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ORIGINAL ARTICLE

Self-reported health in urban–rural continuum: a grid-based analysis of Northern Finland Birth Cohort 1966

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Abstract
Objectives To evaluate the association of self-reported health with residential area type defined by the population density in individual's local environment using a population-based cohort in Finland.
Methods Young adults of the Northern Finland Birth Cohort 1966 (4,201 women and 3,835 men), surveyed by a postal questionnaire in 1997, were linked to population density of their resident grid (1 km^2) depicting different types of residential areas. Self-reported health was regressed on residential area type using ordinal logistic analysis, adjusting for psychosocial well-being, social relationships, health behaviour, education and residence time.
Results Cumulative odds ratios (COR) for poor health were lowest in high-rise centres, highest in scattered settlement areas and second highest in transitional zones. Adjustments (especially for education and time of residence) reduced the CORs to insignificance except the persistently high COR for women in scattered settlement areas.
Conclusion Poor self-reported health is associated with individual's residential area type, with the lowest occurrence in high-rise centres and higher elsewhere. The difference is likely explained, at least partly, by a complex of psychosocial factors, possibly different for women and men.

Keywords Medical geography · Subjective health · Ordinal regression · Urban–rural · Gender differences · GIS

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Introduction

Aspects of the physical, social and cultural environment can affect peoples' health and contribute to area variations in health. Such aspects include physical features of the environment, the healthy/unhealthy environments at home, at work and during leisure time, services to support people in their daily lives, socio-cultural features and the reputation of their neighbourhood (Macintyre et al. 1993). In England and Scotland, fair to very bad self-reported health has been found to be significantly associated with neighbourhood attributes such as poor physical quality residential environment, left-wing political climate, low political engagement, high unemployment, lower access to private transport and low number of high-cost cars (Cummins et al. 2005). In Finland, dissatisfaction with socio-physical living environment has been associated with poor self-reported health and limiting long-term illness (Karvonen and Rintala 2006). Many

studies have associated neighbourhood deprivation with mortality and morbidity (Pickett and Pearl 2001).

Also, rural and urban residential environments may have different implications regarding health. Health disadvantages related to a rural environment can be, e.g. lack of employment opportunities, limited access to facilities and social isolation, and health advantages can include, e.g. lower industrial pollution, better access to green spaces, rural idyll and tranquillity (Curtis and Rees Jones 1998). While rurality does not always mean poorer health, it may aggravate the effects of socio-economic disadvantage, poorer health service availability and more difficult occupational and transportation conditions (Smith et al. 2008). Health differences between places can be due to compositional effects such as population characteristics, or to contextual area-related characteristics, or both (Cummins et al. 2007; Macintyre et al. 2002).

There are distinct regional differences in well-being and in health in Finland. Northern Finland stands out as a deprived area health-wise (Karvonen and Rintala 2006; Näyhä and Järvelin 1998). One characteristic of northern Finland is the sparser and more scattered settlement pattern compared with southern Finland. Sparsely populated areas, particularly in northern and eastern Finland have experienced population loss since the 1970s (Gløersen et al. 2005; Rusanen et al. 2003). Differences in health and well-being exist in Finland between rural and urban areas, too. Age-adjusted mortality tends to be higher and poor self-reported health and long-term illness more common in rural areas than in towns (Karvonen and Kauppinen 2008; Karvonen and Rintala 2006; Näyhä and Hassi 1999). Most previous studies conducted for small areas in Finland have been based on administrative areas such as municipalities. However, both rural and urban municipalities contain residential areas with widely different degrees of urbanisation.

The present study examines self-reported health of young adults, members of the Northern Finland Birth Cohort (NFBC) of 1966, in relation to the rural–urban continuum. The NFBC of 1966 is a follow-up study of people who were born in the two northernmost provinces (Oulu and Lapland) of Finland in 1966. Instead of local government areas used previously, we use 1 km^2 grids to define area types based on population density. This allows us to go beyond conventional administrative divisions and conduct the rural–urban grading so that it closer reflects the actual local circumstances in sparsely populated peripheral areas, too.

