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Higher mortality in urban neighbourhoods in The Netherlands: who is at risk?

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ABSTRACT

Background: Urban residents have higher mortality risks than rural residents. These urban-rural differences might be more pronounced within certain demographic subpopulations.

Aim: To determine urban-rural differences in all-cause and cause-specific mortality within specific demographic subpopulations of the Dutch population.

Method: Mortality records with information on gender, age, marital status, region of origin and place of residence were available for 1995 through 2000. Neighbourhood data on address density and socioeconomic level were linked through postcode information. Variations in all-cause and cause-specific mortality between urban and rural neighbourhoods were estimated through Poisson regression. Additionally, analyses were stratified according to demographic subpopulation.

Result: After adjustments for population composition, urban neighbourhoods have higher all-cause mortality risks than rural neighbourhoods (RR = 1.05; CI 1.04 to 1.05), but this pattern reverses after adjustment for neighbourhood socioeconomic level (RR = 0.98; CI 0.97 to 0.99). The beneficial effect of living in an urban environment applies particularly to individuals aged 10–40 years and 80 years and above, people who never married and residents from non-Western ethnic origins. The beneficial effect of urban residence for non-married people is related to their lower cancer and heart disease mortality. The beneficial effect of urban residence for people of non-Western ethnic origin is related to their lower cancer and suicide mortality.

Conclusion: In The Netherlands, living in an urban environment is not consistently related to higher mortality risks. Young adults, elderly, single and non-Western residents, especially, benefit from living in an urban environment. The urban environment seems to offer these subgroups better opportunities for a healthy life.

Urban residents generally experience higher mortality risks than rural residents,[1–8] but lower risks[9–11] or a lack of urban-rural differences have also been reported.[12] Elevated mortality risks among urban residents have been found in The Netherlands too.[13 14] These higher urban mortality risks might be explained by the more unhealthy physical urban environment with, for instance, higher levels of traffic and air pollution. Yet, urban-rural differences in mortality might also be due to differences in population composition between urban and rural areas.[15] In The Netherlands, for instance, single people more frequently live in urban areas[16] and in general have higher mortality rates than people with a partner; therefore this compositional effect might explain to some extent the higher mortality rates in urban areas.[17–21]

Few studies have addressed mortality in urban settings for specific demographic subpopulations, with contradictory results. Higher mortality risks for both men and women have been found in urban compared to rural areas,[1 2 8] but lack of urban-rural mortality differences have also been reported.[2 12] And, while younger age groups experience slightly lower mortality risks in urban compared to rural areas, no urban-rural differences in mortality seem to exist among the elderly.[12] Two US studies on the relation between urbanicity and mortality for different ethnic groups reported higher risks in urban white residents compared to rural white residents,[1 2] with one study indicating higher risks in urban African-Americans compared to those living in rural areas[1] and the other found the same pattern for African-American males but not for African-American females.[2] No studies focused on the relation between urbanicity and mortality for married versus non-married people. Thus, while it is theoretically possible that the effect of living in an urban environment differs between subpopulations, there is yet little evidence to support this.

Our objective is to determine urban-rural differences in all-cause as well as cause-specific mortality within specific demographic subpopulations of the Dutch population. A national dataset with information on four individual characteristics of residents (sex, age, marital status and ethnicity) and one neighbourhood characteristic (socioeconomic level) is used to examine the possible negative influence of urbanicity on mortality.

METHODS

Data

Individual data

Mortality records and demographic data for the years 1995 through 2000 were provided by Statistics Netherlands (CBS) and linked by personal identification number. All people who died during the study period were registered, irrespective of whether the death occurred in The Netherlands or abroad.

Primary cause of death was based on the International Classification of Diseases, ninth revision, ICD-9 (ninth revision, 1995) and ICD-10 (tenth revision 1996 through 2000). The following causes of death were distinguished: (1) all-cause mortality, (2) cardiovascular disease mortality, in particular ischaemic and cerebrovascular diseases, (3) cancer mortality, in particular lung and breast cancer, and (4) death by external causes, in particular suicide and traffic accidents.

