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Higher smoking prevalence in urban compared to non-urban areas: Time trends in six European countries

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Abstract

We investigated differences in smoking prevalence between urban and non-urban area of residence in six Western European countries (Sweden, Finland, Denmark, Germany, Italy and Spain), and smoking prevalence trends over the period 1985–2000. In most countries, smoking prevalence was highest in urban areas, and increased with urbanization. Urban/non-urban inequalities were most pronounced among individuals with low education levels, and also among females. There were no significant differences in annual rate of change in smoking prevalence between non-urban and urban areas.

Keywords: Smoking; Inequalities; Urban/non-urban areas; Europe

Introduction

Smoking is an established risk factor for many diseases and is one of the most important public health problems worldwide (United States Surgeon

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General, 2004). In western countries, it has been consistently shown that smoking is not equally distributed among population groups, but is more concentrated among people with lower socioeconomic status (Cavelaars et al., 2000). While many studies have investigated socioeconomic differences in smoking, less attention has been given to differences according to area of residence. Given the excess mortality and morbidity of urban areas compared to non-urban areas in many countries (Reijneveld, 1998; Jessop, 1992), and the fact that smoking increases the risk of mortality and morbidity from many diseases (United States Surgeon General, 2004; Doll et al., 2004), it is important to establish whether smoking prevalence is higher in urban areas.

Most studies on geographical variation in smoking to date have compared neighbourhoods within cities. These studies suggest that the area where people live influences their smoking and other health-related behaviours (Smith et al., 1998; Shohaimi et al., 2003; Ross, 2000; Reijneveld, 1998; Duncan et al., 1999). In the international literature, there are few studies that compare smoking prevalence by urban and non-urban residence across countries. Furthermore, recent time trends in smoking prevalence in relation to urban/non-urban residence have not been documented.

Our study provides an overview of smoking inequalities according to urban/non-urban residence, and trends in smoking between urban and non-urban areas over the period of 1985–2000, in six European countries: Finland, Sweden, Denmark, Germany, Italy and Spain. We hypothesized that smoking would be more prevalent in urban compared to non-urban areas, and that the urban excess in smoking would be largest among people from lower socioeconomic backgrounds.

Smoking is thought to diffuse in the population like an epidemic, from people with high status to those with low socioeconomic status, with women lagging behind men (Lopez et al., 1994). We would like to investigate not only whether the smoking epidemic diffuses vertically (between social strata) but also horizontally (between geographical regions) from more to less central areas. Thus, we hypothesized that urban/non-urban inequalities developed in a similar way as inequalities by socioeconomic status, with more favourable trends in smoking in urban areas (similar to high socioeconomic groups) than in non-urban areas (similar to lower socioeconomic groups). In order to test these hypotheses, we analysed a database drawn from a series of national health interview surveys conducted in each country.

Methods

Surveys and respondents

A similar study using the same data source has documented trends in smoking inequalities according to educational level (Giskes et al., 2005). Data on tobacco smoking status, area of residence and education level were obtained from cross-sectional national health interview surveys or multi-purpose surveys. Information on place of residence was available for six countries that represent the major geographical regions of Western Europe: three northern European countries (Sweden, Denmark and Finland), one central country (Germany), and two southern European countries (Italy and Spain).

This study included 279,278 non-institutionalized respondents aged 25–79 years for most countries except Finland (age range 25–69 years). We used data from surveys held at four time points between 1985 and 2000, except for Denmark (three time points) and Italy (two recent time points). In Italy, information on area of residence was not available for earlier time points. Response rates ranged from 61% to 92%, but were above 70% for most countries and time points. Participants with missing data on smoking status, area of residence or education level were excluded from the analyses ($n = 1880$, 0.7%). Survey names, number of respondents and response rates are detailed elsewhere (Giskes et al., 2005).

Smoking status, education level, and area of residence

The measurement of smoking status has been documented in detail in a previous study (Giskes et al., 2005). In general, respondent's smoking status was grouped in two levels: current daily smokers and non-smokers (occasional, former and never smokers). However, for Denmark, daily and occasional smokers had to be combined because the Danish survey did not differentiate between these two groups of smokers.

