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Cumulative social disadvantage and hospitalisations due to ambulatory care sensitive conditions in Finland in 2011–2013: a register study

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Abstract

Objectives To study the interplay between several indicators of social disadvantage and hospitalisations due to ambulatory care sensitive conditions (ACSC) in 2011–2013. To evaluate whether the accumulation of preceding social disadvantage in one point of time or prolongation of social disadvantage had an effect on hospitalisations due to ACSCs. Four common indicators of disadvantage are examined: living alone, low level of education, poverty, and unemployment.

Design A population-based register study

Setting Nationwide individual-level register data on hospitalisations due to ACSCs for the years 2011–2013 and data on social and socioeconomic factors for the years 2006–2010

Participants Finnish residents aged 45 or older in 2011–2013

Outcome measure Hospitalisations due to ACSCs. The effect of accumulation of disadvantage in one point of time and its prolongation on ACSCs was studied using logistic regression.

Results People with preceding cumulative social disadvantage were more likely to be hospitalised due to ACSCs. The most hazardous combination was simultaneously living alone, low level of education, and poverty among the middle-aged (aged 45-64) and the elderly (over 64). Odds ratios (OR) of being hospitalized due to ACSC were 3.41 (95% confidence interval 3.26-3.56) among middle-aged men and 3.77 (3.57-3.97) among middle-aged women compared with individuals without any of these risk factors when controlling for age and residential area. For the elderly, the OR was 1.81 (1.75-1.87) among men and 1.82 (1.76-1.88) among women.

Conclusions To improve social equity in health care, it is important to recognise not only patients with cumulative disadvantage, but – as this study shows – patients with particular combinations of disadvantage who may be more susceptible. The identification of these vulnerable patients groups is also necessary to reduce the use of more expensive treatment in specialised health care.

Keywords: Socioeconomic disadvantage, social disadvantage, ambulatory care sensitive conditions, inequities, health care, register data

Strengths and limitations of this study

- The individual-level register-based data allowed us to study simultaneously several indicators of social and socioeconomic disadvantage
- The nationwide register data covered all hospitalisations due to ambulatory care sensitive conditions (ACSCs) in Finland
- We were able to study social disadvantage of period preceding hospitalisations and its effect on being hospitalised due to ACSCs
- Hospitalisations due to ACSCs is an indirect indicator of the effectiveness and quality of primary health care
- While the study addressed associations between social disadvantage and hospitalisations due to ACSCs, the causality between morbidity and social disadvantage could not be studied

Background

Inadequate access to health care is one of the important determinants of social inequities in health.[1] Well organised primary care has repeatedly been shown to promote population health and prevent ill-health. There is also evidence that primary care (in contrast to specialist care) is associated with a more equitable distribution of health in populations through prevention and early management of health problems and through facilitating entry to the rest of the health care system.[2] The Finnish health-care system provides a good case for examining equity as the system operates on the principle of universality and therefore, in general, supports equal access to health services according to need.[3] Simultaneously, studies from both Finland and some other countries with universal health care systems show systematic and persistent socioeconomic inequities in physician utilisation in relation to need.[2-5] Challenges in providing timely access to primary care are encountered in some areas[6] and there are indications of differences in primary health care quality between regions.[7] However, Finland has – compared to most other European countries – a strong publicly funded primary health care.[8]

Hospitalisations due to ambulatory care sensitive conditions (ACSC) are used to indirectly evaluate the effectiveness and quality of primary care.[9, 10] They are defined as hospitalisations that could be prevented by primary care interventions. Earlier studies have used slightly different lists of conditions, but have usually examined three types of conditions: conditions that can be prevented by vaccination, acute conditions in which hospitalisation can be prevented by adequate (acute) management of the condition, and chronic conditions where good quality and timely primary care can prevent later admissions, e.g., due to complications of diabetes. Several studies from the U.S.,[11-13] Canada,[14-16] Australia,[17-19] New Zealand[20] and European countries[21-27] have examined socioeconomic differences in ACSC and reported more ACSC hospitalisations among persons with lower socioeconomic background.

Most earlier studies examining socioeconomic differences in ACSC have used ecological data of single socioeconomic indicators, mainly income[12, 14, 15, 22, 23, 26] or deprivation indices based on ecological data,[17-21, 23, 25, 27] while few studies have focused on the individual-level socioeconomic indicators.

Socioeconomic position is, however, a complex construct reflecting different dimensions of the individuals' standing in the social hierarchy.[28] The persistence of health inequalities have led researchers to point out that we need to analyse multiple social circumstances simultaneously in order to assess their impact on health and health care.[29] We found few studies utilizing this approach with ACSCs. A study, which examined elderly Medicare beneficiaries in the USA, used multiple individual-level indicators of socioeconomic position but it did not examine them simultaneously.[11] Another from the Stockholm County in Sweden[24] analysed several individual-level socioeconomic variables simultaneously. And third from Ontario, Canada, examined trends and regional differences in acute diabetes complications and accounted for income and education at the community level.[16]

In addition to social position, social relationships may also contribute to outcomes of health care.[30, 31] Social relationships can be measured using self-reported measures of social isolation or loneliness. Using register data, it is possible to study living arrangements and to use living alone as a proxy measure for social isolation. Although previous studies have found a strong association between living alone and social isolation and loneliness,[32] these conditions are distinct. However, also living alone has been found to increase the use of health services[33, 34] and living alone has been applied as a measure of social isolation.[35] Social isolation has been identified as a risk factor for avoidable hospitalisation in one interview study from rural Australia.[36] On the other hand, a study using area-level measures of social deprivation detected lower admission rates for several chronic diseases in areas with higher proportions of elderly individuals living alone in London.[27] A study in the US found no association between living alone and hospitalisations due to ACSCs among retirement age (65+) individuals.[37] The population studied was, however, a sample of participants having access to an integrated delivery system with a preventive approach in the management of services and thus representing healthier residents than the general population.

Cumulative disadvantage may refer to two distinct social processes. On the one hand, it may imply accumulation of individual forms of disadvantage cross-sectionally. On the other hand, cumulative disadvantage may be observed with one or several forms of disadvantage persisting over time. The above-

mentioned studies have not examined how these social risk factors cumulate at individual-level either in one point of time or during a longer time period and whether the accumulation is associated with the risk of being hospitalised due to ACSCs. In recent literature, researchers have suggested that the effects of risk factors accumulate over time and thus increase socioeconomic disparities in health outcomes.[38, 39] A large number of studies have found associations between cumulative disadvantage and health. However, the relationship between accumulation of social disadvantage and health care in terms of effectiveness and quality, has received relatively little attention.

Social risk factors may have different impacts on outcomes of health care. Accumulation of the risk factors may also increase the risk of poor outcomes. Additionally, the effect of accumulation may vary depending on the combination of the risk factors and the persistence of accumulation. The main aim of the current study is to examine whether the preceding accumulation of social disadvantage increases inequities in outcomes of health care. We study hospitalisations due to ACSCs as an outcome of health care and as a study population we examine Finns aged 45 and over. The more specific study questions are: 1) What is the independent effect of different social risk factors on the risk of being hospitalised due to ACSCs? 2) What combination of social disadvantage in one point of time is the most hazardous in terms of hospitalisations due to ACSCs? 3) Does prolongation of cumulative disadvantage in time have effect on hospitalisations due to ACSCs? We examine four common indicators of social disadvantage: living alone, poverty, low level of education, and unemployment. We utilise comprehensive individual-level register data on sociodemographic and social factors and hospitalisations between 2006–2013.

Materials

This study utilised register data for years 2006−2013 for the non-institutionalised Finnish residents aged 45 years or older in January 1st 2011. For this population, annual individual-level information on sociodemographic factors in 2006−2010 was obtained from different administrative registers maintained by Statistics Finland. These factors included information on gender, age and region of residence as well as factors which were used to define risk factors for disadvantage: living arrangements, income, education, and annual number of unemployment months within a calendar year. Register data on hospitalisations due to ACSCs for the population at risk were individually linked to the sociodemographic data. Our outcome measure was hospitalisations due to ACSCs in 2011−2013. Information on hospitalisations was obtained from the Care Register for Health Care maintained by the Finnish Institute for Health and Welfare. We applied the UK definition of ACSCs with an addition of unspecified pneumonia (ICD-10 code J18.9) and influenza (J09)[10] (supplementary file 1). We categorised ACSCs as acute, chronic, or vaccine-preventable conditions as suggested by previous studies.[40] We included only inpatient hospital admissions, at least one night length of stay, both emergence and elective admissions.

We examined the data in two age groups: individuals aged 45-64 (the middle-aged) and 65 and older (the elderly) and studied them separately in all analyses. This allowed us to study whether there were differences between the middle-aged and the elderly in the association between ACSC hospitalisations and cumulative disadvantage and enabled us to include unemployment as a risk factor in the analysis in the younger age group. In addition, there are structural differences in access to ambulatory care services between the working aged population and others due to occupational health care.[3] We studied men and women mainly separately due to differing levels of hospitalisations due to ACSCs[7] and effects of risk factors. We used 20 hospital districts, based on an administrative division of the Finnish hospital care system, as an indicator of region of residence.

The situation of living arrangements on December 31st in each year was used to define a dichotomous variable indicating whether an individual had lived alone during the year. We studied disposable family net

income as an indicator for income. The family income was adjusted for family size using the OECD modified equivalence scale. Poverty was defined as net family income lower than 60% of the median family income.[41] Data on level of education was used to categorize the risk factor related to education. Low level of education was defined as having no degrees after comprehensive school. We defined the individual as being unemployed for that year if being unemployed for 6-12 months during the year. For the older age group in this study we did not use unemployment as a risk factor as they are rarely in paid labour in Finland.

Ethics

Ethical approval for the study was received from the Research Ethics Committee of the Finnish Institute for Health and Welfare.

Patient and Public Involvement

Patients were not involved in the design or the implementation of the study.

Statistical methods

We treated ACSC hospitalisations as a binary outcome variable, combining those with one and several ACSC hospitalisations into one category and thus we used logistic regression method in analysing the data. Our main interest was the effect of preceding social and socioeconomic factors on hospitalisations due to ACSCs in 2011–2013. The studied social and socioeconomic risk factors were living alone, poverty, and low level of education (and also unemployment for the younger age group) and these explanatory variables were also included in the model as binary variables. All analyses throughout the study were adjusted for region of residence and age, age treated as categorical variable by 5-year age groups. The modest correlations between the explanatory variables were taken into account by creating composite variables.

Objective 1: We aimed to study the independent effect of each social risk factor on hospitalisations due to ACSCs by analysing separately each risk factor including only that variable as an explanatory variable in the model in addition to age and region. In these analyses we assessed the effect of each social risk factor separately for those who had experienced only that social disadvantage in 2006–2010 (at least in one year) compared with individuals who had none of the risk factors during the whole period. Additionally, the differences of the independent effects of the risk factors were tested by creating a composite variable made up of all social risk factor variables indicating independent risks and using pairwise contrast effects procedure.

Objective 2: We aimed to identify the most hazardous combination of social disadvantage in terms of hospitalisations due to ACSCs for the combinations of two, three (and four among the younger age group) risk factors. This was done by creating composite variables of different combinations of the risk factors in 2006–2010 and these composite variables were modelled separately as the explanatory variables. If this risk factor was present at least in one year, it was considered as a risk factor and the prolongation was not taken into consideration in these analyses. Those who had none of the social risk factors during the years served as the reference group.

Objective 3: The effect of prolongation of cumulative disadvantage on hospitalisations due to ACSCs was studied for the most hazardous combination of the risk factors found in the analyses of the Objective 2. We studied how the prolongation of the cumulative disadvantage modified the risk by categorising the number of years (0 to 5 years) of cumulative disadvantage during the period and treating this categorical variable as an explanatory variable. For instance, if an individual had simultaneously all studied risk factors in each year between 2006−2010, he/she was categorised as having 5 years of prolonged cumulative disadvantage. Again, those who had none of the risk factors in 2006−2010 served as the reference group. Additionally, we performed pairwise comparison tests using contrast effects to study whether the number of years of prolongation of cumulative disadvantage had an effect on the ORs among those who had experienced cumulative disadvantage.

We analysed men and women separately but we performed additional analyses and tested gender differences in the associations of risk factors (as independent, cumulative, and prolonged cumulative) and hospitalisations due to ACSCs. This was done by including an interaction term between gender and risk factors in analyses combining both genders.

Sensitivity analyses

We conducted additional analyses for analyses concerning the Objective 2. In these additional analyses we included only incident hospitalisations due to ACSCs and excluded those patients who had preceding hospitalisation due to ACSCs in 1987−2010. Otherwise, the assumptions and definitions were similar to the main analyses.

Additionally, to study the Objective 2 in more detail, we performed analyses treating the number of ACSC hospitalisations as an ordinal response variable and these analyses were conducted using ordinal logistic regression model. Otherwise, the assumptions and definitions were similar to the main analyses.

We used SAS (SAS Institute Inc., Cary, NC, USA) version 9.4 to analyse the data.

Results

In the study period 2006−2013, the population at risk comprised altogether 1 530 397 (50% men) individuals aged 45-64 and 927 152 (42% men) individuals aged 65 or over. The number of hospitalisations due to ambulatory care sensitive conditions in 2011−2013 was 50 121 (58% men) among the middle-aged and 133 341 (45% men) among the elderly. Of those men, who had ACSC hospitalisations, 75% had only one ACSC hospitalisation during the study period among the middle-aged and 64% among the elderly. Among women, the corresponding proportions were 79% and 67%.

Results concerning the Objective 1

All the studied social and socioeconomic risk factors had an independent effect on hospitalisations due to ACSCs after controlling for area of residence and age (Table 1). Each of the risk factors increased significantly the odds of being hospitalized due to ACSCs after adjustment for age and area of residence compared to individuals who had none of the risk factors in 2006−2010. Poverty and low level of education had the strongest independent effect on ACSCs among both age groups and genders. The independent effect of unemployment was statistically significantly smaller than the effect of all the other studied risk factors among middle-aged men (p-values < 0.0001). Among middle-aged women, the independent effect of unemployment was statistically smaller than the effect of poverty and low level of education (p-values < 0.0001). The independent effect of living alone was statistically significantly smaller than the effect of poverty and low level of education among the elderly (p-values < 0.0001). The effect of living alone was significantly larger for men among the middle-aged (p-value for interaction between gender and living alone < 0.0001) and the effect of low level of education was greater for women among the elderly (p-value for interaction between gender and low level of education 0.005).

Table 1. Independent effects of the risk factors on hospitalisations due to ambulatory care sensitive conditions by age and gender in Finland in 2011–2013

	Men aged 45-64		**Women aged 45-64**	
	OR	**95% CI**	**OR**	**95% CI**
Living alone	1.41	1.35–1.46	1.21	1.16–1.26
Poverty	1.56	1.48–1.64	1.56	1.48–1.64
Low level of education	1.44	1.39–1.49	1.57	1.51–1.64
Unemployment	1.19	1.13–1.25	1.15	1.08–1.23
	Men aged ≥ 65		**Women aged ≥ 65**	
	OR	**95% CI**	**OR**	**95% CI**
Living alone	1.21	1.16–1.26	1.14	1.10–1.19
Poverty	1.34	1.27–1.41	1.37	1.29–1.45
Low level of education	1.32	1.28–1.35	1.35	1.31–1.40

The reference category is those individuals who had none of the risk factors during the period 2006–2010. ORs estimated from separate models for each risk factor. Adjusted for age and region of residence.

Results concerning the Objective 2

Next we studied the associations between different combinations of cumulative disadvantage and hospitalisations due to ACSCs (Table 2). All combinations of two, and three (and four among the middle-aged) risk factors increased significantly the odds of being hospitalized due to ACSC compared with the reference group who had none of the risk factors. The only exception was the combination of living alone and unemployment, which was not statistically significant among middle-aged women. Among the middle-aged, the most hazardous combination of two risk factors was living alone and poverty among both genders; the OR was 2.77 (95% confidence interval 2.66–2.89) among men and 2.62 (2.49–2.76) among women. Those risk combinations which included unemployment had the smallest ORs. The most hazardous combination of three risk factors was living alone, poverty, and low level of education with OR of 3.41 (3.26–3.56) among men and 3.77 (3.57–3.97) among women. The effect of cumulative disadvantage on hospitalisations due to ACSCs was not statistically different between men and women. When all the four

risk factors were present, the ORs were 2.34 (2.18–2.51) and 2.03 (1.84–2.24), respectively and the effect was larger for men (p-value for interaction between gender and cumulative disadvantage 0.005). Among elderly men, the most hazardous combination of two risk factors was living alone and poverty: the OR was 1.63 (1.55–1.72). Among elderly women, the present of poverty and low level of education was the most hazardous combination of two risk factors: the OR was 1.57 (1.51–1.64). When all the three risk factors (living alone, poverty, and low level of education) were present, the OR was 1.81 (1.75–1.87) and 1.82 (1.76–1.88), respectively.

Table 2. The effect of different combinations of the risk factors on hospitalisations due to ambulatory care sensitive conditions in Finland in 2011–2013

Living alone	Poverty	Low level of education	Unemployment	Men aged 45-64		Women aged 45-64	
				OR	**95% CI**	**OR**	**95% CI**
Combinations of two risk factors							
X	X	–	–	2.77	2.66–2.89	2.62	2.49–2.76
X	–	X	–	1.74	1.66–1.84	1.60	1.49–1.71
X	–	–	X	1.41	1.29–1.54	1.08	0.94–1.24
–	X	X	–	2.10	1.99–2.22	2.61	2.46–2.77
–	X	–	X	1.64	1.52–1.78	1.53	1.41–1.67
–	–	X	X	1.25	1.17–1.35	1.28	1.18–1.39
Combinations of three risk factors							
X	X	X	–	3.41	3.26–3.56	3.77	3.57–3.97
X	X	–	X	2.19	2.07–2.32	1.78	1.64–1.94
X	–	X	X	1.42	1.24–1.62	1.41	1.17–1.70
–	X	X	X	1.83	1.67–2.02	1.87	1.69–2.07
All four risk factors							
X	X	X	X	2.34	2.18–2.51	2.03	1.84–2.24

Living alone	Poverty	Low level of education	Men ≥ 65		Women ≥ 65	
			OR	**95% CI**	**OR**	**95% CI**
Combinations of two risk factors						
X	X	–	1.63	1.55–1.72	1.51	1.44–1.57
X	–	X	1.52	1.46–1.57	1.43	1.37–1.48
–	X	X	1.40	1.36–1.45	1.57	1.51–1.64
All three risk factors						
X	X	X	1.81	1.75–1.87	1.82	1.76–1.88

The reference category is those individuals who had none of the risk factors during the period 2006–2010. ORs estimated from separate models for each combination of risk factors.
Adjusted for age and region of residence

Results concerning the Objective 3

The effect of prolonged cumulative disadvantage between 2006–2010 on ACSCs in 2011–2013 was examined for the most hazardous combination of the risk factors, i.e. simultaneously living alone, experiencing poverty and low level of education. All ORs for being hospitalised due to ACSCs for those experiencing one or more years of cumulative disadvantage were statistically significant compared with those individuals who had none of the risk factors during the period 2006–2010 among both genders and age groups (Table 3). The OR for being hospitalized was 4.36 (4.11–4.62) for those middle-aged men who had all the three risk factors in each year compared with those who had none of the risk factors between 2006–2010. Among middle-aged women, the corresponding OR was 5.23 (4.86–5.62). For the elderly, the OR was 1.88 (1.81–1.95) and 1.87 (1.80–1.94).

