ORIGINAL INVESTIGATION

Dorly J. H. Deeg · G. C. Fleur Thomése

Discrepancies between personal income and neighbourhood status: effects on physical and mental health

Abstract During their life course, older persons' income level may become discrepant with the socio-economic status of their neighbourhood. This study examines whether and how such discrepancies affect older persons' physical and mental health. Using baseline data from the Longitudinal Aging Study Amsterdam, 2,540 non-institutionalised persons aged 55–85 years were classified based on self-reported income and neighbourhood status. Two categories defined discrepancies: discrepant-low (DL, low income in high-status neighbourhood), and discrepant-high (DH, high income in low-status neighbourhood). Both categories were compared with the same reference category: matched-high (MH, high personal and high neighbourhood income status). A range of health indicators were examined, as well as mediating effects of neighbourhood and individual characteristics. Among the 504 persons who reported a high income, 16% lived in a low-status neighbourhood (DH). Conversely, among the 757 persons living in a high-status neighbourhood, 24% had a low income (DL). The DL category mainly lived in rural areas, and the DH category predominantly in large cities. The data show discrepant income effects (DL vs. MH) on physical and cognitive ability, self-rated health, and loneliness, and discrepant neighbourhood effects (DH vs. MH) on physical and cognitive ability, depressive symptoms, and loneliness. Personal income effects were partly mediated by other personal characteristics, and neighbourhood effects were fully mediated by socio-economic neighbourhood characteristics as well as by older persons' perceptions of their neighbourhood and their income. It is concluded that discrepancies between personal income and neighbourhood status, accrued throughout the life course, are associated with poor health.

Keywords Neighbourhood · Income · Physical health · Mental health · Perceptions

D. J. H. Deeg (✉)
Institute for Research in Extramural Medicine/LASA,
Vrije Universiteit Medical Centre, Van der Boechorststraat 7,
1081 BT Amsterdam, The Netherlands
E-mail: DJH.Deeg@vumc.nl
Tel.: +31-20-4446767
Fax: +31-20-4446775

G. C. F. Thomése
Department of Socio-Cultural Sciences,
Faculty of Social Sciences, Vrije Universiteit,
Amsterdam, The Netherlands

Introduction

The existence of income-based differences in health is supported by ample evidence from socio-epidemiological studies in the general population. More recent cross-national evidence shows that also among older persons, lower income levels are associated with poorer health (Grundy and Holt 2001; Huisman et al. 2003). Some authors on health inequalities have stated that health differentials may stem not only from individual characteristics but also—or even more so—from characteristics of the neighbourhood in which people live. This view is in line with the long-standing interest of medical geographers and sociologists in the association between area and health (Sampson et al. 2002; Krause 2003; Macintyre and Ellaway 2003). Recently, there has been an increase in research on the association between neighbourhood and health in older people. This research has demonstrated small but consistent neighbourhood effects on both physical and mental health outcomes. Physical functioning (Balfour and Kaplan 2002; Wainwright and Surtees 2004; Fisher et al. 2004), and self-rated health (Kobetz et al. 2003; Patel et al. 2003) have been shown to be associated with neighbourhood characteristics such as neighbourhood income level and social integration. Walters et al. (2004) found increased depression and anxiety in more densely populated areas, but associations with neighbourhood deprivation were explained by individual factors. Wainwright and Surtees (2004) found only a weak effect of area deprivation on mental health.

The association between neighbourhood and health has been shown to be stronger in older than in younger and middle-aged groups, with the strongest association in early old age (Robert and Li 2002). A common explanation is that older people tend to be more dependent on their immediate surroundings, as they are less likely to engage in activities such as employment, and have a greater chance of becoming functionally disabled (Simonsick et al. 1995; Rowles and Ravdal 2002; Mollenkopf et al. 2004). This explanation, however, overemphasises the detrimental effects of ageing, and may represent a very partial view. In this contribution, we suggest instead a life course perspective on the relevance of the neighbourhood and its effects on older adults' health (Robert 2002; Golant 2003). It may be postulated that in the course of their adult lives, people move to a neighbourhood which best fits their income. This is the place where they intend to grow old. Over the years, however, they may experience changes in two respects. First, their income may decline, because of retirement, widowhood or for other reasons. Once income has declined in later life, it is very unlikely that it will return to former levels (Braam 2001). The lower income is therefore to be faced as a permanent state. Second, the neighbourhood may undergo changes. Although there may be neighbourhoods which improve over time, our interest is in neighbourhoods which deteriorate. In particular, some urban neighbourhoods may experience an increasing in-migration of lower-income and culturally diverse groups, which often goes hand in hand with physical deterioration (Krause 1996). Because of such changes, discrepancies may occur between the socio-economic status of the neighbourhood older persons live in and their personal income level. Our general hypothesis is, then, that such discrepancies contribute to neighbourhood effects on health.

Research on individuals in "discrepant" situations can teach us more about the influence of either of the two discrepant factors. Moreover, the discrepancy itself may cause distress, as well-being depends more on relative income—compared to relevant others—than on absolute income (Marmot and Wilkinson 2001). This is in line with social comparison and cognitive dissonance theories, which would predict that distress results from experiencing a discrepancy between some standard for comparison and reality ("I want to be well-off but everybody around me is richer, so I cannot be that well-off"). Furthermore, although living in a higher-status neighbourhood can compensate for negative effects of individual poverty, through better physical and social living conditions (Fauth et al. 2004; Hou and Myles 2005), other people's wealth may also emphasise one's own lack of it, thus causing distress. To explore possible effects of discrepant situations, older persons who live in a neighbourhood which "matches" their income level are compared to those with "discrepant" incomes and to those who live in a "discrepant" neighbourhood respectively.