Among many measures of socioeconomic status, education level was the only socioeconomic measure available for all countries included in the analysis. Details of education level classification were also described in the previous study (Giskes et al., 2005).

In our analyses, we simplified the classifications into a two-levels classification: low and high education. The "low" group consisted of participants with elementary or lower secondary education and the "high" group comprised of participants who completed upper secondary or tertiary education.

Different types of classifications were used in the national surveys for defining place of residence, i.e. according to: number of inhabitants in the areas (in Germany and Spain), qualitative classifications of cities and non-urban areas (in Sweden and Finland), or a combination of both (in Denmark and Italy). For most analyses, these classifications were simplified to "urban" and "non-urban". "Urban" residence was defined as living in municipalities with 100,000 or more inhabitants, while "non-urban" residence was defined as living in smaller municipalities. Even though the latter includes areas that could be qualified as "semi-urban" we use the summary term "non-urban" throughout this text. For Italy, we took the largest quantitative classification used in the survey as the cut-off point, i.e. more than 50,000 inhabitants. For Sweden, we grouped "semi-urban" and "non-urban" into the non-urban category, and for Finland we grouped "towns" and "non-urban areas". With this classification, the proportion of respondents living in non-urban areas was around 60% in each country, except for Sweden with 30%. The proportions of low-educated respondents were greater in non-urban areas in all countries and across all survey time-points (Table 1).

Analyses

Analyses were performed separately for each country, and were stratified by gender. We defined smoking prevalence as the proportion of current daily smokers in the study population. This was not possible for Denmark, for the reason described above. Smoking prevalence rates were age-standardized by the direct method, using the age-distribution of the European population in 2000 as the standard. Odds ratios were calculated by logistic regression, using non-urban smoking prevalence as the reference, and adjusted for age and education level.

We combined all survey time-points in each country to investigate urban/non-urban differences in smoking prevalence over the period of 1985–2000. In these combined analyses, period-specific weights were applied so that each time point had equal representation, despite differences between surveys in the number of respondents.

We also calculated prevalence rates and odds ratios in an expanded classification of urban areas, using the original classification of place of residence used in each survey. Sweden was excluded from these analyses since its urban classification was not more detailed. In other analyses, we stratified participants according to education level (low and high), and then we calculated smoking prevalence for each level according to participants' urban/non-urban classification and calculated the corresponding odds ratios.

We performed trend analyses by calculating annual rates of change in smoking for both urban and non-urban areas. The rates of change were calculated by entering survey year in a logistic regression model with smoking status as the dependent variable and adjusting for age and education. The regression coefficient corresponding to the variable "survey year" was used to calculate the slope estimate. A positive slope estimate indicated an annual increase in smoking prevalence, while negative slope estimates indicated a general decline in smoking over the period of 1985 and 2000. These slope estimates were compared between urban and non-urban areas, and were considered to be significantly different from each other if their 95% confidence intervals did not overlap. In addition to age adjustment, we examined possible differences in trends among age groups (i.e. 25–44, 45–64 and 65–79 years) by performing age-stratified analyses for all countries. All analyses were performed using SPSS version 11 (SPSS, Inc., Chicago, IL).

Results

Over the period from 1985 to 2000, smoking prevalence in all countries was highest in urban areas, for both males and females (Table 2). However, the confidence intervals for the odds ratios often overlapped. The only exceptions to the higher rates in urban areas were among Finnish and Spanish males, where the prevalence in non-urban areas was marginally higher. In most cases, odds ratios increased when subsequent adjustment was made for educational level in addition to adjustment for age only. The odds ratios demonstrated that urban/non-urban differences in smoking were larger among females in most countries. No north–south pattern was evident in the magnitude of urban/non-urban differences in smoking.

