla, L., Peasey, A., Marmot, M. and Bobak, M. (2009) Dietary habits in three Central and Eastern European countries: the HAPIEE study. *BMC Public Health* **9**, 439-2458-9-439.

Brown, D. (2006) Do food frequency questionnaires have too many limitations? *J Am Diet Assoc* **106**, 1541-1542.

Brubacher, G. and Vuillemier, J. P. (1978) Vitamin C. In *Clinical Biochemistry. Principles and Methods,* Vol. 2, Curtius, H.,C. and Roth, M. eds, pp. 989-997. Walter de Gruyter, Berlin, Germany.

Brubacher, D., Moser, U. and Jordan, P. (2000) Vitamin C concentrations in plasma as a function

of intake: a meta-analysis. *Int J Vitam Nutr Res* **70**, 226-237.

Caggiula, A. W. and Mustad, V. A. (1997) Effects of dietary fat and fatty acids on coronary artery disease risk and total and lipoprotein cholesterol concentrations: epidemiologic studies. *Am J Clin Nutr* **65**, 1597S-1610S.

Carlsen, M. H., Karlsen, A., Lillegaard, I. T., Gran, J. M., Drevon, C. A., Blomhoff, R. and Andersen, L. F. (2011) Relative validity of fruit and vegetable intake estimated from an FFQ, using carotenoid and flavonoid biomarkers and the method of triads. *Br J Nutr* **105**, 1530-1538.

Christensen, A. I., Ekholm, O., Glumer, C., Andreasen, A. H., Hvidberg, M. F., Kristensen, P. L., Larsen, F. B., Ortiz, B. and Juel, K. (2012) The Danish National Health Survey 2010. Study design and respondent characteristics. *Scand J Public Health* **40**, 391-397.

Clarke, R., Frost, C., Collins, R., Appleby, P. and Peto, R. (1997) Dietary lipids and blood cholesterol: quantitative meta-analysis of metabolic ward studies. *BMJ* **314**, 112-117.

Cockerham, W. C. (1997) The social determinants of the decline of life expectancy in Russia and eastern Europe: a lifestyle explanation. *J Health Soc Behav* **38**, 117-130.

Cockerham, W. C., Hinote, B. P., Cockerham, G. B. and Abbott, P. (2006) Health lifestyles and political ideology in Belarus, Russia, and Ukraine. *Soc Sci Med* **62**, 1799-1809.

Connor Gorber, S., Tremblay, M., Moher, D. and Gorber, B. (2007) A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obes Rev* **8**, 307-326.

Cooper, R. and Schatzkin, A. (1982) Recent trends in coronary risk factors in the USSR. *Am J Public Health* **72**, 431-440.

Coyne, T., Ibiebele, T. I., McNaughton, S., Rutishauser, I. H., O'Dea, K., Hodge, A. M., McClintock, C., Findlay, M. G. and Lee, A. (2005) Evaluation of brief dietary questions to estimate vegetable and fruit consumption - using serum carotenoids and red-cell folate. *Public Health Nutr* **8**, 298-308.

Dennis, B. H., Thomas, R. P., Irving, S. H., Furberg, B., Zhukovsky, G. S. and Khaltaev, N. G. (1988) Nutrient intake in men aged 20 to 39 years from U.S. and U.S.S.R. Lipid Research Clinic populations. *Atherosclerosis Reviews* **17**, 139-155.

Dennis, B. H., Zhukovsky, G. S., Shestov, D. B., Davis, C. E., Deev, A. D., Kim, H. and Tyroler, H. A. (1993) The association of education with coronary heart disease mortality in the USSR Lipid Research Clinics Study. *Int J Epidemiol* **22**, 420-427.

Dickson-Spillmann, M. and Siegrist, M. (2011) Consumers' knowledge of healthy diets and its correlation with dietary behaviour. *J Hum Nutr Diet* **24**, 54-60.

Dragsted, L. O. (2010) Biomarkers of meat intake and the application of nutrigenomics. *Meat Science* **84**, 301-307.

Eliasson, M., Janlert, U., Jansson, J. H. and Stegmayr, B. (2006) Time trends in population cholesterol levels 1986-2004: influence of lipid-lowering drugs, obesity, smoking and educational level. The northern Sweden MONICA study. *J Intern Med* **260**, 551-559.

Ernstsen, L., Strand, B. H., Nilsen, S. M., Espnes, G. A. and Krokstad, S. (2012) Trends in absolute and relative educational inequalities in four modifiable ischaemic heart disease risk factors: repeated cross-sectional surveys from the Nord-Trøndelag Health Study (HUNT) 1984-2008. *BMC Public Health* **12**, 266-2458-12-266.

Estaquio, C., Druesne-Pecollo, N., Latino-Martel, P., Dauchet, L., Hercberg, S. and Bertrais, S. (2008) Socioeconomic differences in fruit and vegetable consumption among middle-aged French adults: adherence to the 5 A Day recommendation. *J Am Diet Assoc* **108**, 2021-2030.

Federal State Statistics Service (2011) All-Russia Population Census of 2010.

Federal State Statistics Service (2004) Population of Russia, its federal districts, federal subjects, districts, urban localities - administrative centers and rural localities with population of over 3,000. (All-Russia Population Census of 2002). [In Russian].

Filippova, V. A., Lysenkova, A. V. and Prishchepova, L. V. (2001) Vitamin C status of inhabitants of the Gomel region. [In Russian] *Voprosy pitaniia* **70**, 10-11.

Frankenfeld, C. L., Lampe, J. W., Shannon, J., Gao, D. L., Li, W., Ray, R. M., Chen, C., King, I. B. and Thomas, D. B. (2012) Fruit and vegetable intakes in relation to plasma nutrient concentrations in women in Shanghai, China. *Public Health Nutr* **15**, 167-175.

Friedewald, W. T., Levy, R. I. and Fredrickson, D. S. (1972) Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem* **18**, 499-502.

Garcia, A. L., Mohan, R., Koebnick, C., Bub, A., Heuer, T., Strassner, C., Groeneveld, M. J., Katz, N., Elmadfa, I., Leitzmann, C. and Hoffmann, I. (2010) Plasma beta-carotene is not a suitable biomarker of fruit and vegetable intake in german subjects with a long-term high consumption of fruits and vegetables. *Ann Nutr Metab* **56**, 23-30.