Table 3. The effect of prolonged cumulative disadvantage in 2006–2010 on ambulatory care sensitive conditions in Finland in 2011–2013 for the combination of living alone, poverty, and low level of education

The number of years of cumulative disadvantage	**Men aged 45-64**		**Women aged 45-64**	
	OR	**95% CI**	**OR**	**95% CI**
0	1.00	ref.[1]	1.00	ref.[1]
1	2.60	2.37–2.84	2.54	2.27–2.84
2	2.90	2.62–3.22	2.66	2.32–3.05
3	2.89	2.59–3.23	3.55	3.10–4.06
4	3.30	2.96–3.69	3.84	3.34–4.40
5	4.36	4.11–4.62	5.23	4.86–5.62
	Men aged ≥ 65		**Women aged ≥ 65**	
	OR	**95% CI**	**OR**	**95% CI**
0	1.00	ref.[1]	1.00	ref.[1]
1	1.77	1.65–1.90	1.64	1.55–1.74
2	1.73	1.59–1.89	1.70	1.58–1.81
3	1.78	1.65–1.92	1.80	1.69–1.91
4	1.59	1.48–1.70	1.79	1.69–1.89
5	1.88	1.81–1.95	1.87	1.80–1.94

[1] The reference category is those individuals who had none of the risk factors during the period 2006–2010

Adjusted for age and region of residence

Among middle-aged men and women, the prolongation of the cumulative disadvantage increased gradually the odds of being hospitalized due to ACSCs. The ORs for those who had experienced prolonged cumulative disadvantage in one, two, three, or four years was statistically smaller than if an individual had experienced cumulative disadvantage in each year. Among the middle-aged, the effect of prolongation of cumulative disadvantage on hospitalisations due to ACSCs was statistically different between men and women (p-value for interaction between gender and prolonged cumulative disadvantage 0.01).

Among elderly men, the prolongation of the cumulative disadvantage did not increase the odds of being hospitalized due to ACSC, i.e. experiencing one or more years of cumulative disadvantage did not change the odds compared with those individuals who had experienced cumulative disadvantage in each of the five years. Only the difference between four and five years of cumulative disadvantage was statistically significant (pairwise comparison p-value < 0.001). Among elderly women, the differences experiencing one or two years of cumulative disadvantage compared with five years were statistically significant (pairwise comparison p-values < 0.002). Among the elderly, prolongation of cumulative disadvantage had also statistically different effect on hospitalisations due to ACSCs among men and women (p-value for interaction between gender and prolonged cumulative disadvantage 0.005).

Results concerning the sensitivity analyses

The odds of being hospitalised due to ACSC for those with cumulative disadvantage compared with those without any of the examined risk factors decreased when including only incident ACSC hospitalisations. For the most hazardous combination of cumulative disadvantage (living alone, poverty, and low level of education), the OR was 2.60 (2.46 2.76) among middle-aged men and 2.82 (2.62−3.02) among middle-aged women when excluding all individuals who were hospitalised due to ACSC before 2011 from the analyses. For the elderly, the OR was 1.65 (1.58−1.72) and 1.64 (1.57−1.71).

We performed additional analyses using the number of hospital admissions due to ACSCs as an ordinal outcome variable which yielded similar results among both genders and age groups. For the most

hazardous combination of cumulative disadvantage (living alone, poverty, and low level of education), the OR was 3.45 (3.30−3.60) among middle-aged men and 3.81 (3.61−4.02) among middle-aged women (other results not shown).

Discussion

This population-based register study found strong associations between preceding cumulative social disadvantage and hospitalisations due to ambulatory care sensitive conditions. The study population included all Finnish residents aged 45 years or older in 2011–2013 and for this population we utilised comprehensive data from several administrative registers to examine their hospitalisations in 2011–2013 and preceding social and socioeconomic risk factors in 2006–2010. We defined cumulative social disadvantage as combination of several simultaneous risk factors for disadvantage preceding the study period: living alone, poverty, low level of education, and unemployment. The risk of being hospitalised due to ACSCs was markedly elevated if an individual had lived alone and had experienced poverty during the preceding years, and had also poor education. The same combination of the risk factors for social disadvantage was the most hazardous for both age groups (45–64 and over 64) among both genders. Additionally, we found that prolongation of cumulative disadvantage in time increased further the risk of being hospitalized due to ACSCs among the middle-aged (aged 45–64). Among the middle-aged the prolongation of accumulation of risks was even more hazardous for women than for men.

The lack of nationwide comprehensive register data on the use of primary health care is a common limitation in health services research. Hospitalisations due to ACSCs provide an indirect measure of the effectiveness and quality of primary health care. Some studies have questioned the accuracy of this indicator to reflect access to primary care. However, the studies concluding that hospitalisations due to ACSCs are not associated with poor access to health care, have used area-level data and have not been able to take into account need for care at individual-level.[42-44] Thus conclusive evidence that more efficient or more accessible primary care could not prevent a notable proportion of hospitalisations due to ACSCs is lacking.

A universal list of ACSCs does not exist since hospitalisation criteria vary between countries and health care systems.[10] We applied the UK definition with some minor modifications to maintain international comparability. However, the main purpose of this study was to examine social disadvantage as a risk factor for hospitalisations due to ACSCs within Finland and not to compare countries. We expect there to be no differences in coding practices between socioeconomic groups in administrative regions of Finland. Thus we assume that there is no considerable inconsistence in using this ACSC definition list for our purposes.

In this study both emergency and elective hospital admissions were included while some earlier studies have included only emergency admissions.[9, 23] In regard to social and socioeconomic differences, the use of both emergency and elective hospitalisations is likely to somewhat diminish these differences since social disadvantage might increase the risk of emergency hospitalisations while acting as a barrier to elective care.[45] Additionally, the majority of the hospital admissions due to ACSCs in our data were emergency admissions. Thus we presume our results of social inequity would be even greater, had we studied only emergency hospital admissions.

With register data we were not able to measure social isolation directly and thus we used living alone as a crude proxy. This measure excludes the individual's social networks outside their home. Living alone does not always denote social isolation or loneliness, although they are interrelated and overlapping. Despite these limitations we detected strong associations between living arrangements and hospitalisations due to ACSCs and our results suggest that living arrangements reflect social support relatively accurately. Another limitation is that we were not able to take into account for ill-health, morbidity or disease severity.

Our results of independent effects of the socioeconomic risk factors on hospitalisations due to ACSCs are in line with the results found in several earlier studies reporting that disadvantaged socioeconomic position is associated with increased risk of being hospitalised due to ACSCs.[15, 22, 25] These previous studies examined only one socioeconomic factor or used small area based deprivation indices in assessing socioeconomic position. Few studies have examined several socioeconomic factors at the same time. Blustein et al.[11] found that poorer and less-educated individuals were likely to be hospitalised due to

ACSCs in the US in the early 1990's, but they modelled education and income separately. A study from Sweden detected that individuals with lower income and those not gainfully employed had higher risk of becoming hospitalised due to ACSCs in the mid 2000's.[24] Booth et al.[16] studied the effect of education and income at the community-level on acute diabetes complications in Canada in the late 1990's and found that only low neighbourhood income increased the risk of being hospitalised. However, these studies did not examine how the accumulation of individual-level socioeconomic risk factors affects the risk of being hospitalised due to ACSCs. Higher prevalence of morbidity among individuals with low socioeconomic position is likely to partly explain inequalities in hospitalisation due to ACSCs. While primary health care obviously cannot prevent all ACSC events leading to hospital admissions, an efficient health care system should diminish differences between socioeconomic groups which may also be partly due to higher morbidity among the lower socioeconomic groups.

We evaluated the effect of living alone as a proxy for social isolation on hospitalisations due to ACSCs. We found that the independent effect of living alone was significant and increased the risk of being hospitalised due to ACSCs and the effect was greater for middle-aged men than for middle-aged women. Living alone was as hazardous as poverty and low level of education among middle-aged men. The strong association between living alone and the risk of being hospitalized due to ACSC suggests that absence of adequate social support might also play a role in seeking care especially among men with low socioeconomic position. Using interview data Longman et al.[36] have reported a similar finding concerning social isolation as a contributory factor in avoidable hospital admissions in Australia. Ennis et al.[37] studied the association of living alone and hospitalisations due to ACSCs in the US and concluded that living alone in later life did not increase hospitalisation risk. Their study cohort included about 2 600 selected participants who were presumably healthier than the general population. Thus, the results might not be applicable to broader population groups. Saxena et al.[27] found significant negative association between asthma, hypertension and COPD hospitalisations and proportion of elderly living alone in London. Their interpretation of this finding was that the support structures in the affluent areas prevent hospitalisations among the elderly.

We found the independent effect of unemployment and its effect as a co-factor in accumulation of risk factors to be smaller than the effect of the other risk factors. This finding is likely to reflect at least to some extent the fact that long-term unemployment is difficult to measure using register data. It is possible that our indicator does not properly capture all people suffering from long-term unemployment since it is based on statistics that includes people registered as active job applicants. Further, the study took place during a severe recession with high prevalence of unemployment resulting in the unemployed becoming more heterogeneous and being unemployed less stigmatizing than in times when the economy is booming. Thus, due to the recession, unemployment in our study may have represented less of a risk factor for social deprivation and less severe health consequences. Alternatively, the finding of the small effect of unemployment may derive from a homogenous unemployed population. Especially in the beginning of unemployment the Finnish welfare state is relatively generous in buffering against the economic effect resulting from the loss of a job. An unemployed is entitled to earning-related benefit for 14 to 23 months, depending on the length of the employment history. Thus, it is only after a longer period of time that the effects of unemployment regarding the loss of earnings will take place. Since we could not disentangle those still enjoying the subsidies from those that no longer did, the effects among the latter "hard core" unemployed group are potentially downplayed.

The higher risk of being hospitalised due to ACSCs among individuals with several simultaneous risk factors for social disadvantage found in our study is probably due to multiple causes. The inequalities found in hospitalisations due to ACSCs certainly partly reflect differences in access to and quality of primary health care. Earlier studies have found that individuals with higher socioeconomic position have clearly more annual visits to physicians than those with lower position after controlling for health status.[4, 46] There is area-level evidence that low socioeconomic position and fewer physicians are associated with poorer access to care in addition to higher hospitalisations due to ACSCs.[47] Moreover, earlier studies have suggested that for instance continuity of primary care is associated with reduced risk of avoidable hospitalisations.[48, 49] Especially a long-term relationship between a patient and a physician effectively reduces the risk.[50] It is likely that there are differences between socioeconomic groups in the continuity

of care in the treatment of many common chronic conditions. The increased risk of being hospitalised due to ACSCs among individuals with cumulative disadvantage may also be caused by inadequate resources in primary health care to recognise the needs of people with simultaneous social and physical health problems and inability to treat and prevent these diseases from worsening. Socioeconomic inequalities in the use of health care are likely to be explained at least partly also by differences in seeking the care needed.[13]

The finding that the prolongation of cumulative disadvantage increased further the risk of being hospitalized for ACSCs among the middle-aged is likely to reflect the interplay of social disadvantage and health problems over time. Prolongation of cumulative disadvantage worsens further social and physical health problems gradually. However, among the elderly (aged over 64), the prolongation of cumulative disadvantage did not increase the risk further. This may be due to the fact that chronic conditions potentially leading to ACSC are relatively common among older age groups. Additionally, selective mortality may play a role by diminishing differences between socioeconomic groups.

The sensitivity analyses included only those individuals who had no previous hospitalisations due to ACSCs. They detected that cumulative disadvantage increases the risk of being hospitalised due to ACSCs somewhat less than when including all individuals. This suggests that accumulation of social disadvantage can have worse effects for those who have chronic conditions and/or recurring hospitalisations. On the other hand this finding supports the conclusion that persons without previous avoidable hospitalisations have increased risk of being hospitalised due to ACSCs after experiencing social disadvantage.

To our knowledge, this is the first study to assess exhaustively the relationship between the accumulation of social disadvantage and hospitalisations due to ACSCs. The use of comprehensive individual-level register data enabled us to avoid ecological bias which is common in studies using area-level socioeconomic and social disadvantage variables. We were also able to study a rather long period of time and thus evaluate the effect of prolongation of accumulating social disadvantage; the retrospective follow-up time was eight years at longest. In our data avoidable hospitalisations were derived from the Care Register for Health Care,

which has been found to be of good quality and coverage in general.[51] The methodological approach of the study allowed us to study simultaneously several risk factors that are to some extent dependent of each other.

The results of our study underline the importance of improving coordination of care across the system between social and health care, as well as primary and secondary care. Also primary prevention in the management of care should be emphasized. Universalism is not enough; the recognition of patients with chronic conditions and simultaneous particular combinations of cumulative disadvantage is important to diminish these extensive differences between social groups to improve social equity in health care. The identification of these vulnerable patients groups – who may be more susceptible – is also necessary to reduce the use of more expensive treatment in specialised health care. Treating people with multiple chronic conditions and social problems in primary care requires more attention and active means and for instance strengthening continuity of care is even more significant for these vulnerable patients groups.

Author's contribution SL participated in the conception and planning of the study, designed the study, analysed and interpreted the data and was a major contributor in writing the manuscript. KM, MA, SK, and IK participated in the conception and planning of the study and the interpretation of the results for important intellectual content and writing the manuscript. All authors read and approved the final manuscript.

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A data sharing statement No additional data are available

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ACSC conditions	*ICD-10*	*Notes*
Vaccine-preventable		
Bacterial Pneumonia & Influenza	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, not included if D57 is as a secondary diagnose
Immunization-Related and Preventable Conditions	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field
Chronic		
Acute Bronchitis	J20	Only when as a primary diagnose, and J41-J44 or J47 as a secondary diagnose
Angina	I20, I24.0, I24.8, I24.9	Only when as a primary diagnose, cases with surgical procedures (A) excluded
Asthma	J45, J46	Only when as a primary diagnose
Chronic Obstructive Pulmonary Disease (COPD)	J41, J42, J43, J44, J47	Only when as a primary diagnose
Congestive Heart Failure	I11.0, I50, J81	Only when as a primary diagnose, cases with cardiac procedures (B) excluded
Diabetes Complications	E10.0-10.8, E11.0-E11.8, E12.0-E12.8, E13.0-E13.8, E14.0-E14.8	Only when as a primary diagnose
Hypertension	I10, I11.9	Only when as a primary diagnose, cases with cardiac procedures (B) excluded
Iron Deficiency Anaemia	D50.1-D50.9	Only when as a primary diagnose
Nutritional Deficiencies	E40, E41, E42, E43, E55.0, E64.3	Only when as a primary diagnose
Acute		
Cellulitis	L03, L04, L08.0, L08.8, L88, L98.0	Only when as a primary diagnose, cases with other surgical procedures than skin procedures (C) excluded
Convulsions and Epilepsy	G40, G41, O15, R56	Only when as a primary diagnose
Dehydration and Gastroenteritis	E86, K52.2, K52.8, K52.9	Only when as a primary diagnose
Dental Conditions	A69.0, K02-K06, K08, K09.8, K09.9, K12, K13	Only when as a primary diagnose
Gangrene	R02	In any diagnosis field
Kidney and Urinary Tract Infections	N10, N11, N12, N13.6	Only when as a primary diagnose
Pelvic Inflammatory Disease	N70, N73, N74	Only when as a primary diagnose
Perforated or Bleeding Ulcer	K25.0-K25.2, K25.4-K25.6, K26.0-K26.2, K26.4-K26.6, K27.0-K27.2, K27.4-K27.6, K28.0-K28.2, K28.4-K28.6	Only when as a primary diagnose
Severe ENT infection	H66, H67, J02, J03, J06, J31.2	Only when as a primary diagnose

A) Angina

procedure field contains none of the following (NCSP, Nordic Classification of Surgical Procedures):