Table 1
Survey characteristics, classification of place of residence, and distribution of participants by urban/non-urban residence and education, by country

Country	Classification of area of residence		Survey years	Proportion (%) of respondents in non-urban area	Proportion (%) of low-educated respondents	
	Original classification[a]	Simplified urban/non-urban[b]			Urban	Non-urban
Sweden	1 = Urban 2 = Semi-urban 3 = Rural	Urban = 1 Non-urban = 2–3	1988–1989 1992–1993 1996–1997 2000–2001	36.4 31.6 31.8 29.9	33.0 26.1 24.0 19.8	44.5 35.0 31.2 26.7
Finland	1 = Capital 2 = Cities 3 = Towns 4 = Rural	Urban = 1–2 Non-urban = 3–4	1986 1991 1996 2001	62.3 61.4 58.5 58.4	40.1 27.9 24.4 17.3	52.9 42.1 31.7 25.3
Denmark	1 = Capital 2 = Capital suburbs 3 = Rest of capital region 4 = Cities >100,000 5 = Cities 10,000–100,000 6 = Rest of country	Urban = 1–4 Non-urban = 5–6	1987 1994 2000	58.2 59.6 62.4	24.5 16.8 12.3	44.2 30.8 23.3
Germany	1⩽2000 2 = 2000–5000 3 = 5000–20,000 4 = 20,000–50,000 5 = 50,000–100,000 6 = 100,000–500,000 7⩾500,000	Urban = 6–7 Non-urban = 1–5	1984 1987 1990 1998	69.3 69.5 70.2 70.1	57.6 55.9 48.2 45.2	70.8 71.0 65.3 53.7
Italy	1⩽2000 2 = 2000–10,000 3⩾10,000–50,000 4⩾50,000 5 = Metro areas 6 = Outskirts of metro areas	Urban = 4–6 Non-urban = 1–3	1994 1999–2000	66.7 66.4	33.2 29.3	42.2 39.2
Spain	1⩽2001 2 = 2001–10,000 3 = 10,001–50,000 4 = 50,001–100,000 5 = 100,001–400,000 6 = 400,001–1,000,000 7⩾1,000,000	Urban = 5–7 Non-urban = 1–4	1987 1993 1995 1997	61.7 61.4 57.4 57.6	67.5 61.7 59.9 54.2	80.4 76.6 74.7 73.8

[a]Original classification as used in the surveys. Numbers referred to number of inhabitants in the area.
[b]Classification used in the analyses.

Application of the expanded urban classification in five countries (summarized in Table 3) showed that in most cases smoking prevalence was directly related to the level of urbanization, with the highest prevalence rates seen in the most urbanized areas. Odds ratios comparing large cities to non-urban areas were around 1.50 among women in all five countries, about 1.25 for men in Denmark, Germany and Italy, but close to 1.00 for men in Finland and Spain. Similar to the results in Table 2, odds ratios were higher when adjusted for age and education compared to adjustment for age only, except for females in Italy and Spain.

Table 2
Age-standardized prevalence (%) and odds ratios (95% CI) of current smokers between urban and non-urban[a] areas, all survey time-points combined

Country	Males				Females			
	Urban	Non-urban	OR (95% CI)[b]	OR (95% CI)[c]	Urban	Non-urban	OR (95% CI)[b]	OR (95% CI)[c]
Sweden	23.7	21.7	**1.21** (1.04, 1.21)	**1.14** (1.06, 1.23)	25.3	24.9	1.01 (0.94, 1.08)	1.02 (0.95, 1.10)
Finland	25.6	27.5	0.90 (0.80, 1.01)	1.04 (0.92, 1.18)	17.4	14.7	**1.26** (1.11, 1.43)	**1.42** (1.25, 1.62)
Denmark	46.6	46.3	1.01 (0.91, 1.13)	**1.14** (1.02, 1.28)	43.1	40.7	1.11 (0.99, 1.23)	**1.22** (1.09, 1.36)
Germany	38.3	35.4	**1.15** (1.05, 1.26)	**1.23** (1.12, 1.36)	29.8	23.9	**1.42** (1.29, 1.57)	**1.51** (1.37, 1.67)
Italy	35.9	33.9	**1.10** (1.05, 1.15)	**1.15** (1.10, 1.20)	21.8	17.4	**1.36** (1.29, 1.43)	**1.31** (1.24, 1.38)
Spain	49.6	50.5	0.96 (0.92, 1.01)	1.01 (0.97, 1.06)	26.9	20.7	**1.56** (1.48, 1.66)	**1.47** (1.38, 1.55)

Note: significant odds ratios, i.e. those with 95% CI that does not include the value of one, are presented in bold.
[a]Reference category.
[b]Odds ratios adjusted for age.
[c]Odds ratios adjusted for age and education.