Study population

The NFBC originally consists of all 12,058 live births in 1966 in the two northernmost provinces of Finland (Lapland and Oulu). The cohort has been followed up since birth, the latest survey having been done in 1997 when the subjects were 31 years of age. In addition, data from various national registers has been collected (NFBC website 2010; Rantakallio 1988; Sorri and Järvelin 1998).

The study population in present study consisted of those members of the NFBC 1966, who were alive and still living in Finland in 1997, had answered the postal questionnaire and for whom the coordinate data of the place of residence in 1997 were available. In 1997, 11,637 cohort members were still alive, 10,685 lived in Finland and 856 abroad, and for 96 the postal address remained unknown. The postal questionnaire was sent to all 11,541 cohort members whose address was known, and 8,767 (76%) returned it. The cohort members who lived in Finland received their questionnaire in Finnish. A Swedish questionnaire was sent to those living in Sweden and those who requested it. Seventy-five subjects declined the use of their data and were excluded.

Out of the remaining 8,692 subjects, the coordinate data were available for 8,217 subjects. Based on coordinates of the subjects' places of residence in 1997 and residential area (in 1 km × 1 km grids), each cohort member was linked with the population density data of his/her resident grid using ArcGIS. 181 people could not be linked due to errors in the datasets; this left 8,036 subjects (4,201 women and 3,835 men) in the final study population. The study area covers the entire country, though 68% of the subjects were still living in the two northernmost provinces of Finland. The study was reviewed by the Ethical Committee of the Northern Ostrobothnia Hospital District. Permission for record linkages was given by the Finnish Ministry of Social Affairs and Health.

Variables used in the analysis

Outcome

A respondent's own assessment of his/her health was used as an outcome variable. Each subject was asked "What is your own estimate of your health right now?" response alternatives being very good, good, moderate, bad and very bad. The two last categories 'bad' and 'very bad' were combined in the analysis, because the numbers were small. The distribution of this variable is shown in Table 1.

Self-reported health predicts morbidity and is an independent predictor of mortality (Kaplan et al. 1996; Manor et al. 2001; Idler and Benyamini 1997). Self-reported health is a multidimensional concept. Aspects that people consider when assessing their health include physical aspects (e.g. mental and somatic illnesses, medical

Table 1 Demographic characteristics and residential environment of women and men surveyed in the Northern Finland Birth Cohort 1966 follow-up study in 1997

Characteristics	Women		Men	
	%	N	%	N
Self-reported health				
Very good	14.2	594	15.8	603
Good	54.4	2,270	52.3	1,993
Moderate	28.4	1,184	28.8	1,099
Bad	2.8	116	2.7	101
Very bad	0.2	10	0.4	15
Feeling lonely				
Yes	29.7	1,238	25.3	963
No	70.3	2,934	74.7	2,838
Social relationships				
Marital status				
Divorced/widowed	5.2	217	3.6	138
Single	18.2	758	27.6	1,049
Cohabiting	23.9	994	24.9	949
Married	52.7	2,195	43.9	1,671
Social support				
Little	31.4	1,231	37.8	1,364
Some	34.4	1,350	34.3	1,239
A lot	34.1	1,338	27.9	1,006
Physical activity				
Inactive	24.4	1,020	30.2	1,150
Moderately active	35.1	1,464	27.7	1,057
Very active/Active	40.5	1,692	42.1	1,604
Education				
Basic (<10 years)	8.0	334	12.4	473
Secondary (10–12 years)	62.9	2,642	60.9	2,329
Tertiary (>12 years)	29.1	1,222	26.8	1,025
Residential area type				
Scattered settlement (1–5 inh/km^2)	2.0	86	3.1	120
Rural areas proper (6–20 inh/km^2)	7.6	320	8.2	314
Transition zone (21–100 inh/km^2)	12.6	531	12.5	481
Built-up areas and suburbs (101–1,000 inh/km^2)	34.5	1,451	33.9	1,301
High-rise centres and big suburbs (over 1,000 inh/km^2)	43.2	1,813	42.2	1,619
Time of residence in same residential area before 1997				
≥5 years	33.3	1,400	31.2	1,196
<5 years	66.7	2,801	68.8	2,639

treatment), functional ability, a generally good or fit feeling, adaptation and attitude towards an illness, and to some extent, also health behaviour and lifestyle, psychosocial and socioeconomic status and social environment (Kaplan and Baron-Epel 2003; Shooshtari et al. 2007; Simon et al. 2005).