Garland, M., Morris, J. S., Stampfer, M. J., Colditz, G. A., Spate, V. L., Baskett, C. K., Rosner, B., Speizer, F. E., Willett, W. C. and Hunter, D. J. (1995) Prospective study of toenail selenium levels and cancer among women. *J Natl Cancer Inst* **87**, 497-505.

Giskes, K., Turrell, G., van Lenthe, F. J., Brug, J. and Mackenbach, J. P. (2006) A multilevel study of socio-economic inequalities in food choice behaviour and dietary intake among the Dutch population: the GLOBE study. *Public Health Nutr* **9**, 75-83.

Glei, D. A., Goldman, N., Shkolnikov, V. M., Jdanov, D., Shalnova, S., Shkolnikova, M. and Weinstein, M. (2013) To what extent do biomarkers account for the large social disparities in health in Moscow? *Soc Sci Med* **77**, 164-172.

Gordon, D. J., Salz, K. M., Roggenkamp, K. J. and Franklin, F. A.,Jr (1982) Dietary determinants of plasma cholesterol change in the recruitment phase of the Lipid Research Clinics Coronary Primary Prevention Trial. *Arteriosclerosis* **2**, 537-548.

Graham, I., Atar, D., Borch-Johnsen, K., Boysen, G., Burell, G., Cifkova, R., Dallongeville, J., De Backer, G., Ebrahim, S., Gjelsvik, B., Herrmann-Lingen, C., Hoes, A., Humphries, S., Knapton, M., Perk, J., Priori, S. G., Pyorala, K., Reiner, Z., Ruilope, L., Sans-Menendez, S., Op Reimer, W. S., Weissberg, P., Wood, D., Yarnell, J., Zamorano, J. L. and ESC Committee for Practice Guidelines (2007) European guidelines on cardiovascular disease prevention in clinical practice: executive summary. *Atherosclerosis* **194**, 1-45.

Haftenberger, M., Heuer, T., Heidemann, C., Kube, F., Krems, C. and Mensink, G. B. (2010) Relative validation of a food frequency questionnaire for national health and nutrition monitoring. *Nutr J* **9**, 36-2891-9-36.

Harding, A. H., Wareham, N. J., Bingham, S. A., Khaw, K., Luben, R., Welch, A. and Forouhi, N. G. (2008) Plasma vitamin C level, fruit and vegetable consumption, and the risk of new-onset type 2 diabetes mellitus: the European prospective investigation of cancer--Norfolk prospective study. *Arch Intern Med* **168**, 1493-1499.

He, F. J., Nowson, C. A., Lucas, M. and MacGregor, G. A. (2007) Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies. *J Hum Hypertens* **21**, 717-728.

Helakorpi, S., Berg, M. and Puska, P. (1993) *Pohjois-Karjalan läänin aikuisväestön terveys-käyttäytyminen vuosina 1992-93. Health behaviour*

among North Karelian adult population in 1992-93. Publications of the National Public Health Institute B11/1993, Kansanterveyslaitos (KTL), Helsinki.

Helakorpi, S., Uutela, A. and Puska, P. (2007) Työikäisen väestön elintapojen muutokset - ylipaino on yleistynyt ja alkoholin kulutus kasvanut. *Suom Lääkäril* **62**, 2975-2980.

Helakorpi, S., Prättälä, R., Uutela, A. and Kansanterveyslaitos (2008) *Suomalaisen aikuisväestön terveyskäyttäytyminen ja terveys, kevät 2007. Health behaviour and Health among the Finnish Adult Population, Spring 2007.* Publications of the National Public Health Institute B6/2008. Kansanterveyslaitos (KTL), Helsinki.

Hendrie, G. A., Coveney, J. and Cox, D. (2008) Exploring nutrition knowledge and the demographic variation in knowledge levels in an Australian community sample. *Public Health Nutr* **11**, 1365-1371.

Henkin, S. D., Sehl, P. L. and Meyer, F. (2010) Sweat rate and electrolyte concentration in swimmers, runners, and nonathletes. *Int J Sports Physiol Perform* **5**, 359-366.

Horska, A., Mislanova, C., Bonassi, S., Ceppi, M., Volkovova, K. and Dusinska, M. (2011) Vitamin C levels in blood are influenced by polymorphisms in glutathione S-transferases. *Eur J Nutr* **50**, 437-446.

Hulshof, K. F. A. M. and Ocké, M. C. (2005) Voedselconsumptiepeilingen 2003: onderzoek bij jongvolwassen Nederlanders. Focus op macrovoedingsstoffen [in Dutch]. *Ned Tijdschr Klin Chem Labgeneesk* **30**, 185-191.

Humphries, S. E., Whittall, R. A., Hubbart, C. S., Maplebeck, S., Cooper, J. A., Soutar, A. K., Naoumova, R., Thompson, G. R., Seed, M., Durrington, P. N., Miller, J. P., Betteridge, D. J., Neil, H. A. and Simon Broome Familial Hyperlipidaemia Register Group and Scientific Steering Committee (2006) Genetic causes of familial hypercholesterolaemia in patients in the UK: relation to plasma lipid levels and coronary heart disease risk. *J Med Genet* **43**, 943-949.

Inglis, V., Ball, K. and Crawford, D. (2005) Why do women of low socioeconomic status have poorer dietary behaviours than women of higher socioeconomic status? A qualitative exploration. *Appetite* **45**, 334-343.

Ingram, D. D., Thorn, M. D., Stinnett, S. S. and Deev, A. D. (1985) U.S.S.R. and U.S. nutrient intake, plasma lipids, and lipoproteins in men ages 40-59 sampled from Lipid Research Clinics populations. *Prev Med* **14**, 264-271.

Irala-Estévez, J. D., Groth, M., Johansson, L., Oltersdorf, U., Prättälä, R. and Martínez-González, M. A. (2000) A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables. *Eur J Clin Nutr* **54**, 706-714.

Jensen, K. and Holm, L. (1999) Preferences, quantities and concerns: socio-cultural perspectives on the gendered consumption of foods. *Eur J Clin Nutr* **53**, 351-359.

Johansson, G., Wikman, A., Åhrén, A. M., Hallmans, G. and Johansson, I. (2001) Underreporting of energy intake in repeated 24-hour recalls related to gender, age, weight status, day of interview, educational level, reported food intake, smoking habits and area of living. *Public Health Nutr* **4**, 919-927.