Table 3
Age-standardized prevalence rates and odds ratios (95% CI) of current smokers in expanded[a] urban classification and non-urban[b] areas, all survey time-points combined

Country	Males			Females		
	ASPR[c]	OR (95% CI)[d]	OR (95% CI)[e]	ASPR[c]	OR (95% CI)[d]	OR (95% CI)[e]
Finland						
Helsinki	24.5	0.84 (0.72, 0.99)	1.02 (0.87, 1.21)	18.2	**1.44** (1.14, 1.58)	**1.58** (1.34, 1.87)
Cities	26.5	0.95 (0.82, 1.09)	1.05 (0.91, 1.22)	16.7	**1.19** (1.02, 1.40)	**1.31** (1.11, 1.53)
Non-urban	27.5	1.00	1.00	14.7	1.00	1.00
Denmark						
Capital	50.3	1.12 (0.93, 1.35)	**1.29** (1.07, 1.56)	48.0	**1.29** (1.08, 1.53)	**1.48** (1.23, 1.77)
Suburbs of the capital region	46.9	1.04 (0.88, 1.22)	1.16 (0.98, 1.38)	41.5	1.06 (0.90, 1.24)	1.15 (0.98, 1.36)
The rest of the capital region	44.7	0.96 (0.78, 1.18)	1.06 (0.86, 1.31)	38.9	0.95 (0.77, 1.17)	1.02 (0.82, 1.26)
Cities >100,000	44.8	0.92 (0.77, 1.11)	1.05 (0.87, 1.26)	43.9	1.12 (0.94, 1.33)	**1.21** (1.01, 1.45)
Non-urban	46.3	1.00	1.00	40.7	1.00	1.00
Germany						
> 500,000 inhabitants	39.1	**1.20** (1.07, 1.36)	**1.31** (1.16, 1.48)	30.5	**1.47** (1.29, 1.67)	**1.58** (1.39, 1.80)
100,000–500,000 inhabitants	37.8	1.10 (0.98, 1.24)	**1.17** (1.04, 1.32)	29.3	**1.38** (1.22, 1.57)	**1.45** (1.28, 1.64)
Non-urban	35.4	1.00	1.00	23.9	1.00	1.00
Italy						
Metropolitan areas	38.1	**1.20** (1.11, 1.29)	**1.22** (1.13, 1.32)	24.9	**1.64** (1.51, 1.78)	**1.52** (1.40, 1.65)
Outskirts of metropolitan areas	35.8	**1.10** (1.01, 1.19)	**1.10** (1.02, 1.20)	20.0	**1.21** (1.10, 1.33)	**1.20** (1.09, 1.32)
Cities with >50,000 inhabitants	34.8	1.05 (0.99, 1.11)	1.06 (1.00, 1.13)	20.8	**1.28** (1.20, 1.37)	**1.22** (1.14, 1.31)
Non-urban	33.9	1.00	1.00	17.4	1.00	1.00
Spain						
>1,000,000 inhabitants	45.7	0.88 (0.82, 0.95)	0.98 (0.91, 1.06)	27.9	**1.82** (1.67, 1.99)	**1.68** (1.54, 1.84)
400,001-1,000,000 inhabitants	51.3	1.10 (1.00, 1.20)	**1.21** (1.10, 1.32)	26.6	**1.70** (1.52, 1.90)	**1.67** (1.50, 1.87)
100,001-400,000 inhabitants	47.3	0.96 (0.91, 1.02)	1.03 (0.97, 1.09)	23.1	**1.40** (1.31, 1.51)	**1.33** (1.23, 1.43)
Non-urban	48.0	1.00	1.00	18.9	1.00	1.00

Note: significant odds ratios, i.e. those with 95% CI that does not include the value of one, are presented in bold.
[a]Using the original classification used in the surveys.
[b]Reference category.
[c]Age-standardized prevalence rate.
[d]Odds ratios adjusted for age.
[e]Odds ratios adjusted for age and education level.