Demographic information on sex, age, marital status (never married, married, divorced,

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widowed), region of origin (Dutch, Turkish, Moroccan, Antillean, Surinamese and other) and address of each individual was available. Five-year age categories were used except for the 0–1-year olds and 95 years and older. The standard definition of CBS was used to define non-Western individuals.[22] A person was considered to be of non-Western origin if at least one parent or the person in question was born in a non-Western country or continent—that is, Turkey, Africa, Latin America or Asia. In families from mixed origin the country of birth of the mother prevailed.

Neighbourhood data

In The Netherlands, neighbourhoods are small geographical units. The boundaries of a neighbourhood are based on topography or socioeconomic similarities of residents. Neighbourhood data for the year 1995 was used for analyses because mortality records were available from this year onwards. In 1995, The Netherlands consisted of 10 381 neighbourhoods with on average 1486 residents each.

Urbanicity was based on the number of addresses per square kilometre in a neighbourhood. The five standard urbanicity categories of CBS were applied—that is, rural (0–499 addresses/km^2), semi-rural (500–999 addresses/km^2), intermediate urban-rural (1000–1499 addresses/km^2), semi-urban (1500–2499 addresses/km^2) and urban (>2499 addresses/km^2) with about 20% of the Dutch population in each category.[23]

Socioeconomic status (SES) is an important confounder in the relation between urbanicity and health. In The Netherlands individual SES is not routinely collected but neighbourhood socioeconomic level can be used as a proxy for individual SES instead.[24] Neighbourhood socioeconomic level was indicated by the percentage of residents with a low income—that is, below

Table 1 The distribution of demographic and socioeconomic characteristics and absolute number of deaths of the Dutch population over the five urbanicity categories

	Rural	Semi-rural	Intermediate urban-rural	Semi-urban	Urban
Number of neighbourhoods	4156	1244	998	1225	729
Number of residents (as percentage of total study population)	21.0	20.3	19.4	21.1	18.2
Demographic characteristics					
Percentage male	50.8	49.6	49.3	48.6	48.9
Percentage 20–40-year-olds	27.5	28.0	29.1	30.3	37.5
Percentage married residents	49.5	48.6	46.3	42.6	32.5
Percentage residents of Western origin	92.9	88.8	84.1	21.0	66.2
Socioeconomic characteristics					
Percentage residents with a low income	39.1	37.9	38.1	40.8	43.7
Deaths (absolute number in 1995–2000)					
All-cause mortality	154 329	157 705	140 606	183 319	171 389
Cause-specific mortality					
Cancer	44 811	43 676	40 114	51 111	44 683
Lung	10 287	9593	8953	11 491	10 259
Breast	3987	4131	3917	4693	4117
Cardiovascular diseases	57 027	57 530	51 282	67 658	61 338
Ischaemic	22 795	21 757	19 643	25 709	23 007
Cerebrovascular	13 301	14 455	12 680	16 337	14 908
External causes	6229	5591	5004	6536	6686
Suicide	1657	1606	1547	2028	2128
Traffic accidents	4471	3874	3320	4205	4062
Demographic subpopulations (all-cause mortality)					
Sex					
Male	84 011	77 733	69 422	88 957	79 663
Female	70 318	79 972	71 184	94 362	91 726
Age (years)					
0–9	1708	1554	1410	1579	1512
10–19	851	612	464	519	358
20–29	1345	1165	1133	1419	1521
30–39	2296	2071	2097	2510	3157
40–49	5362	5396	5377	6249	5966
50–59	11 881	11 063	10 253	11 900	10 570
60–69	23 714	22 282	20 567	25 529	21 365
70–79	41 901	41 697	39 054	52 439	44 792
80–89	47 494	51 273	44 106	59 426	58 656
90+	17 777	20 592	16 145	21 749	23 492
Marital status					
Never married	20 698	17 209	14 498	18 886	23 095
Married	74 172	70 500	64 442	79 050	61 857
Widowed	53 992	62 350	52 606	71 136	68 265
Divorced	5467	7646	9060	14 247	18 172
Region of origin					
Western	144 906	144 171	125 862	161 189	145 055
Non-Western	9423	13 534	14 744	22 130	26 334

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Table 2 Urban-rural differences in all-cause mortality