Johansson, I., Nilsson, L. M., Stegmayr, B., Boman, K., Hallmans, G. and Winkvist, A. (2012) Associations among 25-year trends in diet, cholesterol and BMI from 140,000 observations in men and women in Northern Sweden. *Nutr J* **11**, 40-2891-11-40.

Keep, J. L. H. (1995) *Last of the empires,* Oxford University Press, New York.

Kellera, A. A. (1990) Medical-geographical Atlas of Karelian ASSR [in Russian], Karelian Research Center, Petrozavodsk.

Kettings, C., Sinclair, A. J. and Voevodin, M. (2009) A healthy diet consistent with Australian health recommendations is too expensive for welfare-

dependent families. *Aust N Z J Public Health* **33**, 566-572.

Keys, A., Aravanis, C., Blackburn, H., Van Buchem, F., Buzina, R., Djordjević, B., Dontas, A., Fidanza, F., Karvonen, M., Kimura, N., Lekos, D., Monti, M., Puddu, V. and Taylor, H. (1966) Epidemiological studies related to coronary heart disease: characteristics of men aged 40-59 in seven countries. *Acta Med Scand.Suppl* **460**, 1-392.

Kohlmeier, L., Mendez, M., Shalnova, S., Martinchik, A., Chakraborty, H. and Kohlmeier, M. (1998) Deficient dietary iron intakes among women and children in Russia: evidence from the Russian Longitudinal Monitoring Survey. *Am J Public Health* **88**, 576-580.

Konttinen, H., Sarlio-Lähteenkorva, S., Silventoinen, K., Männistö, S. and Haukkala, A. (2013) Socio-economic disparities in the consumption of vegetables, fruit and energy-dense foods: the role of motive priorities. *Public Health Nutr* **16**, 873-882.

Koskinen, E. H., Pekkarinen, M. and Roine, P. (1974) A recent dietary survey in Finland. *Bibl Nutr Dieta* **20**, 189-192.

Krachler, B., Eliasson, M. C., Johansson, I., Hallmans, G. and Lindahl, B. (2005) Trends in food intakes in Swedish adults 1986-1999: findings from the Northern Sweden MONICA (Monitoring of Trends and Determinants in Cardiovascular Disease) Study. *Public Health Nutr* **8**, 628-635.

Kriaucioniene, V., Klumbiene, J., Petkeviciene, J. and Sakyte, E. (2012) Time trends in social differences in nutrition habits of a Lithuanian population: 1994-2010. *BMC Public Health* **12**, 218-2458-12-218.

Kristal, A. R., Peters, U. and Potter, J. D. (2005) Is it time to abandon the food frequency questionnaire? *Cancer Epidemiol Biomarkers Prev,* **14**, 2826-2828.

Kromhout, D., Keys, A., Aravanis, C., Buzina, R., Fidanza, F., Giampaoli, S., Jansen, A., Menotti, A., Nedeljkovic, S. and Pekkarinen, M. (1989) Food consumption patterns in the 1960s in seven countries. *Am J Clin Nutr* **49**, 889-894.

Kuhnle, G. G., Joosen, A. M., Kneale, C. J. and O'Connell, T. C. (2013) Carbon and nitrogen isotopic ratios of urine and faeces as novel nutritional biomarkers of meat and fish intake. *Eur J Nutr* **52**, 389-395.

Laaksonen, M., McAlister, A. L., Laatikainen, T., Drygas, W., Morava, E., Nüssel, E., Oganov, R., Pardell, H., Uhanov, M. and Puska, P. (2001) Do health behaviour and psychosocial risk factors explain the European east-west gap in health status? *Eur J Public Health* **11**, 65-73.

Laatikainen, T., Tapanainen, H., Alfthan, G., Salminen, I., Sundvall, J., Leiviskä, J., Harald, K., Jousilahti, P., Salomaa, V. and Vartiainen, E. (2003) *FINRISKI 2002. Tutkimus kroonisten kansantautien riskitekijöistä, niihin liittyvistä elintavoista, oireista, psykososiaalisista tekijöistä ja terveyspalvelujen käytöstä. Tutkimuksen toteutus ja tulokset 2, taulukkoliite.* Publications of the National Public Health Institute B7/2003, Kansanterveyslaitos (KTL), Helsinki.

Laatikainen, T., Vlasoff, T., Korpelainen, V., Pokusajeva, S. and Uhanov, M. (2006) *Health behaviour in Pitkaranta - results of the health behaviour surveys in the Pitkaranta district in the Republic of Karelia, Russia in 1998, 2000 and 2004.* Pohjois-Karjalan kansanterveyden keskus. Hyvätuuli Oy, Joensuu.

Lahelma, E., Rahkonen, O., Berg, M. A., Helakorpi, S., Prättälä, R., Puska, P. and Uutela, A. (1997) Changes in health status and health behavior among Finnish adults 1978-1993. *Scand J Work Environ Health* **23 Suppl 3**, 85-90.

Lallukka, T., Aittomäki, A., Piha, K., Roos, E., Kivelä, K. and Silventoinen, K. (2002) Postikyselytutkimukseen vastanneiden edustavuus sosioekonomisten tekijöiden ja sairauspoissaolo-tietojen mukaan. *Sosiaalilääk Aikak* **39**, 164-171.

Lallukka, T., Laaksonen, M., Rahkonen, O., Roos, E. and Lahelma, E. (2007) Multiple socio-economic

circumstances and healthy food habits. *Eur J Clin Nutr* **61**, 701-710.

Lallukka, T., Pitkäniemi, J., Rahkonen, O., Roos, E., Laaksonen, M. and Lahelma, E. (2010) The association of income with fresh fruit and vegetable consumption at different levels of education. *Eur J Clin Nutr* **64**, 324-327.

Larsson, S. C., Virtamo, J. and Wolk, A. (2013) Total and specific fruit and vegetable consumption and risk of stroke: a prospective study. *Atherosclerosis* **227**, 147-152.

Leiviskä, J., Sundvall, J., Alfthan, G., Tähtelä, R., Salomaa, V., Jauhiainen, M. and Vartiainen, E. (2013) What have we learnt about high-density lipoprotein cholesterol measurements during 32years? Experiences in Finland 1980-2012. *Clinica chimica acta* **415**, 118-123.