Explanatory factor

The type of a person's local residential area, defined in terms of population density in his/her resident grid, was used as the explanatory factor. Geo-referenced 1 km × 1 km grid data of population density is provided by Statistics Finland (Statistics Finland 2007). The data covers the entire country and has been produced annually since 1987. In this study, the 1 km × 1 km grids were classified into five groups based on population density in each grid as defined by Rusanen et al. (2003). These residential environment groups are characterised in Table 2. According to Rusanen et al. (2001) the urbanisation processes, including elements such as the growing population density and the concentration of the population, are evident in cells comprising over 100 inhabitants per km^2, and processes of decline such as depopulation, ageing of the population and loss of jobs in agriculture, are typical of grids having <100 people per km^2.

Confounding factors

Feeling of loneliness, i.e. one item in the widely used Hopkins Symptom Checklist-25 (HSCL-25) (Derogatis et al. 1974), was selected as an indicator of psychosocial well-being. The respondent was asked to indicate how much he/she had suffered from a problem or complaint (here: loneliness) during the last week, the response alternatives being: not at all, a little, quite a lot and very much. In the analysis, the responses were dichotomised as 'no' ("not at all") and 'yes' (other alternatives).

A subject's marital status and own estimate of received emotional support and practical help were considered as portraying his/her social relationships. Each respondent was asked "If you had long-term stressful problems with interpersonal relations, mental health or work, how much mental support would you get through listening or advice from: your spouse or partner/a close friend or relative/a colleague/your boss/occupational health service/employment office?" To measure practical help, the respondents were asked "If you were in a difficult situation that you could not cope with on your own (e.g. arranging child care, lack of money, insurmountable problem at work), how much practical help would you get from: your spouse or partner/a close friend or relative/a neighbour/a colleague/your boss/occupational health service/employment office?" The response alternatives to each item were: a lot, quite a lot, some, a little and not at all/I don't want help. The answers were given scores 5 ("a lot") to 1 ("not at all/I don't want help"). The emotional support and practical help were made a composite variable 'social support' by adding the answers (numbers) of individual items from both question together and dividing the sum score into

Table 2 Spatial demographic structure of the Finnish population defined by population density in 1 km^2 grids (Rusanen et al. 2003), and the distribution of the entire Finnish population and the Northern Finland Birth Cohort 1966 (NFBC 1966) population by residential area type in 1997

Population density (inhabitants/km^2)	Residential area type	Finland, 1997		NFBC 1966 in 1997	
		No. of grids	Population (%)	No. of grids with cohort members	No. of cohort members (%)
1–5	Scattered settlement	43,614	123,454 (2.4%)	196	206 (2.6%)
6–20	Rural areas proper	38,552	415,241 (8.2%)	584	634 (7.9%)
21–100	Rural areas with built-up features, transition zone	15,264	611,570 (12.0%)	790	1,012 (12.6%)
101–1,000	Built-up areas and suburbs with private housing	4,486	1,552,312 (30.6%)	1,068	2,752 (34.3%)
Over 1,000	High-rise centres and suburbs of major cities	1,116	2,373,844 (46.8%)	724	3,432 (42.7%)
Total		103,032	5,076,421 (100%)	3,362	8,036 (100%)

three categories, tertiles of social support: 'little', 'some' and 'a lot'.

Physical activity was surveyed by asking the questions "How often do you participate in physical activity/exercise during your leisure-time?" and "How long do you participate in physical activity/exercise at a time?" Three categories 'very active/active', 'moderately active' and 'inactive' were formed as described elsewhere (Tammelin et al. 2003).

Education was classified into the following categories: basic (<10 years), secondary (10–12 years) and tertiary (>12 years) education (Isohanni 2000).

Time of residence prior to 1997 was calculated from each subject's migration data and classified into two categories: those who had resided in the same grid for '5 years or longer' and '<5 years'.