Table 4
Age-standardized prevalence rates (%) of current smokers in urban and non-urban[a] areas, stratified by low and high level of education, all survey time-points combined

Country	Males			Females		
	Urban	Non-urban	OR (95% CI)	Urban	Non-urban	OR (95% CI)
Sweden						
Low	35.2	28.4	**1.33** (1.17, 1.50)	37.0	35.8	1.14 (1.00, 1.30)
High	21.2	19.5	1.09 (0.99, 1.19)	22.9	23.4	0.95 (0.87, 1.04)
Finland						
Low	34.0	34.1	1.05 (0.86, 1.29)	27.5	20.7	**1.91** (1.50, 2.42)
High	23.3	24.9	0.89 (0.76, 1.03)	15.1	13.5	1.13 (0.97, 1.32)
Denmark						
Low	66.3	56.0	**1.31** (1.06, 1.61)	56.7	52.4	**1.43** (1.20, 1.70)
High	45.2	43.8	1.03 (0.94, 1.13)	40.1	37.9	1.05 (0.96, 1.15)
Germany						
Low	43.9	39.2	**1.25** (1.10, 1.41)	36.3	25.9	**1.75** (1.54, 2.00)
High	33.3	29.7	**1.22** (1.06, 1.40)	25.7	21.6	**1.23** (1.06, 1.43)
Italy						
Low	44.2	38.5	**1.16** (1.06, 1.26)	21.0	15.0	**1.44** (1.30, 1.60)
High	35.0	33.4	**1.07** (1.02, 1.13)	24.4	21.1	**1.19** (1.12, 1.27)
Spain						
Low	54.3	52.5	**1.10** (1.03, 1.17)	24.1	19.1	**1.59** (1.47, 1.72)
High	47.0	47.3	0.90 (0.84, 0.97)	34.6	30.3	**1.24** (1.14, 1.36)

Note: significant odds ratios, i.e. those with 95% CI that does not include the value of one, are presented in bold.
[a]Reference category.

Stratification by education level demonstrated higher prevalence among participants living in urban areas compared to their non-urban counterparts of the same education level, with differences being most pronounced among females (Table 4). The results also showed that smoking was more prevalent among the low educated, except for females in Italy and Spain, where the high educated in both urban and non-urban areas smoked more often. The differences in smoking between urban and non-urban areas were generally more marked among the low educated than among the high educated. Even though the 95% confidence intervals for "low" and "high" were large and overlapping in many cases, there was a tendency for the odds ratios to be larger among low educated men and women in all countries.

Across most countries, smoking prevalence in males had declined in both urban and non-urban areas (Fig. 1). The annual rate of decline varied from about 1% per year in Finland up to about 5% per year in Sweden, with other countries being in between. It is noted that the declines were not significant in Finland's urban and non-urban areas, and in Germany's urban area. In each country, the rate of change was approximately similar in urban and non-urban areas.

Among females, annual rates of change varied by country (Fig. 2), with only Sweden and Denmark showing a decline; while strong increases were observed among women in Spain. Within each country, there was a tendency for smoking trends to be more favourable among participants living in urban areas. However, the differences in trends were generally small (less than 2% difference in annual rate) and did not reach statistical significance.

Analyses stratified by age group showed no consistent pattern between younger and older ages in terms of urban/non-urban differences in smoking. In most countries and for both sexes, the differences showed similar trends in all age groups (results not shown).

Further analyses using indicators of heavy smoking (the proportion of smokers smoking more than 10 cigarettes daily) and on former smoking (the proportion of ever smokers who had successfully stopped smoking) did not show any consistent or meaningful urban/non-urban differences (results not shown).