Leon, D. A., Saburova, L., Tomkins, S., Andreev, E., Kiryanov, N., McKee, M. and Shkolnikov, V. M. (2007) Hazardous alcohol drinking and premature mortality in Russia: a population based case-control study. *Lancet* **369**, 2001-2009.

Lin, Y., Wolk, A., Håkansson, N., Peñalvo, J. L., Lagergren, J., Adlercreutz, H. and Lu, Y. (2013) Validation of FFQ-based assessment of dietary lignans compared with serum enterolactone in Swedish women. *Br J Nutr* **109**, 1873-1880.

López-Azpiazu, I., Sánchez-Villegas, A., Johansson, L., Petkeviciene, J., Prättälä, R., Martínez-González, M. A. and FAIR-97-3096 Project (2003) Disparities in food habits in Europe: systematic review of educational and occupational differences in the intake of fat. *J Hum Nutr Dietet* **16**, 349-364.

Martikainen, P., Laaksonen, M., Piha, K. and Lallukka, T. (2007) Does survey non-response bias the association between occupational social class and health? *Scand J Public Health* **35**, 212-215.

Martinchik, A. N., Baturin, A. K., Martinchik, E. A., Peskova, E. V. and Starovoitov, M. L. (2005) Dietary intake of antioxidant vitamins in Russian population. [In Russian]. *Voprosy pitaniia* **74**, 9-13.

Martínez-González, M. A., de la Fuente-Arrillaga, C., López-Del-Burgo, C., Vázquez-Ruiz, Z., Benito, S. and Ruiz-Canela, M. (2011) Low consumption of fruit and vegetables and risk of chronic disease: a review of the epidemiological evidence and temporal trends among Spanish graduates. *Public Health Nutr* **14**, 2309-2315.

Matilainen, T., Vartiainen, E., Puska, P., Alfthan, G., Pokusajeva, S., Moisejeva, N. and Uhanov, M. (1996) Plasma ascorbic acid concentrations in the Republic of Karelia, Russia and in North Karelia, Finland. *Eur J Clin Nutr* **50**, 115-120.

Matilainen, T. K. M., Puska, P., Berg, M. K., Pokusajeva, S., Moisejeva, N., Uhanov, M. and Artemjev, A. (1994) Health-related behaviors in the Republic of Karelia, Russia, and North Karelia, Finland. *Int J Behav Med* **1**, 285-304.

Maughan, R. J., Merson, S. J., Broad, N. P. and Shirreffs, S. M. (2004) Fluid and electrolyte intake and loss in elite soccer players during training. *Int J Sport Nutr Exerc Metab* **14**, 333-346.

McKee, M. (1999) Alcohol in Russia. *Alcohol Alcohol* **34**, 824-829.

McKee, M., Bobak, M., Rose, R., Shkolnikov, V., Chenet, L. and Leon, D. (1998) Patterns of smoking in Russia. *Tob Control* **7**, 22-26.

McKee, M. and Shkolnikov, V. (2001) Understanding the toll of premature death among men in eastern Europe. *BMJ* **323**, 1051-1055.

Mohammadifard, N., Omidvar, N., Houshiarrad, A., Neyestani, T., Naderi, G. A. and Soleymani, B. (2011) Validity and reproducibility of a food frequency questionnaire for assessment of fruit and vegetable intake in Iranian adults(*). *J Res Med Sci* **16**, 1286-1297.

Mosdøl, A., Erens, B. and Brunner, E. J. (2008) Estimated prevalence and predictors of vitamin C deficiency within UK's low-income population. *J Public Health* **30**, 456-460.

Mozaffarian, D., Shi, P., Morris, J. S., Spiegelman, D., Grandjean, P., Siscovick, D. S., Willett, W. C. and Rimm, E. B. (2011) Mercury exposure and risk of cardiovascular disease in two U.S. cohorts. *N Engl J Med* **364**, 1116-1125.

Mullin, G. E. (2012) Micronutrients and inflammatory bowel disease. *Nutr Clin Pract* **27**, 136-137.

Murphy, M., Bobak, M., Nicholson, A., Rose, R. and Marmot, M. (2006) The widening gap in mortality by educational level in the Russian Federation, 1980-2001. *Am J Public Health* **96**, 1293-1299.

Murphy, S. P., Kaiser, L. L., Townsend, M. S. and Allen, L. H. (2001) Evaluation of validity of items for a food behavior checklist. *J Am Diet Assoc* **101**, 751-761.

Myung, S. K., Ju, W., Cho, B., Oh, S. W., Park, S. M., Koo, B. K., Park, B. J. and Korean Meta-Analysis (KORMA) Study Group (2013) Efficacy of vitamin and antioxidant supplements in prevention of cardiovascular disease: systematic review and meta-analysis of randomised controlled trials. *BMJ* **346**, f10.

Månsson, H. L. (2008) Fatty acids in bovine milk fat. *Food & Nutrition Research* **52**, doi:10.3402/fnr.v52i0.1821.

Männistö, S., Ovaskainen, M., Valsta, L., eds (2003) *FINRAVINTO 2002 -tutkimus. The National Findiet 2002 Study.* Publications of the National Public Health Institute B3/2003. Kansanterveyslaitos (KTL), Hakapaino Oy, Helsinki.

Männistö, S., Laatikainen, T., Helakorpi, S. and Valsta, L. M. (2010) Monitoring diet and diet-related chronic disease risk factors in Finland. *Public Health Nutr* **13**, 907-914.

Männistö, S., Virtanen, M., Mikkonen, T. and Pietinen, P. (1996) Reproducibility and validity of a food frequency questionnaire in a case-control study on breast cancer. *J Clin Epidemiol* **49**, 401-409.

Nelson, M. and Bingham, S. A. (1997) Assessment of food consumption and nutrient intake. In *Design Concepts in Nutritional Epidemiology,* Margetts, B. and Nelson, M. eds, pp. 123. Oxford University Press, New York.

Ness, A. R., Powles, J. W. and Khaw, K. T. (1996) Vitamin C and cardiovascular disease: a systematic review. *J Cardiovasc Risk* **3**, 513-521.