AA4WT, AA400, AA5LT, AAA-AAW, AB4AT, AB4BT, AB4CT, AB4DT, AB4FT, AB5, AB6AT, AB6BT, AB6CT, AB6DT, ABA-ABW, ACA-ACW, AD-AW, AXX90, BA3AT, BA4KT, BAA, BB2AT, BB3AT, BB4WT, BBA, BC1LT, BC2-BC4, BCA, BD-BW, CAA-CAW, CB, CCA-CCW, CD-CJ, CKA-CKW, CW, DAA-DAW, DB, DCA-DCW, DD, DEA-DEW, DFA-DFE, DFW99, DG, DHA-DLW, DMA-DPW, DQ-DW, EA, EBA-EBW, EC, EDA-EDW, EEA-EW, EF, EGA-EGW, EHA-EHW, EJ-EK, EL3AT, EL3RT, EL3YT, EL4 ,ELA-ELW, EMA-EMW, EP1AT, EP1LT, EP2AT, EP3AT, ENA-ENW, EW, FA, FBA-FBW, FCA-FCE, FD, FE1AT, FE2, FEA-FEW, FF-FL, FMA-FMW, FN1ST, FN1XT, FNA-FNW, FP-FX, GA2-GA4, GAA-GAW, GBA-GBW, GCA, GD1AT, GD1BT, GD1CT, GD1LT, GD2AT, GD2BT, GD2CT, GD3, GDA-GDW, GE1AT, GE1CT, GE1DT, GE2, GEA-GEW, GW, HA0, HA1AT, HA1DT, HA1MT, HA1ST, HA2-HA5, HAA-HAF, HW, JA1LT, JA2-JA3, JAA-JAW, JB, JCA-JCW, JDA-JDW, JE, JF3, JFA-JFW, JGA-JGW, JHA-JHW, JJ1AT, JJ2-JJ8, JJA-JJW, JK1-JK2, J3KAT, JK3BT, JK3CT, JK3FT, JK3LT, JK3NT, JK3RT, JK4-JK5, JKA-JKW, JL1-JL3, JLA-JLW, JM1AT, JM1LT, JM2, JMA-JMW, JN4LT, JW, JX1LT, JX1RT, JXA, KA2AT, KA3AT, KA3CT, KA3DT, KA3LT, KA4-KA6, KAA-KAW, KBA-KBW, KC1AT, KC2AT, KC3AT, KCA-KCW, KDA-KDW, KE1AT, KE1CT, KE2, KEA-KEW, KF1-KF7, KF8AT, KF8KT, KFA-KFW, KGA-KGW, KH1AT, KH1BT, KH1CT, KH1CT, KH1DT, KH1FT, KH1YT, KKA-KKW, KW, KX, LA1, LAA-LAW, LB1AT, LB1YT, LBA-LBW, LCA-LCW, LDA-LDW, LEA-LEW, LF-LW, LX1LT, MAA-MAW, MBA-MBW, MC-MW, NA0, NA6CT, NA7BT, NA7FT, NA7KT, NA7LT, NA9KT, NAA-NAW, NB1AT,NB1BT, NB1ZT, NB2, NBA-NBW, NCA-NCW, NDA-NDW, NEA-NEW, NFA-NFW, NGA-NGW, NHA-NHW, NJ3LT, NK1AT, NK1CT, NK1DT, NK1LT, NK2-NK3, NK4AT, NK4BT, NK5, NK6AT, NK6BT, NK6CT, NK6DT, NK6KT, NK7AT, NX, PA2ZT, PA3-PA5, PA6AT, PA8KT, PA9KT, PAA-PAW, PB1AT, PB1BT, PB1ST, PB1YT, PBA-PBW, PC2DT, PC2ET, PC5AT, PC5BT, PC5DT, PC5ET, PC5GT, PC5HT, PC5JT, PC5NT, PC5PT, PC5YT, PC6DT, PC6ET, PC6FT, PC7NT, PCA-PCW, PD1AT, PD1YT, PD2DT, PD3, PD4ST, PD5YT, PD6YT, PD7YT, PDA-PDW, PE, PG1AT, PG1BT, PG1ET-PG1LT, PG1MT-PG1VT, PG1YT-PG3YT, PG5RT-PG6NT, PGA-PGW, PH1AT, PH1FT, PH1UT, PH2ST, PH3YT, PH4AT, PH5GT, PH6GT, PH7FT, PH7UT, PH9AT, PH9ST, PH900, PHA-PHW, PJ2AT, PJ2CT, PJ2HT, PJ3-PJ4, PJ5AN, PJA-PJW, PW, PXA-PXX, QAA-QAW, QBA-QBW, QCA-QCW, QDA-QDW, QW, QXA-QXW, QX2ZT, QX3AT, QX3CT, QX3LT, QX3YT, QX4, S, TAA-TAD, TAW99, TA100, TBA-TJF, TJG10, TJJ, TJL-TJW, TK-TL, TMA-TPX, TQ, U, WXQ, WW20, WW30-WW31, WW40, WW50, WX100-WX105, WX140-WX144, WX7-WX9, XCC00, XFE00, XFN96, XFX00, XFX10, XFX20, XFX97, XJW99, XPX00, XPX04, XPX08, XPX99, XW000, XW1-XW5, XX1AT, XX1BT, XX1CT, XX1DT, XX1XT, XX2AT-XX2DT, XX2XT, XX3AT-XX3DT, XX3XT, XX4-XX7, Y, ZC-ZP, ZS-ZX, ZZ

B) Congestive heart failure and hypertension

procedure field contains none of the following (NCSP, Nordic Classification of Surgical Procedures):

FEA-FEW, FFA00, FFA10-FFA30, FFA96, FFB-FFW, FG-FH, FJA00, FJA96, FJB-FJW, FKA-FKW, FK1BT, FLA00, FLA96, FLB-FLW, FMA-FMW, FN1AT, FN1BT, FN1ST, FN1XT, FN1YT, FNA-FNW, FPA-FPF, FPH-FPW, FQ, FXA00-FXN00, TFN10, TFN99, TFP00, TFP40-TFP59

C) Cellulitis

procedure field contains none of the following (NCSP, Nordic Classification of Surgical Procedures):

AA4WT, AA400, AA5LT, AAA-AAW, AB4AT, AB4BT, AB4CT, AB4DT, AB4FT, AB5, AB6AT, AB6BT, AB6CT, AB6DT, ABA-ABW, ACA-ACW, AD-AW, AXX90, BA3AT, BA4KT, BAA, BB2AT, BB3AT, BB4WT, BBA, BC1LT, BC2-BC4, BCA, BD-BW, CAA-CAW, CB, CCA-CCW, CD-CJ, CKA-CKW, CW, DAA-DAW, DB, DCA-DCW, DD, DEA-DEW, DFA-DFE, DFW99, DG, DHA-DLW, DMA-DPW, DQ-DW, EA, EBA-EBW, EC, EDA-EDW, EEA-EW, EF, EGA-EGW, EHA-EHW, EJ-EK, EL3AT, EL3RT, EL3YT, EL4, ELA-ELW, EMA-EMW, EP1AT, EP1LT, EP2AT, EP3AT, ENA-ENW, EW, FA, FBA-FBW, FCA-FCE, FD, FE1AT, FE2, FEA-FEW, FF-FL, FMA-FMW, FN1ST, FN1XT, FNA-FNW, FP-FX, GA2-GA4, GAA-GAW, GBA-GBW, GCA, GD1AT, GD1BT, GD1CT, GD1LT, GD2AT, GD2BT, GD2CT, GD3, GDA-GDW, GE1AT, GE1CT, GE1DT, GE2, GEA-GEW, GW, HA0, HA1AT, HA1DT, HA1MT, HA1ST, HA2-HA5, HAA-HAF, HW, JA1LT, JA2-JA3, JAA-JAW, JB, JCA-JCW, JDA-JDW, JE, JF3, JFA-JFW, JGA-JGW, JHA-JHW, JJ1AT, JJ2-JJ8, JJA-JJW, JK1-JK2, J3KAT, JK3BT, JK3CT, JK3FT, JK3LT, JK3NT, JK3RT, JK4-JK5, JKA-JKW, JL1-JL3, JLA-JLW, JM1AT, JM1LT, JM2, JMA-JMW, JN4LT, JW, JX1LT, JX1RT, JXA, KA2AT, KA3AT, KA3CT, KA3DT, KA3LT, KA4-KA6, KAA-KAW, KBA-KBW, KC1AT, KC2AT, KC3AT, KCA-KCW, KDA-KDW, KE1AT, KE1CT, KE2, KEA-KEW, KF1-KF7, KF8AT, KF8KT, KFA-KFW, KGA-KGW, KH1AT, KH1BT, KH1CT, KH1CT, KH1DT, KH1FT, KH1YT, KKA-KKW, KW, KX, LA1, LAA-LAW, LB1AT, LB1YT, LBA-LBW, LCA-LCW, LDA-LDW, LEA-LEW, LF-LW, LX1LT, MAA-MAW, MBA-MBW, MC-MW, NA0, NA6CT, NA7BT, NA7FT, NA7KT, NA7LT, NA9KT, NAA-NAW, NB1AT,NB1BT, NB1ZT, NB2, NBA-NBW, NCA-NCW, NDA-NDW, NEA-NEW, NFA-NFW, NGA-NGW, NHA-NHW, NJ3LT, NK1AT, NK1CT, NK1DT, NK1LT, NK2-NK3, NK4AT, NK4BT, NK5, NK6AT, NK6BT, NK6CT, NK6DT, NK6KT, NK7AT, NX, PA2ZT, PA3-PA5, PA6AT, PA8KT, PA9KT, PAA-PAW, PB1AT, PB1BT, PB1ST, PB1YT, PBA-PBW, PC2DT, PC2ET, PC5AT, PC5BT, PC5DT, PC5ET, PC5GT, PC5HT, PC5JT, PC5NT, PC5PT, PC5YT, PC6DT, PC6ET, PC6FT, PC7NT, PCA-PCW, PD1AT, PD1YT, PD2DT, PD3, PD4ST, PD5YT, PD6YT, PD7YT, PDA-PDW, PE, PG1AT, PG1BT, PG1ET-PG1LT, PG1MT-PG1VT, PG1YT-PG3YT, PG5RT-PG6NT, PGA-PGW, PH1AT, PH1FT, PH1UT, PH2ST, PH3YT, PH4AT, PH5GT, PH6GT, PH7FT, PH7UT, PH9AT, PH9ST, PH900, PHA-PHW, PJ2AT, PJ2CT, PJ2HT, PJ3-PJ4, PJ5AN, PJA-PJW, PW, PXA-PXX, QAA25, QAB00-QAB05, QAB99, QAC, QAD20, QAE-QAF, QAG10-QAG99, QAJ, QBA25, QBB00-QBB05, QBB99, QBC, QBD20, QBE, QBG10-QBG99, QBJ, QCA25, QCA30, QCB00-QCB05, QCB99, QCC, QCD20, QCE-QCG, QCJ, QDA25, QDB00-QDB05, QDB99, QDC, QDD20, QDE, QDG10-QDG99, QDJ, QXA25, QXB00-QXB05, QXB99, QXC, QXD20, QXE, QXG10-QXG99, QXJ, QX2ZT, QX3AT, QX3CT, QX3LT, QX3YT, QX4, S, TAA-TAD, TAW99, TA100, TBA-TJF, TJG10, TJJ, TJL-TJW, TK-TL, TMA-TPX, TQA-TQD, TQW00, TQW02, TQW30-40, TQW99, TQX00-TQX10, U, WW20, WW30-WW31, WW40, WW50, WX100-WX105, WX140-WX144, WX7-WX9, XCC00, XFE00, XFN96, XFX00, XFX10, XFX20, XFX97, XJW99, XPX00, XPX04, XPX08, XPX99, XW000, XW1-XW5, XX1AT, XX1BT, XX1CT, XX1DT, XX1XT, XX2AT-XX2DT, XX2XT, XX3AT-XX3DT, XX3XT, XX4-XX7, Y, ZC-ZP, ZS-ZX, ZZ

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	#1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	#2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	#4-6
Objectives	3	State specific objectives, including any prespecified hypotheses	#6
Methods			
Study design	4	Present key elements of study design early in the paper	#7-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	#7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	#7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	#7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	#7-8
Bias	9	Describe any efforts to address potential sources of bias	#NA
Study size	10	Explain how the study size was arrived at	#7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	#9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	#9
		(*b*) Describe any methods used to examine subgroups and interactions	#10
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, explain how loss to follow-up was addressed	NA
		(*e*) Describe any sensitivity analyses	#10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	#11
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	#11
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	#11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	#11-15
		(*b*) Report category boundaries when continuous variables were categorized	#10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	#10
Discussion			
Key results	18	Summarise key results with reference to study objectives	#16
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	#16-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	#19-21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	#21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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Cumulative social disadvantage and hospitalisations due to ambulatory care sensitive conditions in Finland in 2011–2013: a register study

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Abstract

Objectives To study the interplay between several indicators of social disadvantage and hospitalisations due to ambulatory care sensitive conditions (ACSC) in 2011–2013. To evaluate whether the accumulation of preceding social disadvantage in one point of time or prolongation of social disadvantage had an effect on hospitalisations due to ACSCs. Four common indicators of disadvantage are examined: living alone, low level of education, poverty, and unemployment.

Design A population-based register study

Setting Nationwide individual-level register data on hospitalisations due to ACSCs for the years 2011–2013 and preceding data on social and socioeconomic factors for the years 2006–2010

Participants Finnish residents aged 45 or older in January 1st 2011

Outcome measure Hospitalisations due to ACSCs in 2011–2013. The effect of accumulation of preceding disadvantage in one point of time and its prolongation on ACSCs was studied using modified Poisson regression.

Results People with preceding cumulative social disadvantage were more likely to be hospitalised due to ACSCs. The most hazardous combination was simultaneously living alone, low level of education, and poverty among the middle-aged (aged 45-64) and the elderly (over 64). Risk ratio (RR) of being hospitalized due to ACSC was 3.16 (95% confidence interval 3.03-3.29) among middle-aged men and 3.54 (3.36-3.73) among middle-aged women compared with individuals without any of these risk factors when controlling for age and residential area. For the elderly, the RR was 1.61 (1.57-1.66) among men and 1.69 (1.64-1.74) among women.

Conclusions To improve social equity in health care, it is important to recognise not only patients with cumulative disadvantage, but – as this study shows – patients with particular combinations of disadvantage

who may be more susceptible. The identification of these vulnerable patients groups is also necessary to reduce the use of more expensive treatment in specialised health care.

Keywords: Socioeconomic disadvantage, social disadvantage, ambulatory care sensitive conditions, inequities, health care, register data

Strengths and limitations of this study

- The individual-level register-based data allowed us to study simultaneously several indicators of social and socioeconomic disadvantage
- The nationwide register data covered all hospitalisations due to ambulatory care sensitive conditions (ACSCs) in Finland
- We were able to study social disadvantage of period preceding hospitalisations and its effect on being hospitalised due to ACSCs
- Hospitalisations due to ACSCs is an indirect indicator of the effectiveness and quality of primary health care
- While the study addressed associations between social disadvantage and hospitalisations due to ACSCs, the causality between morbidity and social disadvantage could not be studied

Background

Inadequate access to health care is one of the important determinants of social inequities in health.[1] Well organised primary care has repeatedly been shown to promote population health and prevent ill-health. There is also evidence that primary care (in contrast to specialist care) is associated with a more equitable distribution of health in populations through prevention and early management of health problems and through facilitating entry to the rest of the health care system.[2] The Finnish health-care system provides a good case for examining equity as the system operates on the principle of universality and therefore, in general, supports equal access to health services according to need.[3] Simultaneously, studies from both Finland and some other countries with universal health care systems show systematic and persistent socioeconomic inequities in physician utilisation in relation to need.[2-5] Challenges in providing timely access to primary care are encountered in some areas[6] and there are indications of differences in primary health care quality between regions.[7] However, Finland has – compared to most other European countries – a strong publicly funded primary health care.[8]

Hospitalisations due to ambulatory care sensitive conditions (ACSC) are used to indirectly evaluate the effectiveness and quality of primary care.[9, 10] They are defined as hospitalisations that could be prevented by primary care interventions. Earlier studies have used slightly different lists of conditions, but have usually examined three types of conditions: conditions that can be prevented by vaccination, acute conditions in which hospitalisation can be prevented by adequate (acute) management of the condition, and chronic conditions where good quality and timely primary care can prevent later admissions, e.g., due to complications of diabetes. Several studies from the U.S.,[11-13] Canada,[14-18] Australia,[19-21] New Zealand[22] and European countries[23-29] have examined socioeconomic differences in ACSC and reported more ACSC hospitalisations among persons with lower socioeconomic background.

Most earlier studies examining socioeconomic differences in ACSC have used ecological data of single socioeconomic indicators, mainly income[12, 14, 15, 24, 25, 28] or deprivation indices based on ecological data,[19-23, 25, 27, 29] while few studies have focused on the individual-level socioeconomic indicators.

Socioeconomic position is, however, a complex construct reflecting different dimensions of the individuals' standing in the social hierarchy.[30] The persistence of health inequalities have led researchers to point out that we need to analyse multiple social circumstances simultaneously in order to assess their impact on health and health care.[31] We found few studies utilizing this approach with ACSCs. One study, which examined elderly Medicare beneficiaries in the USA, and another study from Ontario, Canada, utilising survey data linked to administrative databases, used multiple individual-level indicators of socioeconomic position but they did not examine them simultaneously.[11, 17] A study from the Stockholm County in Sweden[26] and a study from Canada[18] analysed several individual-level socioeconomic variables simultaneously. Additionally, a study from Ontario, Canada, examined trends and regional differences in acute diabetes complications and accounted for income and education at the community level.[16]

In addition to social position, social relationships may also contribute to outcomes of health care.[32, 33] Social relationships can be measured using self-reported measures of social isolation or loneliness. Using register data, it is possible to study living arrangements and to use living alone as a proxy measure for social isolation. Although previous studies have found a strong association between living alone and social isolation and loneliness,[34] these conditions are distinct. However, also living alone has been found to increase the use of health services[35, 36] and living alone has been applied as a measure of social isolation.[37] Social isolation has been identified as a risk factor for avoidable hospitalisation in one interview study from rural Australia.[38] On the other hand, a study using area-level measures of social deprivation detected lower admission rates for several chronic diseases in areas with higher proportions of elderly individuals living alone in London.[29] A study in the US found no association between living alone and hospitalisations due to ACSCs among retirement age (65+) individuals.[39] The population studied was, however, a sample of participants having access to an integrated delivery system with a preventive approach in the management of services and thus representing healthier residents than the general population.

Cumulative disadvantage may refer to two distinct social processes. On the one hand, it may imply accumulation of individual forms of disadvantage cross-sectionally. On the other hand, cumulative

disadvantage may be observed with one or several forms of disadvantage persisting over time. The above-mentioned studies have not examined how these social risk factors cumulate at individual-level either in one point of time or during a longer time period and whether the accumulation is associated with the risk of being hospitalised due to ACSCs. In recent literature, researchers have suggested that the effects of risk factors accumulate over time and thus increase socioeconomic disparities in health outcomes.[40, 41] A large number of studies have found associations between cumulative disadvantage and health. However, the relationship between accumulation of social disadvantage and health care in terms of effectiveness and quality, has received relatively little attention.

Social risk factors may have different impacts on outcomes of health care. Accumulation of the risk factors may also increase the risk of poor outcomes. Additionally, the effect of accumulation may vary depending on the combination of the risk factors and the persistence of accumulation. The main aim of the current study is to examine whether the preceding accumulation of social disadvantage increases inequities in outcomes of health care. We study hospitalisations due to ACSCs as an outcome of health care and as a study population we examine Finns aged 45 and over. The more specific study questions are: 1) What is the univariate effect of each risk factor on the risk of being hospitalised due to ACSCs if an individual has no other risk factors? 2) What combination of social disadvantage in one point of time is the most hazardous in terms of hospitalisations due to ACSCs? 3) Does prolongation of cumulative disadvantage in time have effect on hospitalisations due to ACSCs? We examine four common indicators of social disadvantage: living alone, poverty, low level of education, and unemployment. We utilise comprehensive individual-level register data on sociodemographic and social factors and hospitalisations between 2006–2013.

Materials

As a study population we had non-institutionalised Finnish residents aged 45 years or older in January 1st 2011. For this population, we utilised annual individual-level information on sociodemographic factors in 2006−2010, obtained from different administrative registers maintained by Statistics Finland. These exposure factors included information on gender, age and region of residence as well as factors which were used to define risk factors for disadvantage: living arrangements, income, education, and annual number of unemployment months within a calendar year. Register data on hospitalisations due to ACSCs for the population at risk were individually linked to the sociodemographic data. Our outcome measure was hospitalisations due to ACSCs in 2011−2013. Information on hospitalisations was obtained from the Care Register for Health Care maintained by the Finnish Institute for Health and Welfare. We applied the UK definition of ACSCs with an addition of unspecified pneumonia (ICD-10 code J18.9) and influenza (J09)[10] (supplementary file 1). We categorised ACSCs as acute, chronic, or vaccine-preventable conditions as suggested by previous studies.[42] We included only inpatient hospital admissions, at least one night length of stay, both emergence and elective admissions.