	Rural (reference)	Semi-rural	Intermediate urban-rural	Semi-urban	Urban
Control variables	**RR**	**RR (95% CI)**	**RR (95% CI)**	**RR (95% CI)**	**RR (95% CI)**
Age and sex	1.00	1.05 (1.04 to 1.06)	1.04 (1.03 to 1.05)	1.05 (1.04 to 1.06)	1.09 (1.08 to 1.10)
+ marital status	1.00	1.05 (1.04 to 1.05)	1.03 (1.03 to 1.04)	1.03 (1.02 to 1.04)	1.05 (1.04 to 1.05)
+ region of origin	1.00	1.05 (1.04 to 1.05)	1.03 (1.02 to 1.04)	1.03 (1.02 to 1.04)	1.04 (1.04 to 1.05)
+ neighbourhood SES	1.00	1.05 (1.05 to 1.06)	1.04 (1.03 to 1.05)	1.00 (0.99 to 1.00)	0.98 (0.97 to 0.99)

RR, relative risk; CI, 95% confidence interval; SES, socioeconomic level.

the 40% level of the national income distribution (<€12 025 (£8900; $17 660), because it explained most of the geographical variation in mortality across neighbourhoods in The Netherlands.

Neighbourhoods with 100 or fewer residents (n = 1553) were omitted to reduce mortality rate instability. This implies that the analyses excluded remote rural areas. We did not aggregate these small neighbourhoods because this would require arbitrary decisions as to which neighbourhoods should be combined. In addition, 476 neighbourhoods were excluded because of missing data on socioeconomic level. The resulting dataset consists of 8352 neighbourhoods, which covered 77% of all neighbourhoods in The Netherlands and 99% of the total Dutch population. In total, 807 348 people died during the 5-year study period, this is on average 97 deaths per neighbourhood.

Statistical analysis

Poisson regression models were applied to estimate urban-rural differences in mortality. For every urbanicity category, a relative risk was calculated with the group of rural neighbourhoods serving as reference category. In the Poisson regression model, the absolute number of deaths in each neighbourhood is the dependent variable and the logarithm of the expected number of deaths in that neighbourhood is the offset variable. The expected number of deaths in a neighbourhood is the sum of the expected number of deaths of each of the 336 population groups in one neighbourhood stratified by sex, age, marital status and region of origin (Dutch, Turkish, Moroccan, Antillean, Surinamese and other). The expected number of deaths per population group was calculated by multiplying the mortality risk of each population group, based on Poisson regression of the total Dutch population with the number of people in each population group. Additionally, Poisson regression analyses were corrected for neighbourhood socioeconomic level.

These Poisson regression analyses were repeated to estimate urban-rural variations for specific causes of death and different demographic subpopulations—that is, men and women; 10 year age categories; never married, married, divorced and widowed; Western and non-Western.

Finally, we examined urban-rural variations in cause-specific mortalities within non-married (never married, divorced and widowed combined), married, non-Western and Western groups. These subpopulations were selected because we expected large differences between urban and rural neighbourhoods for these subpopulations. The two highest and lowest urbanicity categories were combined to assure a sufficient number of events in the urbanicity categories (table 1).

RESULTS

Urban and rural neighbourhoods differ with regard to population composition and socioeconomic level (table 1). In urban areas the percentages of married and Western residents tend to be lower, while the percentage of individuals aged 20–40 years tend to be higher. The differences in population composition between rural, semi-rural and intermediate urban-rural neighbourhoods are minimal. These urbanicity categories also have fewer residents with a low income, compared to semi-urban and urban neighbourhoods.

All-cause mortality

Slightly elevated mortality risks are found in urban compared to rural neighbourhoods (RR = 1.09; CI 1.08 to 1.10) (table 2). After adjustment for sex, age and marital status, urban-rural differences in all-cause mortality become even smaller, but urban residents still experience higher mortality risks (RR = 1.05; CI 1.04 to 1.05). Further adjustment for region of origin does not alter the urban-rural mortality pattern. The urban-rural pattern in mortality however reverses when neighbourhood socioeconomic level is added to the model,