Niedhammer, I., Bugel, I., Bonenfant, S., Goldberg, M. and Leclerc, A. (2000) Validity of self-reported weight and height in the French GAZEL cohort. *Int J Obes Relat Metab Disord* **24**, 1111-1118.

Novaković, R., Cavelaars, A. E., Bekkering, G. E., Roman-Viñas, B., Ngo, J., Gurinović, M., Glibetić, M., Nikolić, M., Golesorkhi, M., Medina, M. W., Satalić, Z., Geelen, A., Serra Majem, L., van't Veer, P., de Groot, L. C. (2013) Micronutrient intake and status in Central and Eastern Europe compared with other European countries, results from the EURRECA network. *Public Health Nutr* **16**, 824-40.

Oakes, M. E. and Slotterback, C. S. (2001) Gender differences in perceptions of the healthiness of foods. *Psychol Health* **16**, 57-65.

Osler, M., Gerdes, L. U., Davidsen, M., Brønnum-Hansen, H., Madsen, M., Jørgensen, T. and Schroll, M. (2000) Socioeconomic status and trends in risk factors for cardiovascular diseases in the Danish MONICA population, 1982-1992. *J Epidemiol Community Health* **54**, 108-113.

Ottelin, A. M., Lindström, J., Peltonen, M., Martikainen, J., Uusitupa, M., Gylling, H., Poutanen, K., Louheranta, A., Mannelin, M., Paturi, M., Salminen, V., Tuomilehto, J. and Finnish Diabetes Prevention Study Group (2007) Costs of a self-selected, health-promoting diet among the participants of the Finnish Diabetes Prevention Study. *Diabetes Care* **30**, 1275-1277.

Ovaskainen, M. L., Paturi, M., Tapanainen, H. and Harald, K. (2010) Educational differences in the diet of Finnish adults and the associations between education and the determinants and

facilitators of dietary fat quality. *Public Health Nutr* **13**, 925-931.

Paalanen, L., Männistö, S., Virtanen, M. J., Knekt, P., Räsänen, L., Montonen, J. and Pietinen, P. (2006) Validity of a food frequency questionnaire varied by age and body mass index. *J Clin Epidemiol* **59**, 994-1001.

Paalanen, L., Prättälä, R., Alfthan, G., Salminen, I. and Laatikainen, T. (2012) Seasonal variation in plasma vitamin C concentration in Pitkäranta, Northwestern Russia. *Eur J Clin Nutr* doi: 10.1038/ejcn.2012.185. [Epub ahead of print].

Paturi, M., Tapanainen, H., Reinivuo, H. and Pietinen, P. (2008) *Finravinto 2007 –tutkimus. The National FINDIET 2007 Survey.* Publications of the National Public Health Institute B23/2008. Kansanterveyslaitos (KTL), Helsinki.

Peltonen, M., Harald, K., Männistö, S., Saarikoski, L., Lund, L., Sundvall, J., Juolevi, A., Laatikainen, T., Aldén-Nieminen, H., Luoto, R., Jousilahti, P., Salomaa, V., Taimi, M. and Vartiainen, E. (2008) *Kansallinen FINRISKI 2007 -terveystutkimus. Tutkimuksen toteutus ja tulokset: Taulukkoliite.* Publications of the National Public Health Institute B35/2008. Kansanterveyslaitos (KTL), Helsinki.

Petkeviciene, J., Klumbiene, J., Prättälä, R., Paalanen, L., Pudule, I. and Kasmel, A. (2007) Educational variations in the consumption of foods containing fat in Finland and the Baltic countries. *Public Health Nutr* **10**, 518-523.

Petkeviciene, J., Klumbiene, J., Ramazauskiene, V., Kriaucioniene, V., Sakyte, E. and Grabauskas, V. (2012) Diet and dyslipidemias in a Lithuanian rural population aged 25-64: the CINDI survey. *Medicina (Kaunas, Lithuania)* **48**, 211-217.

Petrenya, N., Dobrodeeva, L., Brustad, M., Bichkaeva, F., Menshikova, E., Lutfalieva, G., Poletaeva, A., Repina, V., Cooper, M. and Odland, J. O. (2011) Fish consumption and socio-economic factors among residents of Arkhangelsk city and the rural Nenets autonomous area. *Int J Circumpolar Health* **70**, 46-58.

Pietinen, P., Hartman, A. M., Haapa, E., Räsänen, L., Haapakoski, J., Palmgren, J., Albanes, D., Virtamo, J. and Huttunen, J. K. (1988) Reproducibility and validity of dietary assessment instruments. I. A self-administered food use questionnaire with a portion size picture booklet. *Am J Epidemiol* **128**, 655-666.

Pietinen, P., Kleemola, P., Männistö, S., Valsta, L. and Virtanen, M. (1994) Suomalaisten ravinnon muutokset vuodesta 1982 vuoteen 1992. FINRAVINTO-tutkimuksen tulokset. *Suom Lääkäril* **49**, 1712-1721.

Pietinen, P., Männistö, S., Valsta, L. M. and Sarlio-Lähteenkorva, S. (2010a) Nutrition policy in Finland. *Public Health Nutr* **13**, 901-906.

Pietinen, P., Paturi, M., Reinivuo, H., Tapanainen, H., Korhonen, T., Hirvonen, T., Ovaskainen, M., Männistö, S., Vähätalo, L. and Valsta, L. (2008) Finravinto 2007 -tutkimus: Ravintotottumukset ovat kehittyneet enimmäkseen myönteiseen suuntaan. *Suom Lääkäril* **63**, 2595-2599.

Pietinen, P., Paturi, M., Reinivuo, H., Tapanainen, H. and Valsta, L. M. (2010b) FINDIET 2007 Survey: energy and nutrient intakes. *Public Health Nutr* **13**, 920-924.

Pietinen, P., Vartiainen, E., Seppänen, R., Aro, A. and Puska, P. (1996) Changes in diet in Finland from 1972 to 1992: impact on coronary heart disease risk. *Prev Med* **25**, 243-250.

Poledne, R. and Škodová, Z. (2000) Changes in nutrition, cholesterol concentration, and cardiovascular disease mortality in the Czech population in the past decade. *Nutrition* **16**, 785-786.

Pomerleau, J., McKee, M., Robertson, A., Kadziauskiene, K., Abaravicius, A., Vaask, S., Pudule, I. and Grinberga, D. (2001) Macronutrient and food intake in the Baltic republics. *Eur J Clin Nutr* **55**, 200-207.