We examined the data in two age groups: individuals aged 45-64 (the middle-aged) and 65 and older (the elderly) and studied them separately in all analyses. This allowed us to study whether there were differences between the middle-aged and the elderly in the association between ACSC hospitalisations and cumulative disadvantage and enabled us to include unemployment as a risk factor in the analysis in the younger age group. In addition, there are structural differences in access to ambulatory care services between the working aged population and others due to occupational health care.[3] We studied men and women mainly separately due to differing levels of hospitalisations due to ACSCs[7] and effects of risk factors. We used 20 hospital districts, based on an administrative division of the Finnish hospital care system, as an indicator of region of residence to adjust for the differences in the incidence of hospitalisations due to ACSCs between regions.

The situation of living arrangements on December 31st in each year was used to define a dichotomous variable indicating whether an individual had lived alone during the year. We studied disposable family net income as an indicator for income. The family income was adjusted for family size using the OECD modified equivalence scale. Poverty was defined as net family income lower than 60% of the median family income.[43] Data on level of education was used to categorize the risk factor related to education. Low level of education was defined as having no degrees after comprehensive school which is nine years of schooling. We defined the individual as being unemployed for that year if being unemployed for 6-12 months during the year. For the older age group in this study we did not use unemployment as a risk factor as they are rarely in paid labour in Finland.

Ethics

Ethical approval for the study was received from the Research Ethics Committee of the Finnish Institute for Health and Welfare.

Patient and Public Involvement

Patients were not involved in the design or the implementation of the study.

Statistical methods

We treated ACSC hospitalisations as a binary outcome variable, combining those with one and several ACSC hospitalisations into one category and we used modified Poisson regression method in analysing the data.[44] Our main interest was the effect of preceding social and socioeconomic factors on hospitalisations due to ACSCs in 2011−2013. The studied social and socioeconomic risk factors were living alone, poverty, and low level of education (and also unemployment for the younger age group) and these explanatory variables were also included in the model as binary variables. All analyses throughout the study were adjusted for region of residence and age, age treated as categorical variable by 5-year age groups. The modest correlations between the explanatory variables were taken into account by creating composite variables (Cramer's V was 0.06-0.34 among middle-aged men and 0.06-0.29 among middle-aged women. Among the elderly, the values were 0.09-0.37 and 0.08-0.45).

Objective 1: We aimed to study the univariate effect of each social risk factor on hospitalisations due to ACSCs by analysing separately each risk factor including only that variable as an explanatory variable in the model in addition to age and region. In these analyses we assessed the effect of each social risk factor separately for those who had experienced only that social disadvantage in 2006−2010 (at least in one year) compared with individuals who had none of the risk factors during the whole period. Additionally, the differences of the univariate effects of the risk factors were tested by creating a composite variable made up of all social risk factor variables.

Objective 2: We aimed to identify the most hazardous combination of social disadvantage in terms of hospitalisations due to ACSCs for the combinations of two, three (and four among the younger age group) risk factors. This was done by creating composite variables of different combinations of the risk factors in 2006−2010 and these composite variables were modelled separately as the explanatory variables. If this risk factor was present at least in one year, it was considered as a risk factor and the prolongation was not taken into consideration in these analyses. Those who had none of the social risk factors during the years served as the reference group.

Objective 3: The effect of prolongation of cumulative disadvantage on hospitalisations due to ACSCs was studied for the most hazardous combination of the risk factors found in the analyses of the Objective 2. We studied how the prolongation of the cumulative disadvantage modified the risk by categorising the number of years (0 to 5 years) of cumulative disadvantage during the period and treating this categorical variable as an explanatory variable. For instance, if an individual had simultaneously all studied risk factors in each year between 2006−2010, he/she was categorised as having 5 years of prolonged cumulative disadvantage. Again, those who had none of the risk factors in 2006−2010 served as the reference group. Additionally, we performed pairwise comparison tests to study whether the number of years of prolongation of cumulative disadvantage had an effect on the RRs among those who had experienced cumulative disadvantage.

We analysed men and women separately but we performed additional analyses and tested gender differences in the associations of risk factors (as univariate, cumulative, and prolonged cumulative) and hospitalisations due to ACSCs. This was done by including an interaction term between gender and risk factors in analyses combining both genders.

Sensitivity analyses

We conducted additional analyses for analyses concerning the Objective 2. In these additional analyses we included only incident hospitalisations due to ACSCs and excluded those patients who had preceding hospitalisation due to ACSCs in 1987−2010. Otherwise, the assumptions and definitions were similar to the main analyses.

We used SAS (SAS Institute Inc., Cary, NC, USA) version 9.4 to analyse the data.

Results

In the study period 2011−2013, the population at risk comprised altogether 1 530 397 (50% men) individuals aged 45-64 and 927 152 (42% men) individuals aged 65 or over. In 2011−2013, 4% (29 275/760 139) of middle-aged men and 3% (20 846/770 258) of middle-aged women had been hospitalised due to ACSCs. Among the elderly, the proportions were 16% (60 110/387 970) and 14% (73 231/539 182). Of those men, who had ACSC hospitalisations, 75% had only one ACSC hospitalisation during the study period among the middle-aged and 64% among the elderly. Among women, the corresponding proportions were 79% and 67%.

Living alone was the most common risk factor of the studied social risk factors among the middle-aged. Of men 30% and 28% of women had lived alone at least in one year in 2006−2010 (Table 1). Among the elderly, low level of education was the most common risk factor, with 56% of the men and 62% of the women having low level of education. For each risk factor, the proportion of hospitalisation due to ACSCs in 2011−2013 was clearly higher among those who had the risk factor compared with those who had not experienced the risk factor in any of the years 2006−2010.

Table 1. Characteristics of the study population by social and socioeconomic risk factors in 2006–2010 and hospitalisations due to ambulatory care sensitive conditions (ACSCs) in 2011–2013 by age and gender in Finland

		Men aged 45-64 n = 760 139		Women aged 45-64 n = 770 258	
Risk factor		**% of having risk factor in 2006–2010**	**% of having hospitalisations due to ACSCs in 2011–2013**	**% of having risk factor in 2006–2010**	**% of having hospitalisations due to ACSCs in 2011–2013**
Living alone					
	YES	30	5.4	28	3.8
	NO	70	3.2	72	2.3
Poverty					
	YES	25	6.2	23	4.3
	NO	75	3.1	77	2.2
Low level of education					
	YES	27	5.3	22	4.1
	NO	73	3.3	78	2.3
Unemployment					
	YES	19	4.5	16	3.0
	NO	81	3.7	84	2.7

		Men aged ≥ 65 n = 387 970		Women aged ≥ 65 n = 539 182	
Risk factor		**% of having risk factor in 2006–2010**	**% of having hospitalisations due to ACSCs in 2011–2013**	**% of having risk factor in 2006–2010**	**% of having hospitalisations due to ACSCs in 2011–2013**
Living alone					
	YES	29	19.7	55	16.8
	NO	71	13.8	45	9.7
Poverty					
	YES	31	21.4	47	18.3
	NO	69	12.9	53	9.4
Low level of education					
	YES	56	18.3	62	16.1
	NO	44	11.9	38	9.6

If an individual had the risk factor at least in one year in 2006–2010, he/she was categorised as having the risk factor.

If an individual had not had the risk factor in any of the years 2006−2010, he/she was categorised as not having the risk factor.

Results concerning the Objective 1

All the studied social and socioeconomic risk factors had a univariate effect on hospitalisations due to ACSCs after controlling for area of residence and age (Table 2). Each of the risk factors increased significantly the odds of being hospitalized due to ACSCs after adjustment for age and area of residence compared to individuals who had none of the risk factors in 2006−2010. Poverty and low level of education had the strongest univariate effect on ACSCs among both age groups and genders. The univariate effect of unemployment was statistically significantly smaller than the effect of all the other studied risk factors among middle-aged men (p-values < 0.0001). Among middle-aged women, the univariate effect of unemployment was statistically smaller than the effect of poverty and low level of education (p-values < 0.0001). The univariate effect of living alone was statistically significantly smaller than the low level of education among the elderly (p-values < 0.001). The effect of living alone was significantly larger for men among the middle-aged (p-value for interaction between gender and living alone < 0.0001) and the effect of poverty and low level of education was greater for women among the elderly (p-values for interaction < 0.01).

Table 2. Univariate effects of the risk factors in 2006−2010 on hospitalisations due to ambulatory care sensitive conditions by age and gender in Finland in 2011−2013

	Men aged 45-64		**Women aged 45-64**	
	RR	**95% CI**	**RR**	**95% CI**
Living alone	1.39	1.34−1.44	1.20	1.15−1.26
Poverty	1.53	1.46−1.61	1.54	1.46−1.62
Low level of education	1.42	1.37−1.47	1.55	1.49−1.62
Unemployment	1.18	1.12−1.24	1.15	1.08−1.23
	Men aged ≥ 65		**Women aged ≥ 65**	
	RR	**95% CI**	**RR**	**95% CI**
Living alone	1.17	1.14−1.21	1.12	1.08−1.16
Poverty	1.27	1.21−1.32	1.31	1.24−1.38
Low level of education	1.26	1.23−1.29	1.30	1.27−1.34

The reference category is those individuals who had none of the risk factors during the period 2006−2010. RRs were estimated from separate models for each risk factor.

Adjusted for age and region of residence

Results concerning the Objective 2

Next we studied the associations between different combinations of cumulative disadvantage and hospitalisations due to ACSCs (Table 3). All combinations of two, and three (and four among the middle-aged) risk factors increased significantly the odds of being hospitalized due to ACSC compared with the reference group who had none of the risk factors. The only exception was the combination of living alone and unemployment, which was not statistically significant among middle-aged women. Among the middle-aged, the most hazardous combination of two risk factors was living alone and poverty among both genders; the RR was 2.62 (95% confidence interval 2.52−2.73) among men and 2.53 (2.41−2.65) among women. Those risk combinations which included unemployment had the smallest RRs. The most hazardous combination of three risk factors was living alone, poverty, and low level of education with RR of 3.16 (3.03−3.29) among men and 3.54 (3.36−3.73) among women. The effect of cumulative disadvantage on hospitalisations due to ACSCs was larger for women among the middle-aged (p-value for interaction between gender and cumulative disadvantage 0.02). When all the four risk factors were present, the RRs were 2.24 (2.10−2.39) and 1.98 (1.80−2.18), respectively and the effect was larger for men (p-value for interaction between gender and cumulative disadvantage 0.009). Among elderly men, the most hazardous combination of two risk factors was living alone and poverty: the RR was 1.49 (1.44−1.56). Among elderly women, the present of poverty and low level of education was the most hazardous combination of two risk factors: the RR was 1.48 (1.42−1.53). When all the three risk factors (living alone, poverty, and low level of education) were present, the RR was 1.61 (1.57−1.66) and 1.69 (1.64−1.74), respectively.

Table 3. The effect of different combinations of the risk factors in 2006–2010 on hospitalisations due to ambulatory care sensitive conditions in Finland in 2011–2013

Living alone	Poverty	Low level of education	Unemployment	Men aged 45-64 RR	Men aged 45-64 95% CI	Women aged 45-64 RR	Women aged 45-64 95% CI
Combinations of two risk factors							
X	X	–	–	2.62	2.52–2.73	2.53	2.41–2.65
X	–	X	–	1.70	1.62–1.79	1.57	1.47–1.68
X	–	–	X	1.39	1.28–1.51	1.08	0.94–1.23
–	X	X	–	2.02	1.92–2.13	2.52	2.38–2.66
–	X	–	X	1.61	1.49–1.74	1.52	1.39–1.65
–	–	X	X	1.24	1.16–1.33	1.27	1.17–1.37
Combinations of three risk factors							
X	X	X	–	3.16	3.03–3.29	3.54	3.36–3.73
X	X	–	X	2.11	2.00–2.23	1.75	1.62–1.90
X	–	X	X	1.40	1.23–1.59	1.39	1.17–1.67
–	X	X	X	1.78	1.63–1.95	1.83	1.66–2.02
All four risk factors							
X	X	X	X	2.24	2.10–2.39	1.98	1.80–2.18

Living alone	Poverty	Low level of education	Men aged ≥ 65 RR	Men aged ≥ 65 95% CI	Women aged ≥ 65 RR	Women aged ≥ 65 95% CI
Combinations of two risk factors						
X	X	–	1.49	1.44–1.56	1.43	1.38–1.48
X	–	X	1.40	1.36–1.44	1.36	1.32–1.41
–	X	X	1.31	1.28–1.35	1.48	1.42–1.53
All three risk factors						
X	X	X	1.61	1.57–1.66	1.69	1.64–1.74

The reference category is those individuals who had none of the risk factors during the period 2006–2010. RRs were estimated from separate models for each combination of risk factors.

Adjusted for age and region of residence

Results concerning the Objective 3

The effect of prolonged cumulative disadvantage between 2006–2010 on ACSCs in 2011–2013 was examined for the most hazardous combination of the risk factors, i.e. simultaneously living alone, experiencing poverty and low level of education. All RRs for being hospitalised due to ACSCs for those experiencing one or more years of cumulative disadvantage were statistically significant compared with those individuals who had none of the risk factors during the period 2006–2010 among both genders and

age groups (Table 4). The RR for being hospitalized was 3.91 (3.70−4.12) for those middle-aged men who had all the three risk factors in each year compared with those who had none of the risk factors between 2006−2010. Among middle-aged women, the corresponding RR was 4.75 (4.44−5.07). For the elderly, the RR was 1.66 (1.61−1.71) and 1.72 (1.67−1.78).

Table 4. The effect of prolonged cumulative disadvantage in 2006−2010 on ambulatory care sensitive conditions in Finland in 2011−2013 for the combination of living alone, poverty, and low level of education

The number of years of cumulative disadvantage[1]	Men aged 45-64			Women aged 45-64		
	RR	95% CI	n[2]	RR	95% CI	n[2]
0	1.00	ref.[3]	311 927	1.00	ref.[3]	339 402
1	2.47	2.28−2.69	9 304	2.45	2.20−2.74	7 031
2	2.74	2.49−3.01	6 088	2.57	2.25−2.92	4 368
3	2.72	2.46−3.01	4 767	3.35	2.95−3.80	3 434
4	3.06	2.77−3.39	4 163	3.60	3.16−4.09	2 999
5	3.91	3.70−4.12	12 432	4.75	4.44−5.07	9 189
	Men aged ≥ 65			Women aged ≥ 65		
	RR	95% CI	n[2]	RR	95% CI	n[2]
0	1.00	ref.[3]	116 197	1.00	ref.[3]	91 452
1	1.59	1.51−1.67	6 063	1.56	1.49−1.64	15 941
2	1.56	1.47−1.66	4 220	1.60	1.51−1.69	10 308
3	1.59	1.51−1.68	5 296	1.68	1.59−1.76	12 744
4	1.47	1.39−1.54	6 341	1.67	1.59−1.75	16 167
5	1.66	1.61−1.71	26 598	1.72	1.67−1.78	96 202

[1] In these analyses those individuals who had experienced disadvantage of one risk factor or cumulative disadvantage related to combination of two risk factors were excluded

[2] The total number of individuals in the category

[3] The reference category is those individuals who had none of the risk factors during the period 2006−2010

Adjusted for age and region of residence

Among middle-aged men and women, the prolongation of the cumulative disadvantage increased gradually the odds of being hospitalized due to ACSCs. The ORs for those who had experienced prolonged cumulative disadvantage in one, two, three, or four years was statistically smaller than if an individual had experienced cumulative disadvantage in each year. Among the middle-aged, the effect of prolongation of cumulative

disadvantage on hospitalisations due to ACSCs was statistically different between men and women only for those who had experienced it for three or five years (p-values for interaction between gender and prolonged cumulative disadvantage < 0.05).

Among elderly men, the prolongation of the cumulative disadvantage did not increase the odds of being hospitalized due to ACSC, i.e. experiencing one or more years of cumulative disadvantage did not change the odds compared with those individuals who had experienced cumulative disadvantage in each of the five years. Only the difference between four and five years of cumulative disadvantage was statistically significant (pairwise comparison p-value < 0.001). Among elderly women, the differences experiencing one or two years of cumulative disadvantage compared with five years were statistically significant (pairwise comparison p-values < 0.003). Among the elderly, the prolongation of cumulative disadvantage had also statistically different effect on hospitalisations due to ACSCs among men and women for those who had experienced it for three or more years (p-values for interaction between gender and prolonged cumulative disadvantage < 0.004).

Results concerning the sensitivity analyses

The odds of being hospitalised due to ACSC for those with cumulative disadvantage compared with those without any of the examined risk factors decreased when including only incident ACSC hospitalisations. For the most hazardous combination of cumulative disadvantage (living alone, poverty, and low level of education), the RR was 2.50 (2.37 2.64) among middle-aged men and 2.72 (2.54−2.92) among middle-aged women when excluding all individuals who were hospitalised due to ACSC before 2011 from the analyses. For the elderly, the RR was 1.53 (1.48−1.59) and 1.57 (1.50−1.64).

Discussion

This population-based register study found strong associations between preceding cumulative social disadvantage and hospitalisations due to ambulatory care sensitive conditions. The study population included all Finnish residents aged 45 years or older in 2011–2013 and for this population we utilised comprehensive data from several administrative registers to examine their hospitalisations in 2011–2013 and preceding social and socioeconomic risk factors in 2006–2010. We defined cumulative social disadvantage as combination of several simultaneous risk factors for disadvantage preceding the study period: living alone, poverty, low level of education, and unemployment. The risk of being hospitalised due to ACSCs was markedly elevated if an individual had lived alone and had experienced poverty during the preceding years, and had also poor education. The same combination of the risk factors for social disadvantage was the most hazardous for both age groups (45–64 and over 64) among both genders. Additionally, we found that prolongation of cumulative disadvantage in time increased further the risk of being hospitalized due to ACSCs among the middle-aged (aged 45–64). Among the middle-aged the prolongation of accumulation of risks was even more hazardous for women than for men.

The lack of nationwide comprehensive register data on the use of primary health care is a common limitation in health services research. Hospitalisations due to ACSCs provide an indirect measure of the effectiveness and quality of primary health care. Some studies have questioned the accuracy of this indicator to reflect access to primary care. However, the studies concluding that hospitalisations due to ACSCs are not associated with poor access to health care, have used area-level data and have not been able to take into account need for care at individual-level.[45-47] Thus conclusive evidence that more efficient or more accessible primary care could not prevent a notable proportion of hospitalisations due to ACSCs is lacking.