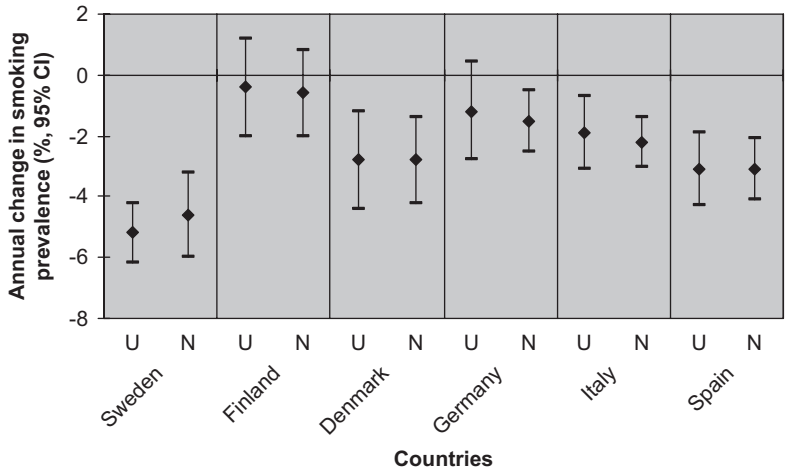

Fig. 1. Annual change in smoking prevalence between 1985 and 2000 by country and place of residence: males (25–79 years). U = urban and N = non-urban.

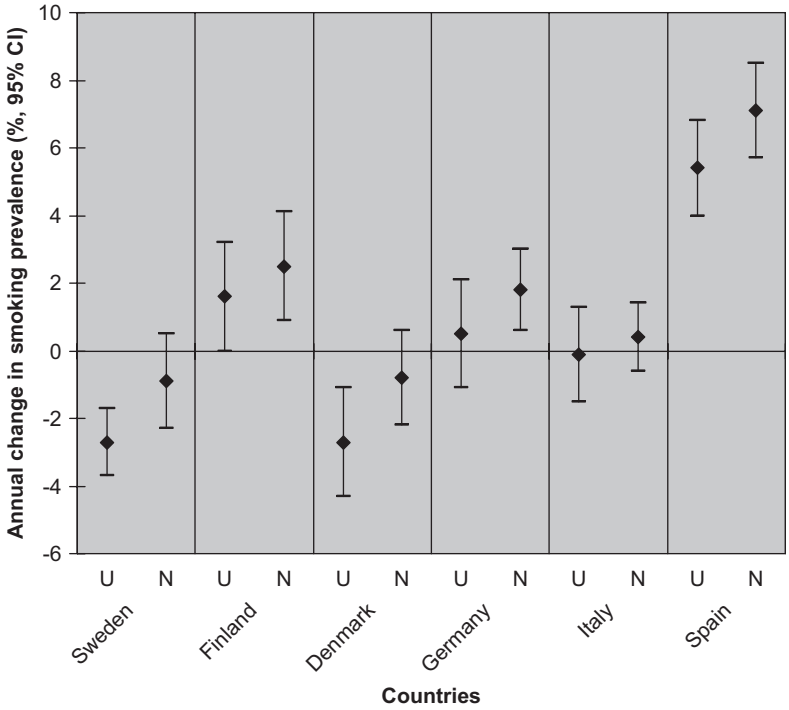

Fig. 2. Annual change in smoking prevalence between 1985 and 2000 by country and place of residence: females (25–79 years). U = urban and N = non-urban.

Discussion

Summary of findings

Our findings showed that in the period of 1985–2000 smoking was more prevalent in urban areas compared to non-urban areas. Smoking prevalence was associated with level of urbanization, with rates being highest in large cities. Urban/non-urban inequalities were larger among women compared to men. Stratification by education suggested that urban/non-urban inequalities were larger among low-educated persons. Annual smoking trends were similar in non-urban and urban

areas, suggesting that the differences were persistent over time, especially among men.

Our results agree with other studies in suggesting that residential area is associated with smoking (Reijneveld, 1998; Shohaimi et al., 2003; Ross, 2000; Duncan et al., 1999; Barnett, 2000). Similar to our findings, a number of other studies in developed countries have documented higher smoking rates in urban areas (Helasoja et al., 2001; Missouri Department of Health, 1995).