Poslusna, K., Ruprich, J., de Vries, J. H., Jakubikova, M. and van't Veer, P. (2009) Misreporting of

energy and micronutrient intake estimated by food records and 24 hour recalls, control and adjustment methods in practice. *Br J Nutr* **101 Suppl 2**, S73-85.

Pritchard, J. M., Seechurn, T. and Atkinson, S. A. (2010) A food frequency questionnaire for the assessment of calcium, vitamin D and vitamin K: a pilot validation study. *Nutrients* **2**, 805-819.

Prättälä, R. S., Groth, M. V., Oltersdorf, U. S., Roos, G. M., Sekula, W. and Tuomainen, H. M. (2003) Use of butter and cheese in 10 European countries: a case of contrasting educational differences. *Eur J Public Health* **13**, 124-132.

Prättälä, R., Hakala, S., Roskam, A. J., Roos, E., Helmert, U., Klumbiene, J., Van Oyen, H., Regidor, E. and Kunst, A. E. (2009) Association between educational level and vegetable use in nine European countries. *Public Health Nutr* **12**, 2174-2182.

Prättälä, R., Helakorpi, S., Sipilä, N., Sippola, R. and Sääksjärvi, K. (2011) *Social determinants of health behaviours. Finbalt Health Monitor 1998-2008.* Report 25/2011, National Institute for Health and Welfare (THL), Tampere.

Prättälä, R., Paalanen, L., Grinberga, D., Helasoja, V., Kasmel, A. and Petkeviciene, J. (2007) Gender differences in the consumption of meat, fruit and vegetables are similar in Finland and the Baltic countries. *Eur J Public Health* **17**, 520-525.

Prättälä, R. S. and Puska, P. (2012) Social determinants of health behaviours and social change. *Eur J Public Health* **22**, 166.

Puska, P. (2009) Fat and heart disease: yes we can make a change--the case of North Karelia (Finland). *Ann Nutr Metab* **54 Suppl 1**, 33-38.

Puska, P., Matilainen, T., Jousilahti, P., Korhonen, H., Vartiainen, E., Pokusajeva, S., Moisejeva, N., Uhanov, M., Kallio, I. and Artemjev, A. (1993) Cardiovascular risk factors in the Republic of Karelia, Russia, and in North Karelia, Finland. *Int J Epidemiol* **22**, 1048-1055.

Puska, P., Vartiainen, E., Laatikainen, T., Jousilahti, P. and Paavola, M. (2009) *The North Karelia Project. From North Karelia to National Action,* The National Institute for Health and Welfare (THL), Helsinki.

Pussinen, P. J., Laatikainen, T., Alfthan, G., Asikainen, S. and Jousilahti, P. (2003) Periodontitis is associated with a low concentration of vitamin C in plasma. *Clin Diagn Lab Immunol* **10**, 897-902.

Ramazauskiene, V., Petkeviciene, J., Klumbiene, J., Kriaucioniene, V. and Sakyte, E. (2011) Diet and serum lipids: changes over socio-economic transition period in Lithuanian rural population. *BMC Public Health* **11:** 447. doi: 10.1186/1471-2458-11-447.

Raulio, S., Roos, E. and Prättälä, R. (2010) School and workplace meals promote healthy food habits. *Public Health Nutr* **13**, 987-992.

Rizov M, Herzfeld T and Huffman SK (2012) The Russian food, alcohol and tobacco consumption patterns during transition. *Coll Antropol* **36**, 1143-1154.

Robertson, A. and Lang, T. (1997) *Food, nutrition and health policy in the Russian Federation.* Report on a WHO workshop, WHO regional office for Europe, Copenhagen.

Rogers, S. and Pryer, J. A. (2012) Who consumed 5 or more portions of fruit and vegetables per day in 1986-1987 and in 2000-2001? *Public Health Nutr* **15**, 1240-1247.

Roos, E., Lahelma, E., Virtanen, M., Prättälä, R. and Pietinen, P. (1998) Gender, socioeconomic status and family status as determinants of food behaviour. *Soc Sci Med* **46**, 1519-1529.

Roos, E., Talala, K., Laaksonen, M., Helakorpi, S., Rahkonen, O., Uutela, A. and Prättälä, R. (2008) Trends of socioeconomic differences in daily vegetable consumption, 1979-2002. *Eur J Clin Nutr* **62**, 823-833.

Roos, G., Johansson, L., Kasmel, A., Klumbiene, J. and Prättälä, R. (2001) Disparities in vegetable and fruit consumption: European cases from the north to the south. *Public Health Nutr* **4**, 35-43.

Rosell, M., Håkansson, N. N. and Wolk, A. (2006) Association between dairy food consumption and weight change over 9 y in 19,352 perimenopausal women. *Am J Clin Nutr* **84**, 1481-1488.

Rydén, P. J. and Hagfors, L. (2011) Diet cost, diet quality and socio-economic position: how are they related and what contributes to differences in diet costs? *Public Health Nutr* **14**, 1680-1692.

Rönmark, E. P., Ekerljung, L., Lötvall, J., Torén, K., Rönmark, E. and Lundbäck, B. (2009) Large scale questionnaire survey on respiratory health in Sweden: effects of late- and non-response. *Respir Med* **103**, 1807-1815.

Salminen, I. and Alfthan, G. (2008) Plasma ascorbic acid preparation and storage for epidemiological studies using TCA precipitation. *Clin Biochem* **41**, 723-727.

Samaras, D., Samaras, N., Lang, P. O., Genton, L., Frangos, E. and Pichard, C. (2013) Effects of widely used drugs on micronutrients: A story rarely told. *Nutrition* **29**, 605-610.

Schleicher, R. L., Carroll, M. D., Ford, E. S. and Lacher, D. A. (2009) Serum vitamin C and the prevalence of vitamin C deficiency in the United States: 2003-2004 National Health and Nutrition Examination Survey (NHANES). *Am J Clin Nutr* **90**, 1252-1263.

Scholes, S., Bajekal, M., Love, H., Hawkins, N., Raine, R., O'Flaherty, M. and Capewell, S. (2012) Persistent socioeconomic inequalities in cardiovascular risk factors in England over 1994-2008: a time-trend analysis of repeated cross-sectional data. *BMC Public Health* **12:**129. doi: 10.1186/1471-2458-12-129.