A universal list of ACSCs does not exist since hospitalisation criteria vary between countries and health care systems.[10] We applied the UK definition with some minor modifications to maintain international comparability. However, the main purpose of this study was to examine social disadvantage as a risk factor

for hospitalisations due to ACSCs within Finland and not to compare countries. We expect there to be no differences in coding practices between socioeconomic groups in administrative regions of Finland. Thus we assume that there is no considerable inconsistence in using this ACSC definition list for our purposes.

In this study both emergency and elective hospital admissions were included while some earlier studies have included only emergency admissions.[9, 25] In regard to social and socioeconomic differences, the use of both emergency and elective hospitalisations is likely to somewhat diminish these differences since social disadvantage might increase the risk of emergency hospitalisations while acting as a barrier to elective care.[48] Additionally, the majority of the hospital admissions due to ACSCs in our data were emergency admissions. Thus we presume our results of social inequity would be even greater, had we studied only emergency hospital admissions.

With register data we were not able to measure social isolation directly and thus we used living alone as a crude proxy. This measure excludes the individual's social networks outside their home. Living alone does not always denote social isolation or loneliness, although they are interrelated and overlapping. Despite these limitations we detected strong associations between living arrangements and hospitalisations due to ACSCs and our results suggest that living arrangements reflect social support relatively accurately. Another limitation is that we were not able to take into account for ill-health, morbidity or disease severity which is an evident shortage when utilising merely register data on the use of hospital care. Thus, we cannot make direct conclusions what part of differences between social groups in hospitalisations due to ACSCs would be explained by the different health status of individuals.

Our results of univariate effects of the socioeconomic risk factors on hospitalisations due to ACSCs are in line with the results found in several earlier studies reporting that disadvantaged socioeconomic position is associated with increased risk of being hospitalised due to ACSCs.[15, 24, 27] These previous studies examined only one socioeconomic factor or used small area based deprivation indices in assessing socioeconomic position. Few studies have examined several socioeconomic factors at the same time. Blustein et al.[11] found that poorer and less-educated individuals were likely to be hospitalised due to

ACSCs in the US in the early 1990's, but they modelled education and income separately. A study from Sweden detected that individuals with lower income and those not gainfully employed had higher risk of becoming hospitalised due to ACSCs in the mid 2000's.[26] Booth et al.[16] studied the effect of education and income at the community-level on acute diabetes complications in Canada in the late 1990's and found that only low neighbourhood income increased the risk of being hospitalised. De Prophetis et al.[17] detected that risk of being hospitalised due to ACSCs was highest for those who jointly had the lowest levels of life satisfaction and low household income. The study by Wallar and Rosella[18], saw that individuals among the two lowest income quintiles were at greatest risk of being hospitalised due to ACSCs when adjusting for education and health behavioural factors. However, these studies did not examine how the accumulation of individual-level socioeconomic risk factors affects the risk of being hospitalised due to ACSCs. Higher prevalence of morbidity among individuals with low socioeconomic position is likely to partly explain inequalities in hospitalisation due to ACSCs. While primary health care obviously cannot prevent all ACSC events leading to hospital admissions, an efficient health care system should diminish differences between socioeconomic groups which may also be partly due to higher morbidity among the lower socioeconomic groups.

We evaluated the effect of living alone as a proxy for social isolation on hospitalisations due to ACSCs. We found that the univariate effect of living alone was significant and increased the risk of being hospitalised due to ACSCs and the effect was greater for middle-aged men than for middle-aged women. Living alone was as hazardous as poverty and low level of education among middle-aged men. The strong association between living alone and the risk of being hospitalized due to ACSC suggests that absence of adequate social support might also play a role in seeking care especially among men with low socioeconomic position. Using interview data Longman et al.[38] have reported a similar finding concerning social isolation as a contributory factor in avoidable hospital admissions in Australia. Ennis et al.[39] studied the association of living alone and hospitalisations due to ACSCs in the US and concluded that living alone in later life did not increase hospitalisation risk. Their study cohort included about 2 600 selected participants who were presumably healthier than the general population. Thus, the results might not be applicable to broader

population groups. Saxena et al.[29] found significant negative association between asthma, hypertension and COPD hospitalisations and proportion of elderly living alone in London. Their interpretation of this finding was that the support structures in the affluent areas prevent hospitalisations among the elderly.

We found the univariate effect of unemployment and its effect as a co-factor in accumulation of risk factors to be smaller than the effect of the other risk factors. This finding is likely to reflect at least to some extent the fact that long-term unemployment is difficult to measure using register data. It is possible that our indicator does not properly capture all people suffering from long-term unemployment since it is based on statistics that includes people registered as active job applicants. Further, the study took place during a severe recession with high prevalence of unemployment resulting in the unemployed becoming more heterogeneous and being unemployed less stigmatizing than in times when the economy is booming. Thus, due to the recession, unemployment in our study may have represented less of a risk factor for social deprivation and less severe health consequences. Alternatively, the finding of the small effect of unemployment may derive from a homogenous unemployed population. Especially in the beginning of unemployment the Finnish welfare state is relatively generous in buffering against the economic effect resulting from the loss of a job. An unemployed is entitled to earning-related benefit for 14 to 23 months, depending on the length of the employment history. Thus, it is only after a longer period of time that the effects of unemployment regarding the loss of earnings will take place. Since we could not disentangle those still enjoying the subsidies from those that no longer did, the effects among the latter "hard core" unemployed group are potentially downplayed.

The higher risk of being hospitalised due to ACSCs among individuals with several simultaneous risk factors for social disadvantage found in our study is probably due to multiple causes. The inequalities found in hospitalisations due to ACSCs certainly partly reflect differences in access to and quality of primary health care. Earlier studies have found that individuals with higher socioeconomic position have clearly more annual visits to physicians than those with lower position after controlling for health status.[4, 49] There is area-level evidence that low socioeconomic position and fewer physicians are associated with poorer access to care in addition to higher hospitalisations due to ACSCs.[50] Moreover, earlier studies have

suggested that for instance continuity of primary care is associated with reduced risk of avoidable hospitalisations.[51, 52] Especially a long-term relationship between a patient and a physician effectively reduces the risk.[53] It is likely that there are differences between socioeconomic groups in the continuity of care in the treatment of many common chronic conditions. The increased risk of being hospitalised due to ACSCs among individuals with cumulative disadvantage may also be caused by inadequate resources in primary health care to recognise the needs of people with simultaneous social and physical health problems and inability to treat and prevent these diseases from worsening. Socioeconomic inequalities in the use of health care are likely to be explained at least partly also by differences in seeking the care needed.[13]

The finding that the prolongation of cumulative disadvantage increased further the risk of being hospitalized for ACSCs among the middle-aged is likely to reflect the interplay of social disadvantage and health problems over time. Prolongation of cumulative disadvantage worsens further social and physical health problems gradually. However, among the elderly (aged over 64), the prolongation of cumulative disadvantage did not increase the risk further. This may be due to the fact that chronic conditions potentially leading to ACSC are relatively common among older age groups. Additionally, selective mortality may play a role by diminishing differences between socioeconomic groups.

The sensitivity analyses included only those individuals who had no previous hospitalisations due to ACSCs. They detected that cumulative disadvantage increases the risk of being hospitalised due to ACSCs somewhat less than when including all individuals. This suggests that accumulation of social disadvantage can have worse effects for those who have chronic conditions and/or recurring hospitalisations. On the other hand this finding supports the conclusion that persons without previous avoidable hospitalisations have increased risk of being hospitalised due to ACSCs after experiencing social disadvantage.

To our knowledge, this is the first study to assess exhaustively the relationship between the accumulation of social disadvantage and hospitalisations due to ACSCs. The use of comprehensive individual-level register data enabled us to avoid ecological bias which is common in studies using area-level socioeconomic and

social disadvantage variables. We were also able to study a rather long period of time and thus evaluate the effect of prolongation of accumulating social disadvantage; the retrospective follow-up time was eight years at longest. In our data avoidable hospitalisations were derived from the Care Register for Health Care, which has been found to be of good quality and coverage in general.[54] The methodological approach of the study allowed us to study simultaneously several risk factors that are to some extent dependent of each other.

The results of our study underline the importance of improving coordination of care across the system between social and health care, as well as primary and secondary care. Also primary prevention in the management of care should be emphasized. Universalism is not enough; the recognition of patients with chronic conditions and simultaneous particular combinations of cumulative disadvantage is important to diminish these extensive differences between social groups to improve social equity in health care. The identification of these vulnerable patients groups – who may be more susceptible – is also necessary to reduce the use of more expensive treatment in specialised health care. Treating people with multiple chronic conditions and social problems in primary care requires more attention and active means and for instance strengthening continuity of care is even more significant for these vulnerable patients groups.

Author's contribution SL participated in the conception and planning of the study, designed the study, analysed and interpreted the data and was a major contributor in writing the manuscript. KM, MA, SK, and IK participated in the conception and planning of the study and the interpretation of the results for important intellectual content and writing the manuscript. All authors read and approved the final manuscript.

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ACSC conditions	*ICD-10*	*Notes*
Vaccine-preventable		
Bacterial Pneumonia & Influenza	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, not included if D57 is as a secondary diagnose
Immunization-Related and Preventable Conditions	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field
Chronic		
Acute Bronchitis	J20	Only when as a primary diagnose, and J41-J44 or J47 as a secondary diagnose
Angina	I20, I24.0, I24.8, I24.9	Only when as a primary diagnose, cases with surgical procedures (A) excluded
Asthma	J45, J46	Only when as a primary diagnose
Chronic Obstructive Pulmonary Disease (COPD)	J41, J42, J43, J44, J47	Only when as a primary diagnose
Congestive Heart Failure	I11.0, I50, J81	Only when as a primary diagnose, cases with cardiac procedures (B) excluded
Diabetes Complications	E10.0-10.8, E11.0-E11.8, E12.0-E12.8, E13.0-E13.8, E14.0-E14.8	Only when as a primary diagnose
Hypertension	I10, I11.9	Only when as a primary diagnose, cases with cardiac procedures (B) excluded
Iron Deficiency Anaemia	D50.1-D50.9	Only when as a primary diagnose
Nutritional Deficiencies	E40, E41, E42, E43, E55.0, E64.3	Only when as a primary diagnose
Acute		
Cellulitis	L03, L04, L08.0, L08.8, L88, L98.0	Only when as a primary diagnose, cases with other surgical procedures than skin procedures (C) excluded
Convulsions and Epilepsy	G40, G41, O15, R56	Only when as a primary diagnose
Dehydration and Gastroenteritis	E86, K52.2, K52.8, K52.9	Only when as a primary diagnose
Dental Conditions	A69.0, K02-K06, K08, K09.8, K09.9, K12, K13	Only when as a primary diagnose
Gangrene	R02	In any diagnosis field
Kidney and Urinary Tract Infections	N10, N11, N12, N13.6	Only when as a primary diagnose
Pelvic Inflammatory Disease	N70, N73, N74	Only when as a primary diagnose
Perforated or Bleeding Ulcer	K25.0-K25.2, K25.4-K25.6, K26.0-K26.2, K26.4-K26.6, K27.0-K27.2, K27.4-K27.6, K28.0-K28.2, K28.4-K28.6	Only when as a primary diagnose
Severe ENT infection	H66, H67, J02, J03, J06, J31.2	Only when as a primary diagnose

A) Angina

procedure field contains none of the following (NCSP, Nordic Classification of Surgical Procedures):

AA4WT, AA400, AA5LT, AAA-AAW, AB4AT, AB4BT, AB4CT, AB4DT, AB4FT, AB5, AB6AT, AB6BT, AB6CT, AB6DT, ABA-ABW, ACA-ACW, AD-AW, AXX90, BA3AT, BA4KT, BAA, BB2AT, BB3AT, BB4WT, BBA, BC1LT, BC2-BC4, BCA, BD-BW, CAA-CAW, CB, CCA-CCW, CD-CJ, CKA-CKW, CW, DAA-DAW, DB, DCA-DCW, DD, DEA-DEW, DFA-DFE, DFW99, DG, DHA-DLW, DMA-DPW, DQ-DW, EA, EBA-EBW, EC, EDA-EDW, EEA-EW, EF, EGA-EGW, EHA-EHW, EJ-EK, EL3AT, EL3RT, EL3YT, EL4 ,ELA-ELW, EMA-EMW, EP1AT, EP1LT, EP2AT, EP3AT, ENA-ENW, EW, FA, FBA-FBW, FCA-FCE, FD, FE1AT, FE2, FEA-FEW, FF-FL, FMA-FMW, FN1ST, FN1XT, FNA-FNW, FP-FX, GA2-GA4, GAA-GAW, GBA-GBW, GCA, GD1AT, GD1BT, GD1CT, GD1LT, GD2AT, GD2BT, GD2CT, GD3, GDA-GDW, GE1AT, GE1CT, GE1DT, GE2, GEA-GEW, GW, HA0, HA1AT, HA1DT, HA1MT, HA1ST, HA2-HA5, HAA-HAF, HW, JA1LT, JA2-JA3, JAA-JAW, JB, JCA-JCW, JDA-JDW, JE, JF3, JFA-JFW, JGA-JGW, JHA-JHW, JJ1AT, JJ2-JJ8, JJA-JJW, JK1-JK2, J3KAT, JK3BT, JK3CT, JK3FT, JK3LT, JK3NT, JK3RT, JK4-JK5, JKA-JKW, JL1-JL3, JLA-JLW, JM1AT, JM1LT, JM2, JMA-JMW, JN4LT, JW, JX1LT, JX1RT, JXA, KA2AT, KA3AT, KA3CT, KA3DT, KA3LT, KA4-KA6, KAA-KAW, KBA-KBW, KC1AT, KC2AT, KC3AT, KCA-KCW, KDA-KDW, KE1AT, KE1CT, KE2, KEA-KEW, KF1-KF7, KF8AT, KF8KT, KFA-KFW, KGA-KGW, KH1AT, KH1BT, KH1CT, KH1CT, KH1DT, KH1FT, KH1YT, KKA-KKW, KW, KX, LA1, LAA-LAW, LB1AT, LB1YT, LBA-LBW, LCA-LCW, LDA-LDW, LEA-LEW, LF-LW, LX1LT, MAA-MAW, MBA-MBW, MC-MW, NA0, NA6CT, NA7BT, NA7FT, NA7KT, NA7LT, NA9KT, NAA-NAW, NB1AT,NB1BT, NB1ZT, NB2, NBA-NBW, NCA-NCW, NDA-NDW, NEA-NEW, NFA-NFW, NGA-NGW, NHA-NHW, NJ3LT, NK1AT, NK1CT, NK1DT, NK1LT, NK2-NK3, NK4AT, NK4BT, NK5, NK6AT, NK6BT, NK6CT, NK6DT, NK6KT, NK7AT, NX, PA2ZT, PA3-PA5, PA6AT, PA8KT, PA9KT, PAA-PAW, PB1AT, PB1BT, PB1ST, PB1YT, PBA-PBW, PC2DT, PC2ET, PC5AT, PC5BT, PC5DT, PC5ET, PC5GT, PC5HT, PC5JT, PC5NT, PC5PT, PC5YT, PC6DT, PC6ET, PC6FT, PC7NT, PCA-PCW, PD1AT, PD1YT, PD2DT, PD3, PD4ST, PD5YT, PD6YT, PD7YT, PDA-PDW, PE, PG1AT, PG1BT, PG1ET-PG1LT, PG1MT-PG1VT, PG1YT-PG3YT, PG5RT-PG6NT, PGA-PGW, PH1AT, PH1FT, PH1UT, PH2ST, PH3YT, PH4AT, PH5GT, PH6GT, PH7FT, PH7UT, PH9AT, PH9ST, PH900, PHA-PHW, PJ2AT, PJ2CT, PJ2HT, PJ3-PJ4, PJ5AN, PJA-PJW, PW, PXA-PXX, QAA-QAW, QBA-QBW, QCA-QCW, QDA-QDW, QW, QXA-QXW, QX2ZT, QX3AT, QX3CT, QX3LT, QX3YT, QX4, S, TAA-TAD, TAW99, TA100, TBA-TJF, TJG10, TJJ, TJL-TJW, TK-TL, TMA-TPX, TQ, U, WXQ, WW20, WW30-WW31, WW40, WW50, WX100-WX105, WX140-WX144, WX7-WX9, XCC00, XFE00, XFN96, XFX00, XFX10, XFX20, XFX97, XJW99, XPX00, XPX04, XPX08, XPX99, XW000, XW1-XW5, XX1AT, XX1BT, XX1CT, XX1DT, XX1XT, XX2AT-XX2DT, XX2XT, XX3AT-XX3DT, XX3XT, XX4-XX7, Y, ZC-ZP, ZS-ZX, ZZ

B) Congestive heart failure and hypertension

procedure field contains none of the following (NCSP, Nordic Classification of Surgical Procedures):

FEA-FEW, FFA00, FFA10-FFA30, FFA96, FFB-FFW, FG-FH, FJA00, FJA96, FJB-FJW, FKA-FKW, FK1BT, FLA00, FLA96, FLB-FLW, FMA-FMW, FN1AT, FN1BT, FN1ST, FN1XT, FN1YT, FNA-FNW, FPA-FPF, FPH-FPW, FQ, FXA00-FXN00, TFN10, TFN99, TFP00, TFP40-TFP59

C) Cellulitis

procedure field contains none of the following (NCSP, Nordic Classification of Surgical Procedures):