Table 3 Urban-rural differences in all-cause and cause-specific mortality

	Rural (reference)	Semi-rural	Intermediate urban-rural	Semi-urban	Urban
Cause of death	**RR***	**RR (95% CI)†**	**RR (95% CI)**	**RR (95% CI)**	**RR (95% CI)**
All-cause	1.00	1.05 (1.05 to 1.06)	1.04 (1.03 to 1.05)	1.00 (0.99 to 1.00)	0.98 (0.97 to 0.99)
Cancer	1.00	1.03 (1.02 to 1.04)	1.04 (1.02 to 1.05)	1.04 (1.02 to 1.05)	1.05 (1.03 to 1.06)
Lung	1.00	1.02 (0.99 to 1.05)	1.04 (1.01 to 1.07)	1.05 (1.02 to 1.07)	1.10 (1.07 to 1.13)
Breast	1.00	1.03 (0.98 to 1.07)	1.06 (1.01 to 1.10)	1.02 (0.97 to 1.06)	1.03 (0.99 to 1.08)
Cardiovascular diseases	1.00	1.03 (1.02 to 1.05)	1.02 (1.01 to 1.04)	0.98 (0.97 to 0.99)	0.94 (0.93 to 0.95)
Ischaemic	1.00	1.00 (0.98 to 1.02)	0.99 (0.98 to 1.01)	0.96 (0.95 to 0.98)	0.94 (0.92 to 0.96)
Cerebrovascular	1.00	1.09 (1.06 to 1.11)	1.06 (1.04 to 1.09)	0.98 (0.95 to 1.00)	0.92 (0.89 to 0.94)
External causes	1.00	0.93 (0.89 to 0.96)	0.88 (0.85 to 0.91)	0.88 (0.85 to 0.91)	0.85 (0.83 to 0.89)
Suicide	1.00	1.02 (0.96 to 1.10)	1.00 (0.93 to 1.07)	1.03 (0.97 to 1.10)	0.99 (0.93 to 1.06)
Traffic accidents	1.00	0.89 (0.85 to 0.93)	0.83 (0.79 to 0.87)	0.80 (0.77 to 0.83)	0.76 (0.73 to 0.79)

*RR, relative risk adjusted for sex, age, marital status, region of origin, and neighbourhood socioeconomic level.
†CI, 95% confidence interval adjusted for sex, age, marital status, region of origin and neighbourhood socioeconomic level.

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Table 4 Urban-rural differences in all-cause mortality within demographic subpopulations of the Dutch population

	Rural (reference)	Semi-rural	Intermediate urban-rural	Semi-urban	Urban
Subpopulation	**RR***	**RR (95% CI)†**	**RR (95% CI)**	**RR (95% CI)**	**RR (95% CI)**
Total	1.00	1.05 (1.05 to 1.06)	1.04 (1.03 to 1.05)	1.00 (0.99 to 1.00)	0.98 (0.97 to 0.99)
Sex					
Male	1.00	1.04 (1.03 to 1.05)	1.03 (1.02 to 1.05)	1.02 (1.01 to 1.03)	1.00 (0.99 to 1.01)
Female	1.00	1.06 (1.05 to 1.07)	1.04 (1.03 to 1.05)	0.98 (0.97 to 0.99)	0.96 (0.96 to 0.97)
Age (years)					
0–9	1.00	0.97 (0.91 to 1.04)	0.92 (0.86 to 0.99)	0.96 (0.90 to 1.03)	0.97 (0.90 to 1.04)
10–19	1.00	0.77 (0.69 to 0.85)	0.62 (0.55 to 0.69)	0.64 (0.58 to 0.72)	0.52 (0.46 to 0.60)
20–29	1.00	0.90 (0.83 to 0.98)	0.86 (0.80 to 0.93)	0.78 (0.73 to 0.85)	0.64 (0.59 to 0.69)
30–39	1.00	0.96 (0.90 to 1.02)	0.95 (0.90 to 1.01)	0.90 (0.85 to 0.96)	0.88 (0.83 to 0.93)
40–49	1.00	1.07 (1.03 to 1.11)	1.09 (1.05 to 1.13)	1.10 (1.06 to 1.14)	1.04 (1.00 to 1.08)
50–59	1.00	1.03 (1.00 to 1.06)	1.03 (1.01 to 1.06)	1.05 (1.03 to 1.08)	1.04 (1.02 to 1.07)
60–69	1.00	1.04 (1.02 to 1.06)	1.04 (1.02 to 1.06)	1.04 (1.03 to 1.06)	1.05 (1.03 to 1.07)
70–79	1.00	1.05 (1.04 to 1.07)	1.04 (1.03 to 1.06)	1.00 (0.99 to 1.02)	1.00 (0.99 to 1.01)
80–89	1.00	1.08 (1.07 to 1.10)	1.05 (1.04 to 1.06)	0.98 (0.96 to 0.99)	0.95 (0.94 to 0.96)
90+	1.00	1.06 (1.03 to 1.08)	1.04 (1.02 to 1.06)	0.98 (0.96 to 1.00)	0.96 (0.94 to 0.98)
Marital status					
Never married	1.00	1.03 (1.01 to 1.05)	1.01 (0.99 to 1.03)	0.94 (0.92 to 0.96)	0.89 (0.87 to 0.91)
Married	1.00	1.03 (1.02 to 1.04)	1.04 (1.03 to 1.05)	1.03 (1.01 to 1.04)	1.03 (1.02 to 1.04)
Widowed	1.00	1.09 (1.08 to 1.10)	1.06 (1.04 to 1.17)	0.99 (0.98 to 1.00)	0.98 (0.97 to 0.99)
Divorced	1.00	1.07 (1.03 to 1.11)	1.02 (0.99 to 1.06)	1.01 (0.98 to 1.04)	0.97 (0.94 to 1.00)
Region of origin					
Western	1.00	1.06 (1.05 to 1.06)	1.04 (1.03 to 1.05)	1.00 (0.99 to 1.01)	0.99 (0.98 to 1.00)
Non-Western	1.00	1.02 (0.99 to 1.05)	1.02 (1.00 to 1.05)	0.97 (0.95 to 1.00)	0.92 (0.89 to 0.94)