Seiluri, T., Lahelma, E., Rahkonen, O. and Lallukka, T. (2011) Changes in socio-economic differences in food habits over time. *Public Health Nutr* **14**, 1919-1926.

Shaternikov, V. A., Stepanova, E. N. and Geller, G. M. (1981) The level of the water-soluble vitamin intake with foods in the USSR. In *Nutrition in Health and Disease and International Development: Symposia from the XII International Congress of Nutrition,* pp. 159-163. Alan R. Liss, Inc, New York.

Shkolnikov, V., McKee, M. and Leon, D. A. (2001) Changes in life expectancy in Russia in the mid-1990s. *Lancet* **357**, 917-921.

Similä, M., Taskinen, O., Männistö, S., Lahti-Koski, M., Karvonen, M., Laatikainen, T. and Valsta, L. (2005) *Terveyttä edistävä ruokavalio, lihavuus ja seerumin kolesteroli karttoina.* Publications of the National Public Health Institute B20/2005, Kansanterveyslaitos (KTL), Helsinki.

Similä, M., Taskinen, O., Männistö, S., Lahti-Koski, M., Laatikainen, T. and Valsta, L. (2006) Suomalaisten ruoankäyttö ja terveysriskit karttoina. *Suom Lääkäril* **61**, 3825-3832.

Soutar, A. K. and Naoumova, R. P. (2007) Mechanisms of disease: genetic causes of familial hypercholesterolemia. *Nat Clin Pract.Cardiovasc Med* **4**, 214-225.

Statistical Office of Karelia (1991) *Republic of Karelia in figures 1986-1990* [in Russian], Statistical Office of Karelia, Petrozavodsk.

Statistics Finland (2012) Statistical databases. www.tilastokeskus.fi. Accessed 31 May 2012.

Stillman, S. (2006) Health and nutrition in Eastern Europe and the former Soviet Union during the decade of transition: A review of the literature. *Econ Hum Biol* **4**, 104-146.

Stillman, S. and Thomas, D. (2008) Nutritional status during an economic crisis: Evidence from Russia. *The Economic Journal* **118**, 1385-1417.

Sublette, M. E., Segal-Isaacson, C. J., Cooper, T. B., Fekri, S., Vanegas, N., Galfalvy, H. C., Oquendo, M. A. and Mann, J. J. (2011) Validation of a food frequency questionnaire to assess intake of n-3 polyunsaturated fatty acids in subjects with and without major depressive disorder. *J Am Diet Assoc* **111**, 117-123.e1-2.

Sundvall, J., Leiviskä, J., Alfthan, G. and Vartiainen, E. (2007) Serum cholesterol during 27 years: assessment of systematic error and affecting

factors and their role in interpreting population trends. *Clinica chimica acta* **378**, 93-98.

Suomen kuntaliitto (2009) Statistics from Suomen Kuntaliitto. http://hosted.kuntaliitto.fi/skriptit/tilastot/kuntakortti2.asp. Accessed 4 October 2009.

Tolonen, H., Dobson, A., Kulathinal, S. and WHO MONICA Project (2005) Effect on trend estimates of the difference between survey respondents and non-respondents: results from 27 populations in the WHO MONICA Project. *Eur J Epidemiol* **20**, 887-898.

Tolonen, H., Helakorpi, S., Talala, K., Helasoja, V., Martelin, T. and Prättälä, R. (2006) 25-year trends and socio-demographic differences in response rates: Finnish adult health behaviour survey. *Eur J Epidemiol* **21**, 409-415.

Tolonen, H., Kuulasmaa, K., Laatikainen, T., Wolf, H. and and the European Health Risk Monitoring Project (2002b) Recommendations for indicators, international collaboration, protocol and manual of operations for chronic disease risk factor surveys. http://www.ktl.fi/publications/ehrm/product2/title.htm. Accessed 3 April 2013.

Tolonen, H., Wolf, H., Jakovjlevic, D. K.,K and the European Health Risk Monitoring Project (2002a) Review of surveys for risk factors of major chronic diseases and comparability of the results. http://www.thl.fi/publications/ehrm/product1/title.htm. Accessed 3 April 2013.

Turrell, G. and Kavanagh, A. M. (2006) Socio-economic pathways to diet: modelling the association between socio-economic position and food purchasing behaviour. *Public Health Nutr* **9**, 375-383.

Ulijaszek, S. J. and Koziel, S. (2007) Nutrition transition and dietary energy availability in Eastern Europe after the collapse of communism. *Econ Hum Biol* **5**, 359-369.

UNC Carolina Population Center. The Russia Longitudinal Monitoring Survey - Higher School of Economics. http://www.cpc.unc.edu/projects/rlms-hse. Accessed 6 April 2013.

UNICEF (1994) *Crisis in mortality, health and nutrition. Economies in transition studies.* Regional monitoring report, No. 2, UNICEF, Florence, Italy.

Vaask, S., Pomerleau, J., Pudule, I., Grinberga, D., Abaravicius, A., Robertson, A. and McKee, M. (2004) Comparison of the Micro-Nutrica Nutritional Analysis program and the Russian Food Composition Database using data from the Baltic Nutrition Surveys. *Eur J Clin Nutr* **58**, 573-579.

van Kappel, A. L., Steghens, J. P., Zeleniuch-Jacquotte, A., Chajès, V., Toniolo, P. and Riboli, E. (2001) Serum carotenoids as biomarkers of fruit and vegetable consumption in the New York Women's Health Study. *Public Health Nutr* **4**, 829-835.

van Lee, L., Geelen, A., van Huysduynen, E. J., de Vries, J. H., van't Veer, P. and Feskens, E. J. (2012) The Dutch Healthy Diet index (DHD-index): an instrument to measure adherence to the Dutch Guidelines for a Healthy Diet. *Nutr J* **11**, 49-2891-11-49.

Vannoni, F., Spadea, T., Frasca, G., Tumino, R., Demaria, M., Sacerdote, C., Panico, S., Celentano, E., Palli, D., Saieva, C., Pala, V., Sieri, S. and Costa, G. (2003) Association between social class and food consumption in the Italian EPIC population. *Tumori* **89**, 669-678.