Data analysis

One- and two-way distributions were shown for the outcome and explanatory variables and suspected confounding factors. The association of self-reported health (outcome) and residential area type (explanatory factor) was examined by logistic regression. Since the outcome was measured in ordered classes $i = 1$–4 (1: very good, 2: good, 3: moderate, 4: bad/very bad), ordinal logistic regression was used to provide cumulative odds ratios (COR), together with their 95% confidence intervals (CI). The COR expresses the ratio of odds for having a health status equal to or worse than category i, compared with all categories better than i. This method combines information from all ordered categories under the assumption that the ORs over all pairs of categories $\geq i$ versus $<i$ are similar (proportionality assumption). To adjust for potential confounding, feeling of loneliness, social relationships (derived from social support and marital status), physical activity, education and time of residence were entered into the model in succession, since all of these could be associated both with self-reported health and place of residence. The proportionality assumption was checked by a Chi-square test each time a variable was entered, using a 5% significance level. The analyses were done using SPSS Statistics 17.0 software. Men and women were analysed separately.

Results

Characteristics of the population studied

Most of the cohort members considered their health as good or very good (68%), 28% as moderate and 3% as bad or very bad (Table 1). Women reported feelings of loneliness more often than men and were more often married and reported receiving social support more than men. Men were more often physically inactive in their leisure time than women. Women were slightly better educated than men. Men and women were similarly distributed to different types of residential areas, and approximately one-third of men and women had spent at least 5 years in the same 1 km^2 grid where they lived in 1997.

Crude associations of health and potential confounders with the type of residential environment

Very good and good self-reported health was most common in high-rise centres and built-up areas among both genders (Table 3). However, some indicators of well-being showed adverse trends in these densely inhabited areas. Thus, women reported more feelings of loneliness in densely inhabited than in sparsely inhabited areas and fewer women were married in high-rise centres and big suburbs than in other areas.

On the other hand, people were less educated in sparsely populated areas than in densely populated areas. Men

Table 3 Distribution of the Northern Finland Birth Cohort 1966 (NFBC 1966) study population according to demographic and individual characteristics and residential area type based on population density in Finland in 1997

	Women (%)					Men (%)				
	Population density (inhabitants/km^2)					Population density (inhabitants/km^2)				
	1–5	6–20	21–100	101–1,000	Over 1,000	1–5	6–20	21–100	101–1,000	Over 1,000
Self-reported health										
Very good	8.2	11.9	11.6	13.1	16.6	13.3	15.4	11.5	14.9	18.3
Good	54.1	53.3	52.2	56.0	53.9	45.0	49.5	51.3	53.1	53.0
Moderate	35.3	32.3	32.4	27.8	26.6	37.5	32.9	34.9	28.8	25.7
Bad/very bad	2.4	2.5	3.8	3.1	2.9	4.2	3.2	2.3	3.3	3.0
Psychosocial well-being										
Feeling lonely										
Yes	25.6	24.8	26.8	30.3	31.1	37.5	28.3	23.6	21.6	27.3
No	74.4	75.2	73.2	69.7	68.9	62.5	71.7	76.4	78.4	72.7
Social relationships										
Marital status										
Divorced/widowed	3.5	0.9	1.7	6.1	6.3	1.7	1.9	2.3	3.0	5.0
Single	11.8	6.3	9.3	14.4	26.3	50.8	39.1	27.8	22.0	27.9
Cohabiting	18.8	19.2	23.9	24.6	24.4	23.3	19.9	22.4	24.6	27.0
Married	65.9	73.5	65.2	54.9	43.0	24.2	39.1	47.5	50.3	40.1
Social support										
Little	33.3	35.0	34.7	31.2	30.0	50.5	42.9	39.0	36.5	36.6
Some	24.4	30.6	31.7	33.7	36.9	28.8	27.6	34.2	33.7	36.6
A lot	42.3	34.4	33.6	35.1	33.1	20.7	29.6	26.8	29.8	26.8
Health behaviour										
Physical activity										
Inactive	24.4	30.1	30.4	22.2	23.5	34.2	36.1	41.5	30.9	24.7
Moderately active	34.9	32.6	34.8	35.0	35.6	31.7	27.2	25.1	27.6	28.5
Very active/active	40.7	37.3	34.8	42.8	40.9	34.2	36.7	33.4	41.5	46.8
Education										
Basic (<10 years)	14.0	9.4	8.9	8.2	7.0	15.0	18.2	15.4	14.0	8.8
Secondary (10–12 years)	64.0	72.1	70.2	64.8	57.6	72.5	68.2	71.5	59.7	56.3
Tertiary (>12 years)	22.1	18.5	20.9	27.0	35.4	12.5	13.7	13.1	26.3	34.9
Time of residence before 1997										
≥5 years	54.7	55.6	45.8	30.9	26.6	54.2	56.4	49.3	28.1	21.7
<5 years	45.3	44.4	54.2	69.1	73.4	45.8	43.6	50.7	71.9	78.3