There was a large difference in smoking trend between Spain and other countries, especially among women. A strong increase in smoking prevalence was observed among Spanish females in both urban and non-urban areas, while the opposite was true for males. Other studies also reported similar trend that smoking prevalence in Spain is increasing in women while decreasing in men (Regidor et al., 2001; Giskes et al., 2005). We should note, however, that the urban/non-urban differences in smoking in Spain do not show different patterns or trends compared to the other countries. For example, increasing prevalence rates among Spanish women are observed in both urban and rural areas.

Limitations of the study

A number of limitations using data available from national surveys need to be acknowledged (Giskes et al., 2005). In all surveys included in the current study, smoking status was self-reported. The validity of self-reported smoking status has been questioned, but previous studies suggested that self-reported status in general is in agreement with biochemical measurements (Patrick et al., 1994; Post et al., 2005). It is also important to note that our study did not take into account the use of other tobacco products. This may be relevant especially in Sweden (Rodu et al., 2002), where the use of moist snuff "snus" is higher in rural compared to urban areas with prevalence rates of about 30% versus 20% among men in 2004 (Statistics Sweden, 2004).

Response rates, which were low in some cases (ranged from 61% to 92%), may have caused bias if the rates were different according to area of residence. But the available data suggested that this is unlikely; for example in Finland, where response rates are among the lowest, response rates for men were 62%, 63% and 66% in the Metropolitan region, other cities and rural areas, respectively (rates for women are 72%, 75% and 75%).

Another limitation to our study was that each national surveys applied different criteria and classifications to measure area of residence. For instance, the cut-off size for urban areas in Italy is half that of other countries. We partially circumvented this problem by using a broad distinction between "urban" and "non-urban" areas that could be applied to each country. None-the-less, the use of different criteria and classifications make comparisons across countries inherently difficult, especially if the aim is to identify and to explain variations between them. Moreover, it should be noted that living in an urban or non-urban area may qualitatively differ between countries due to differences in social circumstances and physical geographies of those countries. More fundamentally, the population size of cities differs between countries included in the analyses. Differences in city size may be associated with differences in environmental features such as the population density in that area, which in turn can influence health-related behaviour (Stead et al., 2001). Given these inherent differences, we have chosen not to focus on cross-national variations, instead identify general patterns that are common to all countries.

Compositional and contextual effects

The higher smoking prevalence that we observed for urban areas in most countries might be explained by compositional or contextual effects. The "compositional effect" stresses the importance of the social and demographic composition of population that lives in urban areas (Diez Roux, 2001). However, the higher smoking rates of urban areas compared to non-urban areas in our analyses cannot be explained by the educational level of their residents, because in each country, residents of urban areas have on average higher education levels (see Table 1). We observed that statistical control for education generally increased the estimates of urban/non-urban differences in smoking prevalence. In other analysis that we could perform for a part of countries, additional control for income and occupation did not substantially change the urban/non-urban differences in smoking (results not shown). As education, income and occupation together comprise the key dimensions of individual-level socioeconomic position, these results strongly suggest that the socioeconomic composition of the population cannot explain the higher smoking prevalence in urban areas.

It is important to note that another compositional effect could not be taken into account in the analysis, which is the ethnicity of respondents. In Sweden for example, about 15% of the resident population was born in other countries, most of these inhabitants live in urban areas (Swedish Integration Board, 2006). The immigrant population has different smoking patterns than individuals born in Sweden. Among immigrant men, the smoking prevalence is considerably higher, while the opposite is true for immigrant women (Rosvall et al., 2005). This compositional effect may in part explain the higher prevalence of smoking among men in urban areas. In most other countries, however, this effect may be less important, as immigrant populations are either small or, as in the case of Germany, excluded from the surveys.