*RR, relative risk adjusted for sex, age, marital status, region of origin, and neighbourhood socioeconomic level.
†95% confidence interval adjusted for sex, age, marital status, region of origin, and neighbourhood socioeconomic level.

resulting in somewhat lower mortality risks in urban compared to rural neighbourhoods (RR = 0.98; CI 0.97 to 0.99). In the semi-urban and intermediate urban neighbourhoods mortality risks are higher compared to both the rural and urban neighbourhoods. These risks are not affected by either neighbourhood composition or socioeconomic level (table 2).

Cause-specific mortality

Compared to rural neighbourhoods, mortality risks are higher in all four urbanicity categories for cancer, in particular lung cancer (table 3). No significant differences between urban and rural neighbourhoods are found for breast cancer mortality. For mortality caused by cardiovascular diseases (including ischaemic and cerebrovascular diseases) a similar urban-rural pattern is found as for all-cause mortality: an initial increase is followed by a decrease in mortality risks. Compared to rural neighbourhoods all four urbanicity categories show lower mortality risks for death due to external causes, in particular for traffic accidents. No significant differences between urban and rural neighbourhoods are found for suicide.

Demographic subpopulation

Comparing the most urban category with the most rural category, no differences in mortality are found among males but females show lower risks (table 4). Lower mortality risks are also found among 10–40 year olds and the oldest old. In contrast, the middle-aged and elderly (50–70 years) living in the most urban neighbourhoods experience higher mortality risks than their rural peers. No urban-rural differences are found for other age groups. In the most urban category mortality rates are also higher for married individuals, while lower risks are found for never married and widowed individuals. For divorced individuals no significant urban-rural differences are found. Also, no urban-rural differences are found among Western residents, but non-Western urban residents have lower mortality risks than their rural peers.

Comparing urban-rural mortality patterns, a similar urban-rural pattern as for the total population, an initial increase followed by a decrease in mortality risks, is found among males, females, people aged 70 years and older, never married, widowed and divorced people (table 4). A gradual decrease in mortality risks with increasing urbanicity is found among the younger age groups (10–40 years). For the other age groups (40–70 years) and married people an increase is found with some irregularities.

Figure 1 illustrates the urban-rural variation in cause-specific mortality according to marital status. The higher rural all-cause mortality risk among non-married people is mostly explained by the higher mortality for heart disease and external causes, in particular traffic accidents in rural areas. The higher urban all-cause mortality risk among married people is related to cancer mortality. The contrasting urban-rural pattern between non-married and married people for all-cause mortality is mostly related to cancer and heart disease mortality. In urban compared to rural neighbourhoods, cancer mortality risks are higher among married people while these are lower for non-married people.