Residential area type: 1–5 inh/km^2 (Scattered settlement), 6–20 inh/km^2 (Rural areas proper), 21–100 (Transition zone), 101–1000 inh/km^2 (Built-up areas and suburbs), over 1,000 inh/km^2 (high-rise centres and big suburbs)

Population density refers to the geographical grid of 1 km × 1 km in which each NFBC 1966 member resided in 1997

reported feelings of loneliness especially in the areas of scattered settlement. In areas of scattered settlement and rural areas proper there were fewer men who were in a relationship, and men in these areas reported receiving the least social support. The highest percentage of physically inactive men and women was seen in the transitional zone.

A higher percentage of cohort members had resided at least 5 years in the same residential area in sparsely populated than in densely populated areas.

Logistic regressions

The crude regressions showed an overall increase of CORs for poor health from high-rise centres to scattered settlement areas both in women and men (Table 4), although in both genders, an elevated COR was also seen in the transitional zone. In women, adding feeling of loneliness, social relationships and physical activity to the model increased the CORs in most areas. When education and

Table 4 Ordinal logistic regression of self-reported health (very good, good, moderate, bad/very bad) on residential area type, adjusted for feeling of loneliness, social relationships (marital status and social support), physical activity, education and time of residence

Residential area type	Crude COR (CI)	Adjusted COR (CI)				
		+ Feeling of loneliness	+ Marital status, social support	+ Physical activity	+ Education	+ Time of residence
Women						
Scattered settlement (1–5 inh/km^2)	1.55 (1.03–2.35)	1.61 (1.06–2.44)	1.79 (1.15–2.79)	1.89 (1.21–2.95)	1.70 (1.08–2.67)	1.63 (1.04–2.57)
Rural areas proper (6–20 inh/km^2)	1.32 (1.05–1.65)	1.39 (1.10–1.74)	1.35 (1.06–1.73)	1.30 (1.01–1.66)	1.17 (0.92–1.51)	1.11 (0.86–1.43)
Transition zone (21–100 inh/km^2)	1.41 (1.17–1.69)	1.45 (1.20–1.75)	1.42 (1.16–1.73)	1.34 (1.09–1.64)	1.23 (1.00–1.51)	1.17 (0.96–1.45)
Built-up areas with suburbs (101–1,000 inh/km^2)	1.14 (1.00–1.30)	1.15 (1.01–1.32)	1.16 (1.01–1.34)	1.22 (1.06–1.40)	1.16 (1.00–1.34)	1.15 (1.00–1.33)
High-rise centres and big suburbs (over 1,000 inh/km^2)	1.00	1.00	1.00	1.00	1.00	1.00
Men						
Scattered settlement (1–5 inh/km^2)	1.70 (1.19–2.41)	1.57 (1.10–2.24)	1.37 (0.94–1.98)	1.19 (0.82–1.74)	1.03 (0.70–1.50)	1.01 (0.69–1.48)
Rural areas proper (6–20 inh/km^2)	1.38 (1.10–1.74)	1.39 (1.10–1.75)	1.27 (1.00–1.62)	1.10 (0.86–1.40)	0.93 (0.72–1.19)	0.91 (0.71–1.17)
Transition zone (21–100 inh/km^2)	1.51 (1.24–1.83)	1.57 (1.29–1.91)	1.60 (1.30–1.96)	1.36 (1.10–1.67)	1.16 (0.94–1.43)	1.14 (0.92–1.42)
Built-up areas with suburbs (101–1,000 inh/km^2)	1.21 (1.05–1.39)	1.27 (1.11–1.47)	1.29 (1.11–1.49)	1.22 (1.05–1.41)	1.12 (0.96–1.30)	1.12 (0.96–1.30)
High-rise centres and big suburbs (over 1,000 inh/km^2)	1.00	1.00	1.00	1.00	1.00	1.00