AA4WT, AA400, AA5LT, AAA-AAW, AB4AT, AB4BT, AB4CT, AB4DT, AB4FT, AB5, AB6AT, AB6BT, AB6CT, AB6DT, ABA-ABW, ACA-ACW, AD-AW, AXX90, BA3AT, BA4KT, BAA, BB2AT, BB3AT, BB4WT, BBA, BC1LT, BC2-BC4, BCA, BD-BW, CAA-CAW, CB, CCA-CCW, CD-CJ, CKA-CKW, CW, DAA-DAW, DB, DCA-DCW, DD, DEA-DEW, DFA-DFE, DFW99, DG, DHA-DLW, DMA-DPW, DQ-DW, EA, EBA-EBW, EC, EDA-EDW, EEA-EW, EF, EGA-EGW, EHA-EHW, EJ-EK, EL3AT, EL3RT, EL3YT, EL4, ELA-ELW, EMA-EMW, EP1AT, EP1LT, EP2AT, EP3AT, ENA-ENW, EW, FA, FBA-FBW, FCA-FCE, FD, FE1AT, FE2, FEA-FEW, FF-FL, FMA-FMW, FN1ST, FN1XT, FNA-FNW, FP-FX, GA2-GA4, GAA-GAW, GBA-GBW, GCA, GD1AT, GD1BT, GD1CT, GD1LT, GD2AT, GD2BT, GD2CT, GD3, GDA-GDW, GE1AT, GE1CT, GE1DT, GE2, GEA-GEW, GW, HA0, HA1AT, HA1DT, HA1MT, HA1ST, HA2-HA5, HAA-HAF, HW, JA1LT, JA2-JA3, JAA-JAW, JB, JCA-JCW, JDA-JDW, JE, JF3, JFA-JFW, JGA-JGW, JHA-JHW, JJ1AT, JJ2-JJ8, JJA-JJW, JK1-JK2, J3KAT, JK3BT, JK3CT, JK3FT, JK3LT, JK3NT, JK3RT, JK4-JK5, JKA-JKW, JL1-JL3, JLA-JLW, JM1AT, JM1LT, JM2, JMA-JMW, JN4LT, JW, JX1LT, JX1RT, JXA, KA2AT, KA3AT, KA3CT, KA3DT, KA3LT, KA4-KA6, KAA-KAW, KBA-KBW, KC1AT, KC2AT, KC3AT, KCA-KCW, KDA-KDW, KE1AT, KE1CT, KE2, KEA-KEW, KF1-KF7, KF8AT, KF8KT, KFA-KFW, KGA-KGW, KH1AT, KH1BT, KH1CT, KH1CT, KH1DT, KH1FT, KH1YT, KKA-KKW, KW, KX, LA1, LAA-LAW, LB1AT, LB1YT, LBA-LBW, LCA-LCW, LDA-LDW, LEA-LEW, LF-LW, LX1LT, MAA-MAW, MBA-MBW, MC-MW, NA0, NA6CT, NA7BT, NA7FT, NA7KT, NA7LT, NA9KT, NAA-NAW, NB1AT,NB1BT, NB1ZT, NB2, NBA-NBW, NCA-NCW, NDA-NDW, NEA-NEW, NFA-NFW, NGA-NGW, NHA-NHW, NJ3LT, NK1AT, NK1CT, NK1DT, NK1LT, NK2-NK3, NK4AT, NK4BT, NK5, NK6AT, NK6BT, NK6CT, NK6DT, NK6KT, NK7AT, NX, PA2ZT, PA3-PA5, PA6AT, PA8KT, PA9KT, PAA-PAW, PB1AT, PB1BT, PB1ST, PB1YT, PBA-PBW, PC2DT, PC2ET, PC5AT, PC5BT, PC5DT, PC5ET, PC5GT, PC5HT, PC5JT, PC5NT, PC5PT, PC5YT, PC6DT, PC6ET, PC6FT, PC7NT, PCA-PCW, PD1AT, PD1YT, PD2DT, PD3, PD4ST, PD5YT, PD6YT, PD7YT, PDA-PDW, PE, PG1AT, PG1BT, PG1ET-PG1LT, PG1MT-PG1VT, PG1YT-PG3YT, PG5RT-PG6NT, PGA-PGW, PH1AT, PH1FT, PH1UT, PH2ST, PH3YT, PH4AT, PH5GT, PH6GT, PH7FT, PH7UT, PH9AT, PH9ST, PH900, PHA-PHW, PJ2AT, PJ2CT, PJ2HT, PJ3-PJ4, PJ5AN, PJA-PJW, PW, PXA-PXX, QAA25, QAB00-QAB05, QAB99, QAC, QAD20, QAE-QAF, QAG10-QAG99, QAJ, QBA25, QBB00-QBB05, QBB99, QBC, QBD20, QBE, QBG10-QBG99, QBJ, QCA25, QCA30, QCB00-QCB05, QCB99, QCC, QCD20, QCE-QCG, QCJ, QDA25, QDB00-QDB05, QDB99, QDC, QDD20, QDE, QDG10-QDG99, QDJ, QXA25, QXB00-QXB05, QXB99, QXC, QXD20, QXE, QXG10-QXG99, QXJ, QX2ZT, QX3AT, QX3CT, QX3LT, QX3YT, QX4, S, TAA-TAD, TAW99, TA100, TBA-TJF, TJG10, TJJ, TJL-TJW, TK-TL, TMA-TPX, TQA-TQD, TQW00, TQW02, TQW30-40, TQW99, TQX00-TQX10, U, WW20, WW30-WW31, WW40, WW50, WX100-WX105, WX140-WX144, WX7-WX9, XCC00, XFE00, XFN96, XFX00, XFX10, XFX20, XFX97, XJW99, XPX00, XPX04, XPX08, XPX99, XW000, XW1-XW5, XX1AT, XX1BT, XX1CT, XX1DT, XX1XT, XX2AT-XX2DT, XX2XT, XX3AT-XX3DT, XX3XT, XX4-XX7, Y, ZC-ZP, ZS-ZX, ZZ

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	#1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	#2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	#4-6
Objectives	3	State specific objectives, including any prespecified hypotheses	#6
Methods			
Study design	4	Present key elements of study design early in the paper	#7-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	#7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	#7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	#7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	#7-8
Bias	9	Describe any efforts to address potential sources of bias	#NA
Study size	10	Explain how the study size was arrived at	#7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	#9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	#9
		(*b*) Describe any methods used to examine subgroups and interactions	#10
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, explain how loss to follow-up was addressed	NA
		(*e*) Describe any sensitivity analyses	#10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	#11
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	#11
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	#11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	#11-15
		(*b*) Report category boundaries when continuous variables were categorized	#10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	#10
Discussion			
Key results	18	Summarise key results with reference to study objectives	#16
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	#16-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	#19-21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	#21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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Cumulative social disadvantage and hospitalisations due to ambulatory care sensitive conditions in Finland in 2011–2013: a register study

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Abstract

Objectives To study the interplay between several indicators of social disadvantage and hospitalisations due to ambulatory care sensitive conditions (ACSC) in 2011–2013. To evaluate whether the accumulation of preceding social disadvantage in one point of time or prolongation of social disadvantage had an effect on hospitalisations due to ACSCs. Four common indicators of disadvantage are examined: living alone, low level of education, poverty and unemployment.

Design A population-based register study

Setting Nationwide individual-level register data on hospitalisations due to ACSCs for the years 2011–2013 and preceding data on social and socioeconomic factors for the years 2006–2010

Participants Finnish residents aged 45 or older in January 1st 2011

Outcome measure Hospitalisations due to ACSCs in 2011–2013. The effect of accumulation of preceding disadvantage in one point of time and its prolongation on ACSCs was studied using modified Poisson regression.

Results People with preceding cumulative social disadvantage were more likely to be hospitalised due to ACSCs. The most hazardous combination was simultaneously living alone, low level of education, and poverty among the middle-aged (aged 45-64) and the elderly (over 64). Risk ratio (RR) of being hospitalized due to ACSC was 3.16 (95% confidence interval 3.03-3.29) among middle-aged men and 3.54 (3.36-3.73) among middle-aged women compared with individuals without any of these risk factors when controlling for age and residential area. For the elderly, the RR was 1.61 (1.57-1.66) among men and 1.69 (1.64-1.74) among women.

Conclusions To improve social equity in health care, it is important to recognise not only patients with cumulative disadvantage, but – as this study shows – patients with particular combinations of disadvantage

who may be more susceptible. The identification of these vulnerable patients groups is also necessary to reduce the use of more expensive treatment in specialised health care.

Keywords: Socioeconomic disadvantage, social disadvantage, ambulatory care sensitive conditions, inequities, health care, register data

Strengths and limitations of this study

- The individual-level register-based data allowed us to study simultaneously several indicators of social and socioeconomic disadvantage
- The nationwide register data covered all hospitalisations due to ambulatory care sensitive conditions (ACSCs) in Finland
- We were able to study social disadvantage of period preceding hospitalisations and its effect on being hospitalised due to ACSCs
- Hospitalisations due to ACSCs is an indirect indicator of the effectiveness and quality of primary health care
- While the study addressed associations between social disadvantage and hospitalisations due to ACSCs, the causality between morbidity and social disadvantage could not be studied

Background

Inadequate access to health care is one of the important determinants of social inequities in health.[1] Well organised primary care has repeatedly been shown to promote population health and prevent ill-health. There is also evidence that primary care (in contrast to specialist care) is associated with a more equitable distribution of health in populations through prevention and early management of health problems and through facilitating entry to the rest of the health care system.[2] The Finnish health-care system provides a good case for examining equity as the system operates on the principle of universality and therefore, in general, supports equal access to health services according to need.[3] Simultaneously, studies from both Finland and some other countries with universal health care systems show systematic and persistent socioeconomic inequities in physician utilisation in relation to need.[2-5] Challenges in providing timely access to primary care are encountered in some areas[6] and there are indications of differences in primary health care quality between regions.[7] However, Finland has – compared to most other European countries – a strong publicly funded primary health care.[8]

Hospitalisations due to ambulatory care sensitive conditions (ACSC) are used to indirectly evaluate the effectiveness and quality of primary care.[9, 10] They are defined as hospitalisations that could be prevented by primary care interventions. Earlier studies have used slightly different lists of conditions, but have usually examined three types of conditions: conditions that can be prevented by vaccination, acute conditions in which hospitalisation can be prevented by adequate (acute) management of the condition, and chronic conditions where good quality and timely primary care can prevent later admissions, e.g., due to complications of diabetes. Several studies from the U.S.,[11-13] Canada,[14-18] Australia,[19-21] New Zealand[22] and European countries[23-29] have examined socioeconomic differences in ACSC and reported more ACSC hospitalisations among persons with lower socioeconomic background.

Most earlier studies examining socioeconomic differences in ACSC have used ecological data of single socioeconomic indicators, mainly income[12, 14, 15, 24, 25, 28] or deprivation indices based on ecological data,[19-23, 25, 27, 29] while few studies have focused on the individual-level socioeconomic indicators.

Socioeconomic position is, however, a complex construct reflecting different dimensions of the individuals' standing in the social hierarchy.[30] The persistence of health inequalities have led researchers to point out that we need to analyse multiple social circumstances simultaneously in order to assess their impact on health and health care.[31] We found few studies utilizing this approach with ACSCs. One study, which examined elderly Medicare beneficiaries in the USA, and another study from Ontario, Canada, utilising survey data linked to administrative databases, used multiple individual-level indicators of socioeconomic position but they did not examine them simultaneously.[11, 17] A study from the Stockholm County in Sweden[26] and a study from Canada[18] analysed several individual-level socioeconomic variables simultaneously. Additionally, a study from Ontario, Canada, examined trends and regional differences in acute diabetes complications and accounted for income and education at the community level.[16]

In addition to social position, social relationships may also contribute to outcomes of health care.[32, 33] Social relationships can be measured using self-reported measures of social isolation or loneliness. Using register data, it is possible to study living arrangements and to use living alone as a proxy measure for social isolation. Although previous studies have found a strong association between living alone and social isolation and loneliness,[34] these conditions are distinct. However, also living alone has been found to increase the use of health services[35, 36] and living alone has been applied as a measure of social isolation.[37] Social isolation has been identified as a risk factor for avoidable hospitalisation in one interview study from rural Australia.[38] On the other hand, a study using area-level measures of social deprivation detected lower admission rates for several chronic diseases in areas with higher proportions of elderly individuals living alone in London.[29] A study in the US found no association between living alone and hospitalisations due to ACSCs among retirement age (65+) individuals.[39] The population studied was, however, a sample of participants having access to an integrated delivery system with a preventive approach in the management of services and thus representing healthier residents than the general population.

Cumulative disadvantage may refer to two distinct social processes. On the one hand, it may imply accumulation of individual forms of disadvantage cross-sectionally. On the other hand, cumulative

disadvantage may be observed with one or several forms of disadvantage persisting over time. The above-mentioned studies have not examined how these social risk factors cumulate at individual-level either in one point of time or during a longer time period and whether the accumulation is associated with the risk of being hospitalised due to ACSCs. In recent literature, researchers have suggested that the effects of risk factors accumulate over time and thus increase socioeconomic disparities in health outcomes.[40, 41] A large number of studies have found associations between cumulative disadvantage and health. However, the relationship between accumulation of social disadvantage and health care in terms of effectiveness and quality, has received relatively little attention.

Social risk factors may have different impacts on outcomes of health care. Accumulation of the risk factors may also increase the risk of poor outcomes. Additionally, the effect of accumulation may vary depending on the combination of the risk factors and the persistence of accumulation. The main aim of the current study is to examine whether the preceding accumulation of social disadvantage increases inequities in outcomes of health care. We study hospitalisations due to ACSCs as an outcome of health care and as a study population we examine Finns aged 45 and over. The more specific study questions are: 1) What is the univariate effect of each risk factor on the risk of being hospitalised due to ACSCs if an individual has no other risk factors? 2) What combination of social disadvantage in one point of time is the most hazardous in terms of hospitalisations due to ACSCs? 3) Does prolongation of cumulative disadvantage in time have effect on hospitalisations due to ACSCs? We examine four common indicators of social disadvantage: living alone, poverty, low level of education and unemployment. We utilise comprehensive individual-level register data on sociodemographic and social factors and hospitalisations between 2006–2013.

Materials

The study population included non-institutionalised Finnish residents aged 45 years or older in January 1st 2011. For this population, annual individual-level information on sociodemographic factors in 2006−2010 was obtained from different administrative registers maintained by Statistics Finland. These exposure factors included information on gender, age and region of residence as well as factors which were used to define risk factors for disadvantage: living arrangements, income, education and annual number of unemployment months within a calendar year. Register data on hospitalisations due to ACSCs for the population at risk were individually linked to the sociodemographic data. Hospitalisations due to ACSCs in 2011−2013 was used as an outcome measure. Information on hospitalisations was obtained from the Care Register for Health Care maintained by the Finnish Institute for Health and Welfare. The UK definition of ACSCs was applied with an addition of unspecified pneumonia (ICD-10 code J18.9) and influenza (J09)[10] (supplementary file 1). ACSCs were categorised as acute, chronic or vaccine-preventable conditions as suggested by previous studies.[42] Both emergence and elective inpatient hospital admissions, at least one night length of stay, were included.

The data were divided into two age groups: individuals aged 45-64 (the middle-aged) and 65 and older (the elderly) and these age groups were studied separately in all analyses. This allowed us to study whether there were differences between the middle-aged and the elderly in the association between ACSC hospitalisations and cumulative disadvantage and enabled us to include unemployment as a risk factor in the analysis in the younger age group. In addition, there are structural differences in access to ambulatory care services between the working aged population and others due to occupational health care.[3] Men and women were studied mainly separately due to differing levels of hospitalisations due to ACSCs[7] and effects of risk factors. Hospital districts were used as an indicator of region of residence. This allowed us to adjust for the differences in the incidence of hospitalisations due to ACSCs between regions. The division of these 20 regions is based on an administrative division of the Finnish hospital care system.

The situation of living arrangements on December 31st in each year was used to define a dichotomous variable indicating whether an individual had lived alone during the year. We studied disposable family net income as an indicator for income. The family income was adjusted for family size using the OECD modified equivalence scale. Poverty was defined as net family income lower than 60% of the median family income.[43] Data on level of education was used to categorize the risk factor related to education. Low level of education was defined as having no degrees after comprehensive school which is nine years of schooling. We defined the individual as being unemployed for that year if being unemployed for 6-12 months during the year. For the older age group in this study, we did not use unemployment as a risk factor as they are rarely in paid labour in Finland.

Ethics

Ethical approval for the study was received from the Research Ethics Committee of the Finnish Institute for Health and Welfare.

Patient and Public Involvement

Patients were not involved in the design or the implementation of the study.

Statistical methods

ACSC hospitalisations was treated as a binary outcome variable, combining those with one and several ACSC hospitalisations into one category and modified Poisson regression method was used in analysing the data.[44] Our main interest was the effect of preceding social and socioeconomic factors on hospitalisations due to ACSCs in 2011−2013. The studied social and socioeconomic risk factors were living alone, poverty, and low level of education (and also unemployment for the younger age group) and these explanatory variables were also included in the model as binary variables. All analyses throughout the study were adjusted for region of residence and age, age treated as categorical variable by 5-year age groups. The modest correlations between the explanatory variables were taken into account by creating composite variables (Cramer's V was 0.06-0.34 among middle-aged men and 0.06-0.29 among middle-aged women. Among the elderly, the values were 0.09-0.37 and 0.08-0.45).

Objective 1: We aimed to study the univariate effect of each social risk factor on hospitalisations due to ACSCs by analysing separately each risk factor including only that variable as an explanatory variable in the model in addition to age and region. In these analyses we assessed the effect of each social risk factor separately for those who had experienced only that social disadvantage in 2006−2010 (at least in one year) compared with individuals who had none of the risk factors during the whole period. Additionally, the differences of the univariate effects of the risk factors were tested by creating a composite variable made up of all social risk factor variables.

Objective 2: We aimed to identify the most hazardous combination of social disadvantage in terms of hospitalisations due to ACSCs for the combinations of two, three (and four among the younger age group) risk factors. This was done by creating composite variables of different combinations of the risk factors in 2006−2010 and these composite variables were modelled separately as the explanatory variables. If this risk factor was present at least in one year, it was considered as a risk factor and the prolongation was not taken into consideration in these analyses. Those who had none of the social risk factors during the years served as the reference group.

Objective 3: The effect of prolongation of cumulative disadvantage on hospitalisations due to ACSCs was studied for the most hazardous combination of the risk factors found in the analyses of the Objective 2. We studied how the prolongation of the cumulative disadvantage modified the risk by categorising the number of years (0 to 5 years) of cumulative disadvantage during the period and treating this categorical variable as an explanatory variable. For instance, if an individual had simultaneously all studied risk factors in each year between 2006−2010, he/she was categorised as having 5 years of prolonged cumulative disadvantage. Again, those who had none of the risk factors in 2006−2010 served as the reference group. Additionally, we performed pairwise comparison tests to study whether the number of years of prolongation of cumulative disadvantage had an effect on the RRs among those who had experienced cumulative disadvantage.

Men and women were studied separately but in the additional analyses gender differences in the associations of risk factors (as univariate, cumulative, and prolonged cumulative) and hospitalisations due to ACSCs were tested in the same model. This was done by including an interaction term between gender and risk factors.

Sensitivity analyses

We conducted additional analyses for analyses concerning the Objective 2. In these additional analyses we included only incident hospitalisations due to ACSCs and excluded those patients who had preceding hospitalisation due to ACSCs in 1987−2010. Otherwise, the assumptions and definitions were similar to the main analyses.

We used SAS (SAS Institute Inc., Cary, NC, USA) version 9.4 to analyse the data.

Results

In the study period 2011−2013, the population at risk comprised altogether 1 530 397 (50% men) individuals aged 45-64 and 927 152 (42% men) individuals aged 65 or over. In 2011−2013, 4% (29 275/760 139) of middle-aged men and 3% (20 846/770 258) of middle-aged women had been hospitalised due to ACSCs. Among the elderly, the proportions were 16% (60 110/387 970) and 14% (73 231/539 182). Of those men, who had ACSC hospitalisations, 75% had only one ACSC hospitalisation during the study period among the middle-aged and 64% among the elderly. Among women, the corresponding proportions were 79% and 67%.