Vartiainen, E., Borodulin, K., Sundvall, J., Laatikainen, T., Peltonen, M., Harald, K., Salomaa, V. and Puska, P. (2012b) FINRISKI-tutkimus: Väestön kolesterolitaso on vuosikymmenien laskun jälkeen kääntynyt nousuun. *Suom Lääkäril* **67**:2364-2368.

Vartiainen, E., Helldán, A. and Virtanen, S. (2012a) Kolesterolitaso ja tyydyttyneen rasvan saanti ovat nousussa. Tutkimuksesta tiiviisti 1,

marraskuu 2012. Terveyden ja hyvinvoinnin laitos, Helsinki.

Vartiainen, E., Jousilahti, P., Juolevi, A., Sundvall, J., Alfthan, G., Salminen, I. and Puska, P. (1998) *FINRISKI 1997. Tutkimus kroonisten kansantautien riskitekijöistä, niihin liittyvistä elintavoista, oireista ja terveyspalvelujen käytöstä. Tutkimuksen toteutus ja perustaulukot.* Publications of the National Public Health Institute B1/1998. Paintmedia, Helsinki.

Vartiainen, E., Jousilahti, P., Tamminen, M., Korhonen, H. J., Tuomilehto, J., Sundvall, J., Jauhiainen, M. and Puska, P. (1993) *FINRISKI '92: Tutkimus kansanterveydellisistä riskitekijöistä, niihin liittyvistä elintavoista, oireista ja terveyspalvelujen käytöstä. Tutkimuksen toteutus ja perustaulukot.* Publications of the National Public Health Institute B9/1993. Kansanterveyslaitos (KTL), Helsinki.

Vartiainen, E., Laatikainen, T., Peltonen, M., Juolevi, A., Männistö, S., Sundvall, J., Jousilahti, P., Salomaa, V., Valsta, L. and Puska, P. (2010) Thirty-five-year trends in cardiovascular risk factors in Finland. *Int J Epidemiol* **39**, 504-518.

Vartiainen, E., Laatikainen, T., Tapanainen, H., Salomaa, V., Jousilahti, P., Sundvall, J., Salminen, M., Männistö, S. and Valsta, L. (2003) Suomalaisten sydän- ja verisuonitautien riskitekijät FINRISKI-tutkimuksessa 1982-2002. *Suom Lääkäril* **58**, 4099-4106.

Vavricka, S. R. and Rogler, G. (2012) Intestinal absorption and vitamin levels: is a new focus needed? *Dig Dis* **30**, 73-80.

Vlasoff, T., Laatikainen, T., Korpelainen, V., Uhanov, M., Pokusajeva, S., Rogacheva, A., Tossavainen, K., Vartiainen, E. and Puska, P. (2008) Ten year trends in chronic disease risk factors in the Republic of Karelia, Russia. *Eur J Public Health* **18**, 666-673.

Wannamethee, S. G., Lowe, G. D., Rumley, A., Bruckdorfer, K. R. and Whincup, P. H. (2006) Associations of vitamin C status, fruit and vegetable intakes, and markers of inflammation and hemostasis. *Am J Clin Nutr* **83**, 567-74; quiz 726-7.

Wardle, J., Haase, A. M., Steptoe, A., Nillapun, M., Jonwutiwes, K. and Bellisle, F. (2004) Gender differences in food choice: the contribution of health beliefs and dieting. *Ann Behav Med* **27**, 107-116.

WHO MONICA Project Principal Investigators. (1988) The World Health Organization MONICA Project (monitoring trends and determinants in cardiovascular disease): a major international collaboration. WHO MONICA Project Principal Investigators. *J Clin Epidemiol* **41**, 105-114.

Willett, W. (1998) *Nutritional epidemiology,* Oxford University Press, New York.

Wolf, H. K., Kuulasmaa, K., Tolonen, H., Sans, S., Molarius, A., Eastwood, B. J. and WHO MONICA Project (2005) Effect of sampling frames on response rates in the WHO MONICA risk factor surveys. *Eur J Epidemiol* **20**, 293-299.

Wolk, A., Furuheim, M. and Vessby, B. (2001) Fatty acid composition of adipose tissue and serum lipids are valid biological markers of dairy fat intake in men. *J Nutr* **131**, 828-833.

World Medical Association (1996) Declaration of Helsinki, 4th (Somerset West) amendment.

Wrieden, W. L., Connaghan, J., Morrison, C. and Tunstall-Pedoe, H. (2004) Secular and socio-economic trends in compliance with dietary targets in the north Glasgow MONICA population surveys 1986-1995: did social gradients widen? *Public Health Nutr* **7**, 835-842.

Wrieden, W. L., Hannah, M. K., Bolton-Smith, C., Tavendale, R., Morrison, C. and Tunstall-Pedoe, H. (2000) Plasma vitamin C and food choice in the third Glasgow MONICA population survey. *J Epidemiol Community Health* **54**, 355-360.

Yarnell, J., Yu, S., McCrum, E., Arveiler, D., Hass, B., Dallongeville, J., Montaye, M., Amouyel, P., Ferrières, J., Ruidavets, J. B., Evans, A., Bingham, A., Ducimetière, P. and PRIME study group (2005) Education, socioeconomic and

lifestyle factors, and risk of coronary heart disease: the PRIME Study. *Int J Epidemiol* **34**, 268-275.

Zatonski, W. A., McMichael, A. J. and Powles, J. W. (1998) Ecological study of reasons for sharp decline in mortality from ischaemic heart disease in Poland since 1991. *BMJ* **316**, 1047-1051.

Zatonski, W. A. and Willett, W. (2005) Changes in dietary fat and declining coronary heart disease in Poland: population based study. *BMJ* **331**, 187-188.

Zazpe, I., Bes-Rastrollo, M., Ruiz-Canela, M., Sánchez-Villegas, A., Serrano-Martínez, M. and Martínez-González, M. A. (2011) A brief assessment of eating habits and weight gain in a Mediterranean cohort. *Br J Nutr* **105**, 765-775.

Zhivotovskiy, A. S., Kutikhin, A. G., Azanov, A. Z., Yuzhalin, A. E., Magarill, Y. A. and Brusina, E. B. (2012) Colorectal cancer risk factors among the population of South-East Siberia: a case-control study. *Asian Pac J Cancer Prev* **13**, 5183-5188.