The data comes from the Northern Finland Birth Cohort 1966 follow-up survey conducted in 1997. The figures are cumulative odds ratios (COR) and their 95% confidence intervals (CI)

time of residence were also adjusted for, the pattern among women remained largely similar, though the CORs in all areas became smaller and were distinctly elevated only in areas of scattered settlement. Thus after all adjustments, women's health remained relatively poor especially in scattered settlements and marginally so also in built-up areas.

In men, the CORs for poor health similarly increased from densely inhabited to sparsely inhabited areas, with some additional increase in the transitional zone. An adjustment for feeling of loneliness did not change the CORs very much. However, further adjustments for social relationships and health behaviour significantly reduced the CORs for rural areas proper and scattered areas, and further adjustments for education reduced the CORs for all remaining areas. After all adjustments, there were no distinct differences in men's self-reported health between area types.

Discussion

Summary of findings

At the time of the postal questionnaire, the cohort members were at the age of 31 years and quite healthy. The CORs revealed distinct geographical trends usually pointing to much poorer health in the countryside and transitional zones than in high-rise urban centres. In men, the trend was largely explained by psychosocial, social and behavioural factors while in women, the reasons underlying the geographical trend remained more unclear.

Variation of self-reported health by residential area type

The crude CORs of men and women showed relatively poor health in scattered settlement areas. These are very sparsely populated areas where social contacts and coverage of everyday services are likely to be limited or even absent. The services provided and socio-cultural features of a neighbourhood may be the factors underlying subjective health at the local level (Macintyre et al. 1993, 2002). The lack of access to facilities and social isolation may have a negative influence on health in rural areas (Curtis and Rees Jones 1998). Loneliness has been found to be associated with a variety of health conditions (e.g. Heinrich and Gullone 2006).

In men, the crude association of health and living in rural areas reduced to non-significance when adjusted for feeling of loneliness and social relationships, and the associations with all other area types vanished when further adjusted for physical activity, education and the time

spent in the area. We, therefore, assume that men's adverse health in areas of scattered settlement and rural areas proper is attributable to the social and lifestyle factors mentioned above, while in transitional and built-up areas, men's poor health is more related to educational level. The finding was different for women, since their poor health in scattered settlements was actually emphasised when adjusted for social and health behaviour factors, and their health remained relatively poor after all adjustments. This suggests that some beneficial factors such as high proportion of married women, availability of social support and healthy lifestyle in scattered settlement areas keep the crude CORs among women slightly lower compared with the final adjusted figures. The persistency of women's health pattern after all adjustments points to unidentified factors which presumably underlie the geographical variation of women's health.

The residential environment itself may be more important to women's health, and individual economic activity to men's health (Kavanagh et al. 2006; Stafford et al. 2005). The local aspects of the socio-political environment (low integration into wider society, low trust, low political engagement, left-wing political climate), amenities (mediocre access to banks, low number of health services, low quality of the physical environment) and economic characteristics (low access to private transport, high unemployment) have been found to be more consistently associated with women's self-reported health than that of men (Stafford et al. 2005). Although we had no relevant contextual data available in our study, many of these characteristics probably describe the environmental conditions in the most sparsely populated areas and could explain the different associations of health and residential environment in men and women.

While poor health usually increased consistently with decreasing population density in both genders, the transitional zone formed an exception since the CORs were relatively high. The finding is not easily explained but we suggest that a confrontation of rural and urban ways of life in transitional grids may expose people to health hazards.