The larger beneficial effect of urban residence for people with a non-Western background compared to people with a Western background is mainly related to cancer mortality and suicide (fig 2). In urban compared to rural neighbourhoods, cancer mortality risks are higher among individuals with a Western background, while these are lower for individuals with a non-Western background. A similar pattern is seen for suicide.

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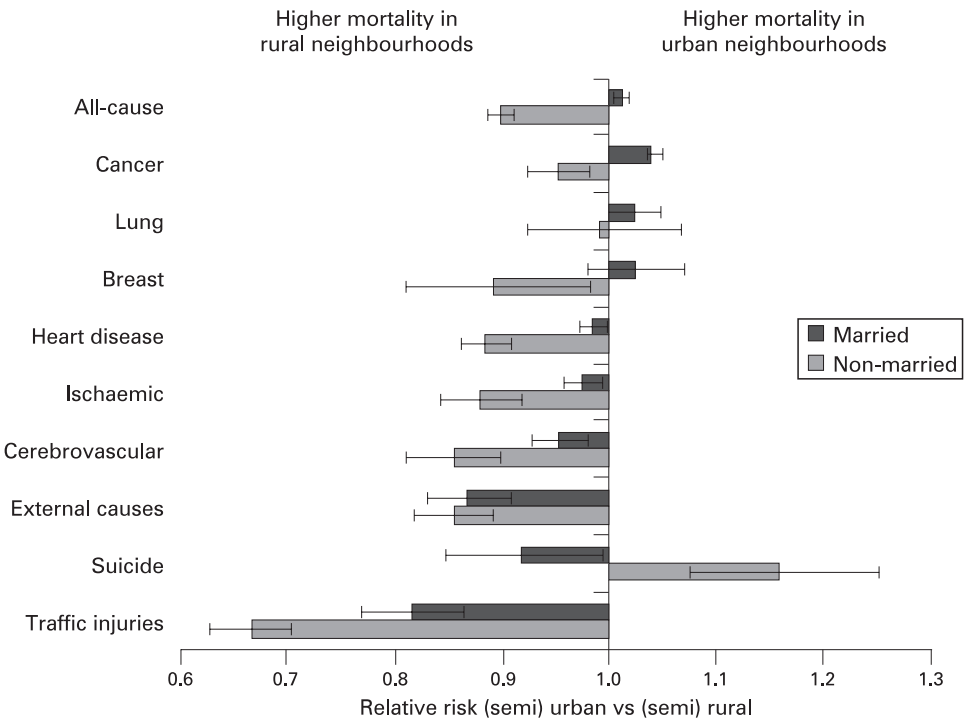

Figure 1 Urban versus rural differences in all-cause and cause-specific mortality risks according to marital status.

DISCUSSION

In The Netherlands, urban neighbourhoods show higher mortality risks than rural neighbourhoods when differences in population composition are considered. However when neighbourhood socioeconomic level is taken into account the urban-rural pattern reverses, resulting in slightly lower mortality risks in urban neighbourhoods. The small beneficial effect of living in urban neighbourhoods applies particularly to younger (10–40 years) and older (80 years and above) age groups, never married people, and people from non-Western origin. In contrast, middle-aged and elderly (50–70 years) and married people living in urban neighbourhoods experience somewhat higher mortality risks compared to those living in rural neighbourhoods. The beneficial effect of urban residence for non-married compared to married people is related to their lower cancer and heart disease mortality. The beneficial effect of urban residence for people of non-Western ethnic origin compared with people of Western ethnic origin is related to their lower cancer and suicide mortality.