Living alone was the most common risk factor of the studied social risk factors among the middle-aged. Of men 30% and 28% of women had lived alone at least in one year in 2006−2010 (Table 1). Among the elderly, low level of education was the most common risk factor, with 56% of the men and 62% of the women having low level of education. For each risk factor, the proportion of hospitalisation due to ACSCs in 2011−2013 was clearly higher among those who had the risk factor compared with those who had not experienced the risk factor in any of the years 2006−2010.

Table 1. Characteristics of the study population by social and socioeconomic risk factors in 2006–2010 and hospitalisations due to ambulatory care sensitive conditions (ACSCs) in 2011–2013 by age and gender in Finland

		Men aged 45-64 n = 760 139		Women aged 45-64 n = 770 258	
Risk factor		**% of having risk factor in 2006–2010**	**% of having hospitalisations due to ACSCs in 2011–2013**	**% of having risk factor in 2006–2010**	**% of having hospitalisations due to ACSCs in 2011–2013**
Living alone					
	YES	30	5.4	28	3.8
	NO	70	3.2	72	2.3
Poverty					
	YES	25	6.2	23	4.3
	NO	75	3.1	77	2.2
Low level of education					
	YES	27	5.3	22	4.1
	NO	73	3.3	78	2.3
Unemployment					
	YES	19	4.5	16	3.0
	NO	81	3.7	84	2.7

		Men aged ≥ 65 n = 387 970		Women aged ≥ 65 n = 539 182	
Risk factor		**% of having risk factor in 2006–2010**	**% of having hospitalisations due to ACSCs in 2011–2013**	**% of having risk factor in 2006–2010**	**% of having hospitalisations due to ACSCs in 2011–2013**
Living alone					
	YES	29	19.7	55	16.8
	NO	71	13.8	45	9.7
Poverty					
	YES	31	21.4	47	18.3
	NO	69	12.9	53	9.4
Low level of education					
	YES	56	18.3	62	16.1
	NO	44	11.9	38	9.6

If an individual had the risk factor at least in one year in 2006–2010, he/she was categorised as having the risk factor.

If an individual had not had the risk factor in any of the years 2006−2010, he/she was categorised as not having the risk factor.

Results concerning the Objective 1

All the studied social and socioeconomic risk factors had a univariate effect on hospitalisations due to ACSCs after controlling for area of residence and age (Table 2). Each of the risk factors increased significantly the odds of being hospitalized due to ACSCs after adjustment for age and area of residence compared to individuals who had none of the risk factors in 2006−2010. Poverty and low level of education had the strongest univariate effect on ACSCs among both age groups and genders. The univariate effect of unemployment was statistically significantly smaller than the effect of all the other studied risk factors among middle-aged men (p-values < 0.0001). Among middle-aged women, the univariate effect of unemployment was statistically smaller than the effect of poverty and low level of education (p-values < 0.0001). The univariate effect of living alone was statistically significantly smaller than the low level of education among the elderly (p-values < 0.001). The effect of living alone was significantly larger for men among the middle-aged (p-value for interaction between gender and living alone < 0.0001) and the effect of poverty and low level of education was greater for women among the elderly (p-values for interaction < 0.01).

Table 2. Univariate effects of the risk factors in 2006−2010 on hospitalisations due to ambulatory care sensitive conditions by age and gender in Finland in 2011−2013

	Men aged 45-64		**Women aged 45-64**	
	RR	**95% CI**	**RR**	**95% CI**
Living alone	1.39	1.34−1.44	1.20	1.15−1.26
Poverty	1.53	1.46−1.61	1.54	1.46−1.62
Low level of education	1.42	1.37−1.47	1.55	1.49−1.62
Unemployment	1.18	1.12−1.24	1.15	1.08−1.23
	Men aged ≥ 65		**Women aged ≥ 65**	
	RR	**95% CI**	**RR**	**95% CI**
Living alone	1.17	1.14−1.21	1.12	1.08−1.16
Poverty	1.27	1.21−1.32	1.31	1.24−1.38
Low level of education	1.26	1.23−1.29	1.30	1.27−1.34

The reference category is those individuals who had none of the risk factors during the period 2006−2010. RRs were estimated from separate models for each risk factor.

Adjusted for age and region of residence

Results concerning the Objective 2

Next we studied the associations between different combinations of cumulative disadvantage and hospitalisations due to ACSCs (Table 3). All combinations of two, and three (and four among the middle-aged) risk factors increased significantly the odds of being hospitalized due to ACSC compared with the reference group who had none of the risk factors. The only exception was the combination of living alone and unemployment, which was not statistically significant among middle-aged women. Among the middle-aged, the most hazardous combination of two risk factors was living alone and poverty among both genders; the RR was 2.62 (95% confidence interval 2.52−2.73) among men and 2.53 (2.41−2.65) among women. Those risk combinations which included unemployment had the smallest RRs. The most hazardous combination of three risk factors was living alone, poverty, and low level of education with RR of 3.16 (3.03−3.29) among men and 3.54 (3.36−3.73) among women. The effect of cumulative disadvantage on hospitalisations due to ACSCs was larger for women among the middle-aged (p-value for interaction between gender and cumulative disadvantage 0.02). When all the four risk factors were present, the RRs were 2.24 (2.10−2.39) and 1.98 (1.80−2.18), respectively and the effect was larger for men (p-value for interaction between gender and cumulative disadvantage 0.009). Among elderly men, the most hazardous combination of two risk factors was living alone and poverty: the RR was 1.49 (1.44−1.56). Among elderly women, the present of poverty and low level of education was the most hazardous combination of two risk factors: the RR was 1.48 (1.42−1.53). When all the three risk factors (living alone, poverty, and low level of education) were present, the RR was 1.61 (1.57−1.66) and 1.69 (1.64−1.74), respectively.

Table 3. The effect of different combinations of the risk factors in 2006–2010 on hospitalisations due to ambulatory care sensitive conditions in Finland in 2011–2013

Living alone	Poverty	Low level of education	Unemployment	Men aged 45-64 RR	Men aged 45-64 95% CI	Women aged 45-64 RR	Women aged 45-64 95% CI
Combinations of two risk factors							
X	X	–	–	2.62	2.52–2.73	2.53	2.41–2.65
X	–	X	–	1.70	1.62–1.79	1.57	1.47–1.68
X	–	–	X	1.39	1.28–1.51	1.08	0.94–1.23
–	X	X	–	2.02	1.92–2.13	2.52	2.38–2.66
–	X	–	X	1.61	1.49–1.74	1.52	1.39–1.65
–	–	X	X	1.24	1.16–1.33	1.27	1.17–1.37
Combinations of three risk factors							
X	X	X	–	3.16	3.03–3.29	3.54	3.36–3.73
X	X	–	X	2.11	2.00–2.23	1.75	1.62–1.90
X	–	X	X	1.40	1.23–1.59	1.39	1.17–1.67
–	X	X	X	1.78	1.63–1.95	1.83	1.66–2.02
All four risk factors							
X	X	X	X	2.24	2.10–2.39	1.98	1.80–2.18

Living alone	Poverty	Low level of education	Men aged ≥ 65 RR	Men aged ≥ 65 95% CI	Women aged ≥ 65 RR	Women aged ≥ 65 95% CI
Combinations of two risk factors						
X	X	–	1.49	1.44–1.56	1.43	1.38–1.48
X	–	X	1.40	1.36–1.44	1.36	1.32–1.41
–	X	X	1.31	1.28–1.35	1.48	1.42–1.53
All three risk factors						
X	X	X	1.61	1.57–1.66	1.69	1.64–1.74

The reference category is those individuals who had none of the risk factors during the period 2006–2010. RRs were estimated from separate models for each combination of risk factors.

Adjusted for age and region of residence

Results concerning the Objective 3

The effect of prolonged cumulative disadvantage between 2006–2010 on ACSCs in 2011–2013 was examined for the most hazardous combination of the risk factors, i.e. simultaneously living alone, experiencing poverty and low level of education. All RRs for being hospitalised due to ACSCs for those experiencing one or more years of cumulative disadvantage were statistically significant compared with those individuals who had none of the risk factors during the period 2006–2010 among both genders and

age groups (Table 4). The RR for being hospitalized was 3.91 (3.70−4.12) for those middle-aged men who had all the three risk factors in each year compared with those who had none of the risk factors between 2006−2010. Among middle-aged women, the corresponding RR was 4.75 (4.44−5.07). For the elderly, the RR was 1.66 (1.61−1.71) and 1.72 (1.67−1.78).

Table 4. The effect of prolonged cumulative disadvantage in 2006−2010 on ambulatory care sensitive conditions in Finland in 2011−2013 for the combination of living alone, poverty, and low level of education

The number of years of cumulative disadvantage[1]	Men aged 45-64			Women aged 45-64		
	RR	95% CI	n[2]	RR	95% CI	n[2]
0	1.00	ref.[3]	311 927	1.00	ref.[3]	339 402
1	2.47	2.28−2.69	9 304	2.45	2.20−2.74	7 031
2	2.74	2.49−3.01	6 088	2.57	2.25−2.92	4 368
3	2.72	2.46−3.01	4 767	3.35	2.95−3.80	3 434
4	3.06	2.77−3.39	4 163	3.60	3.16−4.09	2 999
5	3.91	3.70−4.12	12 432	4.75	4.44−5.07	9 189
	Men aged ≥ 65			Women aged ≥ 65		
	RR	95% CI	n[2]	RR	95% CI	n[2]
0	1.00	ref.[3]	116 197	1.00	ref.[3]	91 452
1	1.59	1.51−1.67	6 063	1.56	1.49−1.64	15 941
2	1.56	1.47−1.66	4 220	1.60	1.51−1.69	10 308
3	1.59	1.51−1.68	5 296	1.68	1.59−1.76	12 744
4	1.47	1.39−1.54	6 341	1.67	1.59−1.75	16 167
5	1.66	1.61−1.71	26 598	1.72	1.67−1.78	96 202

[1] In these analyses those individuals who had experienced disadvantage of one risk factor or cumulative disadvantage related to combination of two risk factors were excluded

[2] The total number of individuals in the category

[3] The reference category is those individuals who had none of the risk factors during the period 2006−2010

Adjusted for age and region of residence

Among middle-aged men and women, the prolongation of the cumulative disadvantage increased gradually the odds of being hospitalized due to ACSCs. The ORs for those who had experienced prolonged cumulative disadvantage in one, two, three or four years was statistically smaller than if an individual had experienced cumulative disadvantage in each year. Among the middle-aged, the effect of prolongation of cumulative

disadvantage on hospitalisations due to ACSCs was statistically different between men and women only for those who had experienced it for three or five years (p-values for interaction between gender and prolonged cumulative disadvantage < 0.05).

Among elderly men, the prolongation of the cumulative disadvantage did not increase the odds of being hospitalized due to ACSC, i.e. experiencing one or more years of cumulative disadvantage did not change the odds compared with those individuals who had experienced cumulative disadvantage in each of the five years. Only the difference between four and five years of cumulative disadvantage was statistically significant (pairwise comparison p-value < 0.001). Among elderly women, the differences experiencing one or two years of cumulative disadvantage compared with five years were statistically significant (pairwise comparison p-values < 0.003). Among the elderly, the prolongation of cumulative disadvantage had also statistically different effect on hospitalisations due to ACSCs among men and women for those who had experienced it for three or more years (p-values for interaction between gender and prolonged cumulative disadvantage < 0.004).

Results concerning the sensitivity analyses

The odds of being hospitalised due to ACSC for those with cumulative disadvantage compared with those without any of the examined risk factors decreased when including only incident ACSC hospitalisations. For the most hazardous combination of cumulative disadvantage (living alone, poverty and low level of education), the RR was 2.50 (2.37 2.64) among middle-aged men and 2.72 (2.54−2.92) among middle-aged women when excluding all individuals who were hospitalised due to ACSC before 2011 from the analyses. For the elderly, the RR was 1.53 (1.48−1.59) and 1.57 (1.50−1.64).

Discussion

This population-based register study found strong associations between preceding cumulative social disadvantage and hospitalisations due to ambulatory care sensitive conditions. The study population included all Finnish residents aged 45 years or older in 2011–2013 and for this population we utilised comprehensive data from several administrative registers to examine their hospitalisations in 2011–2013 and preceding social and socioeconomic risk factors in 2006–2010. We defined cumulative social disadvantage as combination of several simultaneous risk factors for disadvantage preceding the study period: living alone, poverty, low level of education and unemployment. The risk of being hospitalised due to ACSCs was markedly elevated if an individual had lived alone and had experienced poverty during the preceding years, and had also poor education. The same combination of the risk factors for social disadvantage was the most hazardous for both age groups (45–64 and over 64) among both genders. Additionally, we found that prolongation of cumulative disadvantage in time increased further the risk of being hospitalized due to ACSCs among the middle-aged (aged 45–64). Among the middle-aged the prolongation of accumulation of risks was even more hazardous for women than for men.

Strengths and limitations

The lack of nationwide comprehensive register data on the use of primary health care is a common limitation in health services research. Hospitalisations due to ACSCs provide an indirect measure of the effectiveness and quality of primary health care. Some studies have questioned the accuracy of this indicator to reflect access to primary care. However, the studies concluding that hospitalisations due to ACSCs are not associated with poor access to health care, have used area-level data and have not been able to take into account need for care at individual-level.[45-47] Thus conclusive evidence that more efficient or more accessible primary care could not prevent a notable proportion of hospitalisations due to ACSCs is lacking.

A universal list of ACSCs does not exist since hospitalisation criteria vary between countries and health care systems.[10] We applied the UK definition with some minor modifications to maintain international

comparability. However, the main purpose of this study was to examine social disadvantage as a risk factor for hospitalisations due to ACSCs within Finland and not to compare countries. We expect there to be no differences in coding practices between socioeconomic groups in administrative regions of Finland. Thus we assume that there is no considerable inconsistence in using this ACSC definition list for our purposes.

In this study both emergency and elective hospital admissions were included while some earlier studies have included only emergency admissions.[9, 25] In regard to social and socioeconomic differences, the use of both emergency and elective hospitalisations is likely to somewhat diminish these differences since social disadvantage might increase the risk of emergency hospitalisations while acting as a barrier to elective care.[48] Additionally, the majority of the hospital admissions due to ACSCs in our data were emergency admissions. Thus we presume our results of social inequity would be even greater, had we studied only emergency hospital admissions.

With register data we were not able to measure social isolation directly and thus we used living alone as a crude proxy. This measure excludes the individual's social networks outside their home. Living alone does not always denote social isolation or loneliness, although they are interrelated and overlapping. Despite these limitations we detected strong associations between living arrangements and hospitalisations due to ACSCs and our results suggest that living arrangements reflect social support relatively accurately. Another limitation is that we were not able to take into account for ill-health, morbidity or disease severity which is an evident shortage when utilising merely register data on the use of hospital care. Thus, we cannot make direct conclusions what part of the differences between social groups in hospitalisations due to ACSCs would be explained by the different health status of individuals.

Our results of univariate effects of the socioeconomic risk factors on hospitalisations due to ACSCs are in line with the results found in several earlier studies reporting that disadvantaged socioeconomic position is associated with increased risk of being hospitalised due to ACSCs.[15, 24, 27] These previous studies examined only one socioeconomic factor or used small area based deprivation indices in assessing socioeconomic position. Few studies have examined several socioeconomic factors at the same time.

Blustein et al.[11] found that poorer and less-educated individuals were likely to be hospitalised due to ACSCs in the US in the early 1990's, but they modelled education and income separately. A study from Sweden detected that individuals with lower income and those not gainfully employed had higher risk of becoming hospitalised due to ACSCs in the mid 2000's.[26] Booth et al.[16] studied the effect of education and income at the community-level on acute diabetes complications in Canada in the late 1990's and found that only low neighbourhood income increased the risk of being hospitalised. De Prophetis et al.[17] detected that risk of being hospitalised due to ACSCs was highest for those who jointly had the lowest levels of life satisfaction and low household income. The study by Wallar and Rosella[18], saw that individuals among the two lowest income quintiles were at greatest risk of being hospitalised due to ACSCs when adjusting for education and health behavioural factors. However, these studies did not examine how the accumulation of individual-level socioeconomic risk factors affects the risk of being hospitalised due to ACSCs. Higher prevalence of morbidity among individuals with low socioeconomic position is likely to partly explain inequalities in hospitalisation due to ACSCs. While primary health care obviously cannot prevent all ACSC events leading to hospital admissions, an efficient health care system should diminish differences between socioeconomic groups which may also be partly due to higher morbidity among the lower socioeconomic groups.

We evaluated the effect of living alone as a proxy for social isolation on hospitalisations due to ACSCs. We found that the univariate effect of living alone was significant and increased the risk of being hospitalised due to ACSCs and the effect was greater for middle-aged men than for middle-aged women. Living alone was as hazardous as poverty and low level of education among middle-aged men. The strong association between living alone and the risk of being hospitalized due to ACSC suggests that absence of adequate social support might also play a role in seeking care especially among men with low socioeconomic position. Using interview data Longman et al.[38] have reported a similar finding concerning social isolation as a contributory factor in avoidable hospital admissions in Australia. Ennis et al.[39] studied the association of living alone and hospitalisations due to ACSCs in the US and concluded that living alone in later life did not increase hospitalisation risk. Their study cohort included about 2 600 selected participants who were

presumably healthier than the general population. Thus, the results might not be applicable to broader population groups. Saxena et al.[29] found significant negative association between asthma, hypertension and COPD hospitalisations and proportion of elderly living alone in London. Their interpretation of this finding was that the support structures in the affluent areas prevent hospitalisations among the elderly.

We found the univariate effect of unemployment and its effect as a co-factor in accumulation of risk factors to be smaller than the effect of the other risk factors. This finding is likely to reflect at least to some extent the fact that long-term unemployment is difficult to measure using register data. It is possible that our indicator does not properly capture all people suffering from long-term unemployment since it is based on statistics that includes people registered as active job applicants. Further, the study took place during a severe recession with high prevalence of unemployment resulting in the unemployed becoming more heterogeneous and being unemployed less stigmatizing than in times when the economy is booming. Thus, due to the recession, unemployment in our study may have represented less of a risk factor for social deprivation and less severe health consequences. Alternatively, the finding of the small effect of unemployment may derive from a homogenous unemployed population. Especially in the beginning of unemployment the Finnish welfare state is relatively generous in buffering against the economic effect resulting from the loss of a job. An unemployed is entitled to earning-related benefit for 14 to 23 months, depending on the length of the employment history. Thus, it is only after a longer period of time that the effects of unemployment regarding the loss of earnings will take place. Since we could not disentangle those still enjoying the subsidies from those that no longer did, the effects among the latter "hard core" unemployed group are potentially downplayed.