Comparison with previous studies

In Finland, people in the sparsely populated rural municipalities have poorer self-reported health than people in urban municipalities (Karvonen and Kauppinen 2008; Karvonen and Rintala 2006). Ek et al. (2008), based on the NFBC 1966 data, found that there was more poor self-reported health and dissatisfaction with life in rural than urban municipalities. The association was, however, derived mostly from unemployment, poorer education, lack of social support, passive coping strategies and greater pessimism of people living in rural areas. Our study, based on 1 km^2 grids, explains the poor health in rural areas in a slightly different way. Men's poorer health in areas of scattered settlement and rural areas proper was attributed to inadequate social relationships, adverse health behaviour and low educational level. In women the likely explanatory factors were low educational level and time of residence in the grid, although these failed to explain women's poorer health in scattered settlements.

Social and lifestyle factors in various types of areas

Physical inactivity is associated with poor self-reported health (Manderbacka et al. 1999; Molarius et al. 2006). In rural and semirural areas the lifestyle might be less active, since opportunities for integrating physical activity to leisure time or daily activities can be scarce (Eberhardt and Pamuk 2004; Riva et al. 2009).

Education is an important determinant in self-reported health, and educated people are usually healthier than less-educated ones (Blane 2003; Ross and Wu 1995). Areas of scattered settlement, rural areas proper and rural–urban transition zones are the areas that have experienced population loss since 1970, whereas the two most densely inhabited residential area types have gained population (Rusanen et al. 2003). Most higher education facilities are located in densely inhabited areas. Thus, selective migration of the highly educated people could partly explain why cohort members in sparsely populated areas tend to have poorer self-reported health than those in densely populated areas. In northern Finland, young women in rural areas are more willing to move in order to have better education and job possibilities than young men (Muilu and Rusanen 2003).

Strengths and limitations

The cross-sectional study design prevents us from claiming causality of the observed associations. Since population density was the only context-related variable we had, we may not have had information on all relevant confounding factors.

The health and well-being variables were based on subjective assessments which may cause some variability in answers. Some Finnish studies have addressed the validity of self-reported health (e.g. Kaplan et al. 1996; Miilunpalo et al. 1997), and according to them, self-reported health is a reasonably valid measure for health which predicts mortality and myocardial infarction, even though it is also affected by subjective influences. Self-reported health reflects underlying disease burden (e.g. cardiovascular disease risk factors and disease indicators, diabetes and cancer), future mortality and health service use (Kaplan et al. 1996; Miilunpalo et al. 1997). According to Manor et al. (2001) self-reported health is a valid measure for

health both in young and old age groups. We were unable to assess the validity of self-reports in our study, but based on other Finnish studies, reasonable validity can be assumed.

The main strength of our study is the opportunity to use 1 km^2 grids, which allowed us to investigate the association of residential area and health at a much higher resolution than the commonly used administrative areas. In Finland where the inhabited and uninhabited areas mix even within small municipalities, the grid data more likely depict the actual circumstances in an individual's environment (Rusanen et al. 2001). Still, characteristics of the surrounding areas can also modify the effects of local areas (Cummins et al. 2007). Thus, the complexity of the rural residential areas is effectively unveiled by the grid data. This was exemplified here by rural women's poor health only in the most scattered settlements, while in rural areas proper, women's health was just average.

While grid-based data can identify geographical health patterns more effectively than data based on administrative divisions, any local health interventions are best accomplished by local or regional health authorities, which have the necessary infrastructure and resources. The present study actually shows that marked clusters of poor health may exist within local government areas which may need customised interventions. Clusters of poor health needing special interventions have been previously reported in Finnish towns (e.g. Rytkönen et al. 2001).

Conclusion

The occurrence of poor self-reported health increases with decreasing population density, with the exception of transitional zones where people's health is relatively poor. Poor health among men in scattered settlement areas is attributable to adverse social and lifestyle factors while in women, these factors play a lesser role. The reasons for poorer health among women in the most sparsely populated areas remains unknown, though the literature suggests that women's residential environment itself may affect their health, while in men, factors related to economic activity are more important.

Conflict of interest The authors declare that they have no conflicts of interest.

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