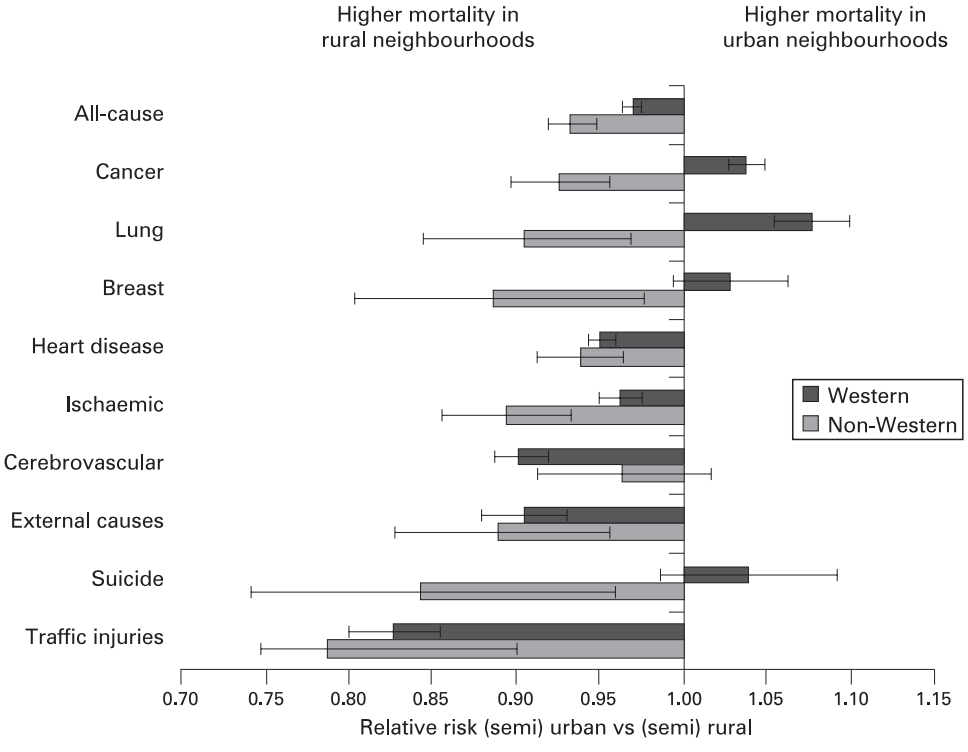

Figure 2 Urban versus rural differences in all-cause and cause-specific mortality risks according to region of origin.

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Evaluation of data and methods

Some limitations of the study need to be considered in the interpretation of the results.

Firstly, a multilevel analysis is generally the recommended approach to study environmental influences of health. However, a national dataset of 16 million people nested in 10 000 neighbourhoods proved to be too large for the multilevel analyses programmes within the CBS infrastructure. Disregarding the clustering of individuals within neighbourhoods underestimates standard errors of regression coefficients resulting in an overestimation of statistical significance. The absence of individual level data on SES was another reason for using ecological level analyses. In addition, we used only one neighbourhood socioeconomic level indicator—that is, proportions of households with low income, because of lack of information on neighbourhood educational level and other potentially relevant indicators. Lower socioeconomic groups with, in general, higher mortality risks more frequently live in urban areas. Incomplete control for neighbourhood and individual SES might therefore have led to an underestimation of the effect of urbanicity on mortality.

Finally, it is important to note that sparsely populated neighbourhoods were excluded from the analyses. In many countries, remote rural areas have higher mortality risks than rural areas, resulting in an U-shaped relation between population density and mortality.[11 25 26] In comparison to other countries, however, The Netherlands is a densely populated country where remote rural areas as found in other countries do not exist.[27 28] The absence of such areas with, in general, higher mortality risks might explain the lack of the U-shaped pattern for The Netherlands. This exclusion might however have led to either a small underestimation or overestimation of the effect of urbanicity on mortality.

Comparison with previous studies

Other studies report similar small urban-rural differences in mortality with some indicating lower mortality[10 11] and others indicating higher mortality risks in urban compared to rural residents.[3–5] In addition, large urban-rural differences in mortality with lower[9] and higher risks in the more urban areas are also found.[1 2 6–8] A previous Dutch study found slightly elevated risks for residents of large municipalities which were defined as having more than 100 000 residents.[13] This result suggest that the choice for another measure of urbanisation may have led to the different results. Another Dutch ecological study found an increased mortality risk of 24% among urban residents aged 65 years.[14] The discrepancy in findings might be related to the imperfect control for relevant individual characteristics in the latter study.