The higher risk of being hospitalised due to ACSCs among individuals with several simultaneous risk factors for social disadvantage found in our study is probably due to multiple causes. The inequalities found in hospitalisations due to ACSCs certainly partly reflect differences in access to and quality of primary health care. Earlier studies have found that individuals with higher socioeconomic position have clearly more annual visits to physicians than those with lower position after controlling for health status.[4, 49] There is area-level evidence that low socioeconomic position and fewer physicians are associated with poorer

access to care in addition to higher hospitalisations due to ACSCs.[50] Moreover, earlier studies have suggested that for instance continuity of primary care is associated with reduced risk of avoidable hospitalisations.[51, 52] Especially a long-term relationship between a patient and a physician effectively reduces the risk.[53] It is likely that there are differences between socioeconomic groups in the continuity of care in the treatment of many common chronic conditions. The increased risk of being hospitalised due to ACSCs among individuals with cumulative disadvantage may also be caused by inadequate resources in primary health care to recognise the needs of people with simultaneous social and physical health problems and inability to treat and prevent these diseases from worsening. Socioeconomic inequalities in the use of health care are likely to be explained at least partly also by differences in seeking the care needed.[13]

The finding that the prolongation of cumulative disadvantage increased further the risk of being hospitalized for ACSCs among the middle-aged is likely to reflect the interplay of social disadvantage and health problems over time. Prolongation of cumulative disadvantage worsens further social and physical health problems gradually. However, among the elderly (aged over 64), the prolongation of cumulative disadvantage did not increase the risk further. This may be due to the fact that chronic conditions potentially leading to ACSC are relatively common among older age groups. Additionally, selective mortality may play a role by diminishing differences between socioeconomic groups.

The sensitivity analyses included only those individuals who had no previous hospitalisations due to ACSCs. They detected that cumulative disadvantage increases the risk of being hospitalised due to ACSCs somewhat less than when including all individuals. This suggests that accumulation of social disadvantage can have worse effects for those who have chronic conditions and/or recurring hospitalisations. On the other hand this finding supports the conclusion that persons without previous avoidable hospitalisations have increased risk of being hospitalised due to ACSCs after experiencing social disadvantage.

To our knowledge, this is the first study to assess exhaustively the relationship between the accumulation of social disadvantage and hospitalisations due to ACSCs. The use of comprehensive individual-level register

data enabled us to avoid ecological bias which is common in studies using area-level socioeconomic and social disadvantage variables. We were also able to study a rather long period of time and thus evaluate the effect of prolongation of accumulating social disadvantage; the retrospective follow-up time was eight years at longest. In our data avoidable hospitalisations were derived from the Care Register for Health Care, which has been found to be of good quality and coverage in general.[54] The methodological approach of the study allowed us to study simultaneously several risk factors that are to some extent dependent of each other.

Conclusions

The results of our study underline the importance of improving coordination of care across the system between social and health care, as well as primary and secondary care. Also primary prevention in the management of care should be emphasized. Universalism is not enough; the recognition of patients with chronic conditions and simultaneous particular combinations of cumulative disadvantage is important to diminish these extensive differences between social groups to improve social equity in health care. The identification of these vulnerable patients groups – who may be more susceptible – is also necessary to reduce the use of more expensive treatment in specialised health care. Treating people with multiple chronic conditions and social problems in primary care requires more attention and active means and for instance strengthening continuity of care is even more significant for these vulnerable patients groups.

Author's contribution SL participated in the conception and planning of the study, designed the study, analysed and interpreted the data and was a major contributor in writing the manuscript. KM, MA, SK, and IK participated in the conception and planning of the study and the interpretation of the results for important intellectual content and writing the manuscript. All authors read and approved the final manuscript.

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A competing interests statement The authors declare that they have no competing interests.

A patient consent form Not applicable

A data sharing statement Data may be obtained from a third party and are not publicly available

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ACSC conditions	*ICD-10*	*Notes*
Vaccine-preventable		
Bacterial Pneumonia & Influenza	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, not included if D57 is as a secondary diagnose
Immunization-Related and Preventable Conditions	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field
Chronic		
Acute Bronchitis	J20	Only when as a primary diagnose, and J41-J44 or J47 as a secondary diagnose
Angina	I20, I24.0, I24.8, I24.9	Only when as a primary diagnose, cases with surgical procedures (A) excluded
Asthma	J45, J46	Only when as a primary diagnose
Chronic Obstructive Pulmonary Disease (COPD)	J41, J42, J43, J44, J47	Only when as a primary diagnose
Congestive Heart Failure	I11.0, I50, J81	Only when as a primary diagnose, cases with cardiac procedures (B) excluded
Diabetes Complications	E10.0-10.8, E11.0-E11.8, E12.0-E12.8, E13.0-E13.8, E14.0-E14.8	Only when as a primary diagnose
Hypertension	I10, I11.9	Only when as a primary diagnose, cases with cardiac procedures (B) excluded
Iron Deficiency Anaemia	D50.1-D50.9	Only when as a primary diagnose
Nutritional Deficiencies	E40, E41, E42, E43, E55.0, E64.3	Only when as a primary diagnose
Acute		
Cellulitis	L03, L04, L08.0, L08.8, L88, L98.0	Only when as a primary diagnose, cases with other surgical procedures than skin procedures (C) excluded
Convulsions and Epilepsy	G40, G41, O15, R56	Only when as a primary diagnose
Dehydration and Gastroenteritis	E86, K52.2, K52.8, K52.9	Only when as a primary diagnose
Dental Conditions	A69.0, K02-K06, K08, K09.8, K09.9, K12, K13	Only when as a primary diagnose
Gangrene	R02	In any diagnosis field
Kidney and Urinary Tract Infections	N10, N11, N12, N13.6	Only when as a primary diagnose
Pelvic Inflammatory Disease	N70, N73, N74	Only when as a primary diagnose
Perforated or Bleeding Ulcer	K25.0-K25.2, K25.4-K25.6, K26.0-K26.2, K26.4-K26.6, K27.0-K27.2, K27.4-K27.6, K28.0-K28.2, K28.4-K28.6	Only when as a primary diagnose
Severe ENT infection	H66, H67, J02, J03, J06, J31.2	Only when as a primary diagnose

A) Angina

procedure field contains none of the following (NCSP, Nordic Classification of Surgical Procedures):

AA4WT, AA400, AA5LT, AAA-AAW, AB4AT, AB4BT, AB4CT, AB4DT, AB4FT, AB5, AB6AT, AB6BT, AB6CT, AB6DT, ABA-ABW, ACA-ACW, AD-AW, AXX90, BA3AT, BA4KT, BAA, BB2AT, BB3AT, BB4WT, BBA, BC1LT, BC2-BC4, BCA, BD-BW, CAA-CAW, CB, CCA-CCW, CD-CJ, CKA-CKW, CW, DAA-DAW, DB, DCA-DCW, DD, DEA-DEW, DFA-DFE, DFW99, DG, DHA-DLW, DMA-DPW, DQ-DW, EA, EBA-EBW, EC, EDA-EDW, EEA-EW, EF, EGA-EGW, EHA-EHW, EJ-EK, EL3AT, EL3RT, EL3YT, EL4 ,ELA-ELW, EMA-EMW, EP1AT, EP1LT, EP2AT, EP3AT, ENA-ENW, EW, FA, FBA-FBW, FCA-FCE, FD, FE1AT, FE2, FEA-FEW, FF-FL, FMA-FMW, FN1ST, FN1XT, FNA-FNW, FP-FX, GA2-GA4, GAA-GAW, GBA-GBW, GCA, GD1AT, GD1BT, GD1CT, GD1LT, GD2AT, GD2BT, GD2CT, GD3, GDA-GDW, GE1AT, GE1CT, GE1DT, GE2, GEA-GEW, GW, HA0, HA1AT, HA1DT, HA1MT, HA1ST, HA2-HA5, HAA-HAF, HW, JA1LT, JA2-JA3, JAA-JAW, JB, JCA-JCW, JDA-JDW, JE, JF3, JFA-JFW, JGA-JGW, JHA-JHW, JJ1AT, JJ2-JJ8, JJA-JJW, JK1-JK2, J3KAT, JK3BT, JK3CT, JK3FT, JK3LT, JK3NT, JK3RT, JK4-JK5, JKA-JKW, JL1-JL3, JLA-JLW, JM1AT, JM1LT, JM2, JMA-JMW, JN4LT, JW, JX1LT, JX1RT, JXA, KA2AT, KA3AT, KA3CT, KA3DT, KA3LT, KA4-KA6, KAA-KAW, KBA-KBW, KC1AT, KC2AT, KC3AT, KCA-KCW, KDA-KDW, KE1AT, KE1CT, KE2, KEA-KEW, KF1-KF7, KF8AT, KF8KT, KFA-KFW, KGA-KGW, KH1AT, KH1BT, KH1CT, KH1CT, KH1DT, KH1FT, KH1YT, KKA-KKW, KW, KX, LA1, LAA-LAW, LB1AT, LB1YT, LBA-LBW, LCA-LCW, LDA-LDW, LEA-LEW, LF-LW, LX1LT, MAA-MAW, MBA-MBW, MC-MW, NA0, NA6CT, NA7BT, NA7FT, NA7KT, NA7LT, NA9KT, NAA-NAW, NB1AT,NB1BT, NB1ZT, NB2, NBA-NBW, NCA-NCW, NDA-NDW, NEA-NEW, NFA-NFW, NGA-NGW, NHA-NHW, NJ3LT, NK1AT, NK1CT, NK1DT, NK1LT, NK2-NK3, NK4AT, NK4BT, NK5, NK6AT, NK6BT, NK6CT, NK6DT, NK6KT, NK7AT, NX, PA2ZT, PA3-PA5, PA6AT, PA8KT, PA9KT, PAA-PAW, PB1AT, PB1BT, PB1ST, PB1YT, PBA-PBW, PC2DT, PC2ET, PC5AT, PC5BT, PC5DT, PC5ET, PC5GT, PC5HT, PC5JT, PC5NT, PC5PT, PC5YT, PC6DT, PC6ET, PC6FT, PC7NT, PCA-PCW, PD1AT, PD1YT, PD2DT, PD3, PD4ST, PD5YT, PD6YT, PD7YT, PDA-PDW, PE, PG1AT, PG1BT, PG1ET-PG1LT, PG1MT-PG1VT, PG1YT-PG3YT, PG5RT-PG6NT, PGA-PGW, PH1AT, PH1FT, PH1UT, PH2ST, PH3YT, PH4AT, PH5GT, PH6GT, PH7FT, PH7UT, PH9AT, PH9ST, PH900, PHA-PHW, PJ2AT, PJ2CT, PJ2HT, PJ3-PJ4, PJ5AN, PJA-PJW, PW, PXA-PXX, QAA-QAW, QBA-QBW, QCA-QCW, QDA-QDW, QW, QXA-QXW, QX2ZT, QX3AT, QX3CT, QX3LT, QX3YT, QX4, S, TAA-TAD, TAW99, TA100, TBA-TJF, TJG10, TJJ, TJL-TJW, TK-TL, TMA-TPX, TQ, U, WXQ, WW20, WW30-WW31, WW40, WW50, WX100-WX105, WX140-WX144, WX7-WX9, XCC00, XFE00, XFN96, XFX00, XFX10, XFX20, XFX97, XJW99, XPX00, XPX04, XPX08, XPX99, XW000, XW1-XW5, XX1AT, XX1BT, XX1CT, XX1DT, XX1XT, XX2AT-XX2DT, XX2XT, XX3AT-XX3DT, XX3XT, XX4-XX7, Y, ZC-ZP, ZS-ZX, ZZ

B) Congestive heart failure and hypertension

procedure field contains none of the following (NCSP, Nordic Classification of Surgical Procedures):

FEA-FEW, FFA00, FFA10-FFA30, FFA96, FFB-FFW, FG-FH, FJA00, FJA96, FJB-FJW, FKA-FKW, FK1BT, FLA00, FLA96, FLB-FLW, FMA-FMW, FN1AT, FN1BT, FN1ST, FN1XT, FN1YT, FNA-FNW, FPA-FPF, FPH-FPW, FQ, FXA00-FXN00, TFN10, TFN99, TFP00, TFP40-TFP59

C) Cellulitis

procedure field contains none of the following (NCSP, Nordic Classification of Surgical Procedures):

AA4WT, AA400, AA5LT, AAA-AAW, AB4AT, AB4BT, AB4CT, AB4DT, AB4FT, AB5, AB6AT, AB6BT, AB6CT, AB6DT, ABA-ABW, ACA-ACW, AD-AW, AXX90, BA3AT, BA4KT, BAA, BB2AT, BB3AT, BB4WT, BBA, BC1LT, BC2-BC4, BCA, BD-BW, CAA-CAW, CB, CCA-CCW, CD-CJ, CKA-CKW, CW, DAA-DAW, DB, DCA-DCW, DD, DEA-DEW, DFA-DFE, DFW99, DG, DHA-DLW, DMA-DPW, DQ-DW, EA, EBA-EBW, EC, EDA-EDW, EEA-EW, EF, EGA-EGW, EHA-EHW, EJ-EK, EL3AT, EL3RT, EL3YT, EL4, ELA-ELW, EMA-EMW, EP1AT, EP1LT, EP2AT, EP3AT, ENA-ENW, EW, FA, FBA-FBW, FCA-FCE, FD, FE1AT, FE2, FEA-FEW, FF-FL, FMA-FMW, FN1ST, FN1XT, FNA-FNW, FP-FX, GA2-GA4, GAA-GAW, GBA-GBW, GCA, GD1AT, GD1BT, GD1CT, GD1LT, GD2AT, GD2BT, GD2CT, GD3, GDA-GDW, GE1AT, GE1CT, GE1DT, GE2, GEA-GEW, GW, HA0, HA1AT, HA1DT, HA1MT, HA1ST, HA2-HA5, HAA-HAF, HW, JA1LT, JA2-JA3, JAA-JAW, JB, JCA-JCW, JDA-JDW, JE, JF3, JFA-JFW, JGA-JGW, JHA-JHW, JJ1AT, JJ2-JJ8, JJA-JJW, JK1-JK2, J3KAT, JK3BT, JK3CT, JK3FT, JK3LT, JK3NT, JK3RT, JK4-JK5, JKA-JKW, JL1-JL3, JLA-JLW, JM1AT, JM1LT, JM2, JMA-JMW, JN4LT, JW, JX1LT, JX1RT, JXA, KA2AT, KA3AT, KA3CT, KA3DT, KA3LT, KA4-KA6, KAA-KAW, KBA-KBW, KC1AT, KC2AT, KC3AT, KCA-KCW, KDA-KDW, KE1AT, KE1CT, KE2, KEA-KEW, KF1-KF7, KF8AT, KF8KT, KFA-KFW, KGA-KGW, KH1AT, KH1BT, KH1CT, KH1CT, KH1DT, KH1FT, KH1YT, KKA-KKW, KW, KX, LA1, LAA-LAW, LB1AT, LB1YT, LBA-LBW, LCA-LCW, LDA-LDW, LEA-LEW, LF-LW, LX1LT, MAA-MAW, MBA-MBW, MC-MW, NA0, NA6CT, NA7BT, NA7FT, NA7KT, NA7LT, NA9KT, NAA-NAW, NB1AT,NB1BT, NB1ZT, NB2, NBA-NBW, NCA-NCW, NDA-NDW, NEA-NEW, NFA-NFW, NGA-NGW, NHA-NHW, NJ3LT, NK1AT, NK1CT, NK1DT, NK1LT, NK2-NK3, NK4AT, NK4BT, NK5, NK6AT, NK6BT, NK6CT, NK6DT, NK6KT, NK7AT, NX, PA2ZT, PA3-PA5, PA6AT, PA8KT, PA9KT, PAA-PAW, PB1AT, PB1BT, PB1ST, PB1YT, PBA-PBW, PC2DT, PC2ET, PC5AT, PC5BT, PC5DT, PC5ET, PC5GT, PC5HT, PC5JT, PC5NT, PC5PT, PC5YT, PC6DT, PC6ET, PC6FT, PC7NT, PCA-PCW, PD1AT, PD1YT, PD2DT, PD3, PD4ST, PD5YT, PD6YT, PD7YT, PDA-PDW, PE, PG1AT, PG1BT, PG1ET-PG1LT, PG1MT-PG1VT, PG1YT-PG3YT, PG5RT-PG6NT, PGA-PGW, PH1AT, PH1FT, PH1UT, PH2ST, PH3YT, PH4AT, PH5GT, PH6GT, PH7FT, PH7UT, PH9AT, PH9ST, PH900, PHA-PHW, PJ2AT, PJ2CT, PJ2HT, PJ3-PJ4, PJ5AN, PJA-PJW, PW, PXA-PXX, QAA25, QAB00-QAB05, QAB99, QAC, QAD20, QAE-QAF, QAG10-QAG99, QAJ, QBA25, QBB00-QBB05, QBB99, QBC, QBD20, QBE, QBG10-QBG99, QBJ, QCA25, QCA30, QCB00-QCB05, QCB99, QCC, QCD20, QCE-QCG, QCJ, QDA25, QDB00-QDB05, QDB99, QDC, QDD20, QDE, QDG10-QDG99, QDJ, QXA25, QXB00-QXB05, QXB99, QXC, QXD20, QXE, QXG10-QXG99, QXJ, QX2ZT, QX3AT, QX3CT, QX3LT, QX3YT, QX4, S, TAA-TAD, TAW99, TA100, TBA-TJF, TJG10, TJJ, TJL-TJW, TK-TL, TMA-TPX, TQA-TQD, TQW00, TQW02, TQW30-40, TQW99, TQX00-TQX10, U, WW20, WW30-WW31, WW40, WW50, WX100-WX105, WX140-WX144, WX7-WX9, XCC00, XFE00, XFN96, XFX00, XFX10, XFX20, XFX97, XJW99, XPX00, XPX04, XPX08, XPX99, XW000, XW1-XW5, XX1AT, XX1BT, XX1CT, XX1DT, XX1XT, XX2AT-XX2DT, XX2XT, XX3AT-XX3DT, XX3XT, XX4-XX7, Y, ZC-ZP, ZS-ZX, ZZ

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	#1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	#2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	#4-6
Objectives	3	State specific objectives, including any prespecified hypotheses	#6
Methods			
Study design	4	Present key elements of study design early in the paper	#7-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	#7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	#7
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	#7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	#7-8
Bias	9	Describe any efforts to address potential sources of bias	#NA
Study size	10	Explain how the study size was arrived at	#7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	#9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	#9
		(*b*) Describe any methods used to examine subgroups and interactions	#10
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, explain how loss to follow-up was addressed	NA
		(*e*) Describe any sensitivity analyses	#10
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	#11
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	#11
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	#11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	#11-15
		(*b*) Report category boundaries when continuous variables were categorized	#10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	#10
Discussion			
Key results	18	Summarise key results with reference to study objectives	#16
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	#16-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	#19-21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	#21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.