Our results seem to agree with the finding of studies which have observed persistent area differences after controlling for individual socioeconomic indicators (Diez Roux, 2001). This indicates the presence of a ''contextual effect'' in which the place where people live has an independent influence on their smoking behaviour (Reijneveld, 1998; Ross, 2000; Duncan et al., 1999; Barnett, 2000). Several factors have been noted to contribute to this contextual effect, including the social and physical environments where people live in. With regard to the social environment, urban areas may have a more permissive norm toward smoking, which promotes smoking initiation, and hinders successful smoking cessation (Godin et al., 1992; Eiser et al., 1989; van den Putte et al., 2005). Smoking is contagious—people may 'contract' smoking from others around them—and this process may play more of a role in urban areas (Ross, 2000). Physical environments may influence smoking behaviour by making life in the urban areas more stressful, which then makes people turn to smoking as a way to relieve stress (Shohaimi et al., 2003). A qualitative study observed that overcrowding, poor housing quality, and lack of recreational facilities contribute to persistent smoking (Stead et al., 2001). In addition, higher smoking prevalence in urban areas may be influenced by other factors such as a greater number of tobacco selling points, a greater availability of cheap tobacco from smuggling, and more illegal sales to minors (Stead et al., 2001).

We observed that the urban excess of smoking was more pronounced among low-educated groups. Studies within specific urban areas have shown smoking rates were highest in deprived urban areas, even after adjusting for individual socioeconomic measures (Reijneveld, 1998; Shohaimi et al., 2003; Duncan et al., 1999; Kleinschmidt et al., 1995). These results imply that the effect of urban environment on smoking influences socioeconomically disadvantaged groups more. This effect was most pronounced among women. Less-educated women may have a higher susceptibility to the adverse social and physical factors of the urban environment, while higher educated men and women may benefit more from the protective effects of some other urban factors, such as a greater availability of smoking cessation services.

One may hypothesize that higher occurrence of area-level deprivation within urban settings or greater income inequalities between areas may contribute to the higher smoking prevalence observed in urban areas. In a European study, Shohaimi et al. found that area deprivation predicts smoking consumption independently of the residents' educational level and occupational social class (Shohaimi et al., 2003). Further study is needed to assess whether a greater geographical concentration of deprivation within urban areas may contribute to the urban excess in smoking.

The smoking epidemic model

We hypothesized that these smoking inequalities developed in a similar way as inequalities by socioeconomic status, with more favourable trends in urban areas (similar to high socioeconomic groups) than in non-urban areas (similar to lower socioeconomic groups). More generally, we hypothesized that, during the study period, the smoking epidemic would be spreading from urban areas towards non-urban areas. This process would occur first among men, with women following later (Lopez et al., 1994). Similarly, in Europe the epidemic first occurred in northern countries, with southern countries lagging behind, giving the north–south pattern of smoking (Cavelaars et al., 2000; Huisman et al., 2005).

Some of our findings agree with this hypothesis. A larger urban excess in smoking among females compared to males may be explained by our hypothesis, as the diffusion of smoking from urban to non-urban areas may have started earlier among men. The finding that annual changes in smoking among men were similar among urban and non-urban areas might suggest stabilization in the male population. Among women, the more favourable

smoking trends in urban areas suggest that the smoking epidemic is still diffusing among women in non-urban areas.

However, some results are at odds with the smoking epidemic model. We did not observe a north–south pattern in urban/non-urban inequalities in smoking. Even though northern European countries have mature smoking epidemics, smoking prevalence rates were still higher in urban areas in most cases, including among men. This suggests that urban/non-urban smoking inequalities, unlike socioeconomic inequalities in smoking, are not strongly influenced by the dynamics of the smoking epidemic.

Implications

The results showed persistently higher smoking rates in urban areas, especially among people with low education and among females. This stresses the need to take into account the greater exposure to tobacco among people living in cities when designing and implementing tobacco control policies and interventions. There are several strategies that can be directed toward urban populations, such as community-based prevention programs, the establishment of local smoking cessation clinics, and a stronger enforcement of laws against smuggling and sales to minors. In the longer term, improvement in living conditions in urban areas may be of critical importance to reduce smoking rates. However, further research is still needed to unravel the contextual effects from the individual effects, and to identify mechanisms that contribute to the higher smoking rates in urban areas.

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