Few studies addressed urban-rural mortality differences within certain demographic subpopulations. Sex differences were most studied. For men both lower[12] as well as higher mortality risks[1 2] were found for urban compared to rural areas. For women higher mortality risks[1] in urban areas and a lack of urban-rural differences[12] were reported. In densely populated municipalities in The Netherlands increased risks were found among elderly residents (65 years and above) but not among the age group below 65 years.[13] An English study reported lower mortality risks in middle-aged men living in urban compared to rural areas and no urban rural differences for middle-aged women or individuals aged 65 years and above.[12] The narrow age groups compared in our study show a more diverse age-pattern of urban-rural mortality differences than observed in these previous studies. If the cut-off point of 65 years were used, lower urban mortality risks would be found in the age group below 65 years and no urban-rural differences would be found for the age group above 65 years of age.

Possible explanations

The different urban-rural mortality patterns found within demographic subpopulations might be related to the different needs people have[29] and the opportunities that either an urban or rural environment offers them. For instance, the urban environment provides more job opportunities, retail businesses and social events,[30] which might be more beneficial to certain groups of people. Single living urban residents may feel less isolated because of the wide range of social events and many nearby places where they can meet other people. The elderly may profit from the better organised public transport[31] and the better availability and accessibility of medical and other services[32 33] in urban environments. Thus, lower mortality risks might be linked to different needs, which are fulfilled by services provided within the urban environment.

The larger beneficial effect of urban residence for people with a non-Western background compared to people with a Western background is related to their lower cancer and suicide mortality. Whereas the cancer risk could involve a wide array of factors, the protective effect on suicide mortality suggests an important role of the social environment. The diversity of cultures together with the existence of diverse social networks within urban environments might create a more supportive and less stressful environment for migrants. In addition, urban governments may be more aware of problems regarding migrant groups and provide supportive and special services such as (medical) information in foreign languages or specialised accommodation.

Middle-aged and married people are better off when living in a rural environment. The larger beneficial effect of non-urban residence for married people is related to the lower cancer and heart disease mortality. The latter cause of death may suggest an important role of behavioural factors such as smoking, diet and physical activity. Middle-aged and married people living in rural and suburban settings might maintain more healthy lifestyles, perhaps because of greater opportunities that the environment offers (for example, recreation spaces, gardening, etc). In addition, middle-aged and married people mostly have children, and rural and suburban environments may be perceived as more child friendly[34–36] because of lower levels of traffic, air and noise pollution, lower crime rates and greater availability of green spaces. The greater daily difficulties of raising children in an urban environment may contribute to higher levels of psychological stress and unhealthier lifestyles.

The urban-rural mortality patterns found in our study may in part be due to selective migration processes, in this case the move of healthier individuals to urban or rural neighbourhoods. A Dutch study found no health differences between individuals who moved from an urban into a rural area or individuals who moved from a rural into an urban area.[37] However, it is possible that different results might be produced for certain demographic subpopulations, since selective migration is related to age[37–40] or marital status.[37] Young people who move tend to be healthier than young people who do not move.[38–40] For the elderly the opposite is found—that is, movers are unhealthier than stayers.[38–40] The lower mortality risks in urban areas found in the younger age groups could be a reflection of young healthy individuals moving into urban areas because of job opportunities. The same explanation could be suggested for the lower mortality risks found in rural areas among middle-aged individuals, with the healthier adults having moved to rural areas because of their children. The lower mortality risks among elderly urban residents could be related to the migration of

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What is already known on this subject

Higher mortality risks are often, but not always, found in the more urban areas. These higher risks might be related to differences in population composition between urban and rural areas or to the "unhealthier" physical environment of a city.

What this study adds

Living in an urban environment is not consistently related to higher mortality risks. In The Netherlands, young adults, the elderly, single people and non-Western residents, especially, benefit from living in an urban environment. These results illustrate that health effects of environmental characteristics may vary according to the characteristics of the residents.

healthy elderly people towards urban environments because of easy access to medical and other services.

CONCLUSION

The urban environment is generally thought to have a negative impact on health. Our results show, however, that the urban environment affects the health of different demographic subpopulations in different ways. These results illustrate that health effects of environmental characteristics may vary according to the characteristics of the residents. As the needs of people vary according to their social position and change during their life course, so will the kind of environment that can best fulfil these needs. Selective migration processes aimed to maintain an optimal match, and the health consequences of emerging mismatches, may both explain the great variability in the links between health and residential environment.

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