To investigate how neighbourhood environment affects health, several authors suggest multiple pathways, including socio-economic conditions (e.g. unemployment rate), social integration (e.g. age homogeneity, population turnover), physical aspects (e.g. housing quality), and services and resources (Macintyre et al. 2002; Sampson et al. 2002; Glass and Balfour 2003; Thomése et al. 2003). The research literature shows little consistency in specific conceptualisations and measurements of these pathways, but nevertheless the outcomes are surprisingly robust in that structural characteristics, social relationships, and social problems in neighbourhoods are interrelated (Sampson et al. 2002). The socio-economic conditions are considered as most influential on health (Glass and Balfour 2003).

Some discussion exists in the literature on the issue whether perceptions of neighbourhood characteristics matter more or less to health than do objective characteristics (Kawachi and Berkman 2003). Clearly, each may affect health according to different mechanisms (Krause 2003). To the extent that subjective perceptions are related to objective characteristics as well as to physical and mental health, they may be considered as intermediary factors in the association between neighbourhood characteristics and health (Brown 1995).

As discrepancies between income and neighbourhood status have not been explicitly studied so far, this contribution is basically exploratory. The following issues are addressed in this study:

– What proportion of the older population lives in a "discrepant" neighbourhood?
– What are the characteristics of neighbourhoods with older persons having "discrepant" incomes compared to those with older persons having "matching" incomes? What are the characteristics of older persons living in "discrepant" neighbourhoods compared to those living in "matching" neighbourhoods?
– How do discrepancies between income and neighbourhood status affect health?
– To what extent do individual and neighbourhood characteristics explain the effect of discrepancy on health? To what extent do subjective perceptions of neighbourhood characteristics explain the effect of discrepancy on health?

Methods

Sample

The data for this study are derived from the Longitudinal Aging Study Amsterdam (LASA). LASA is based on a nationally representative cohort, initial ages 55–85 years, with over-sampling of men and older-old people. The sample was recruited for The Netherlands Stimulating Programme on Research on Aging (NESTOR) study on Living Arrangements and Social Networks of older adults (LSN), which had a response rate

of 62.3% ($n = 3,805$; Knipscheer et al. 1995). About 10 months after the LSN interview, participants were approached for the first LASA cycle (1992–1993). This cycle is the basis for the current study (Deeg et al. 1993). By the start of the LASA baseline, there were 3,679 surviving LSN participants. Of these survivors, 3,107 subjects took part in the interviews and tests, yielding a response rate of 84.5%; the 15.5% non-response consisted of 3.6% ineligibility through frailty, 1.1% not contacted after eight or more attempts, and 10.7% refusals. Non-response was associated with higher age and lower education (Deeg et al. 2002).

For the purpose of this study, institutionalised persons were excluded, leaving 2,981 respondents. Furthermore, respondents were excluded because of missing values on postal code information on neighbourhood status ($n = 14$) and on individual income ($n = 427$), leaving a sample 2,540 non-institutionalised persons.

Measures

"Matched" and "discrepant" groups

Neighbourhood characteristics, derived from the four-digit postal code, were obtained from Statistics Netherlands for the year 1993 (Statistics Netherlands 1993). The postal codes cover on average 5,000 inhabitants. *Neighbourhood income status* was based on the rental price of rented houses, the purchase price of owner-occupied houses, and the monthly household income of a sample of households within each postal code area. It was coded as (1) minimum (up to € 570), (2) under modal, (3) modal (ca. € 1,660), (4) up to twice modal, (5) over twice modal. While the great majority (41%) was categorised as modal (code 3), "low" and "high" neighbourhood status were defined as codes 1 and 2, and codes 4 and 5 respectively.

The respondents were asked to report their *monthly income* from all possible sources in classes ranging from € 453 or less to € 2,269 or more. The classes were converted to the median income. If the respondent had a partner, the partner's income was also asked. In this case, a correction factor of 0.7 was applied to obtain an adjusted adult equivalent (Schiepers 1988). A monthly income of € 680 or less was defined as "low" and a monthly income of € 1,600 or more as "high".

Based on neighbourhood status and respondent income, three categories were defined, indicating agreement between personal and neighbourhood income status (Fig. 1): matched-low (ML), matched-middle (MM), matched-high (MH). Two categories defined discrepancies: discrepant-low (DL, low income in high-status neighbourhood), and discrepant-high (DH, high income in low-status neighbourhood).

Neighbourhood variables

Other neighbourhood characteristics based on the postal code were employed to obtain a further description of the living environment of the groups distinguished, in order to explore the mechanisms which might be promoting or damaging health (Glass and Balfour 2003). Characteristics indicating socio-economic context within the neighbourhoods are the percentage of inhabitants on *social security*, and the extent of *homeownership* in the postal code area (scores: 1 = all rental to 5 = all owner-occupied). Characteristics indicating social integration are *neighbourhood turnover* (the percentage of migration out of the neighbourhood in a year) and *age homogeneity* (the percentage of inhabitants aged 65 and over). Availability of shops and services was indicated by the percent of postal codes in a *large city* and *urbanisation*. The latter is a score based on the number of addresses per square kilometre, ranging from 1 for < 500 to 5 for $> 2,500$. This measure has been shown to be a good indicator of human activity and availability of services (Den Dulk et al. 1992).

Individual variables

Socio-demographic characteristics In addition to gender and age, also level of education, type of household, housing tenure, and years lived in the neighbourhood were included as potential confounders.

Education was assessed as the highest level completed, from 1 = less than elementary school to 9 = university.

Fig. 1 Income–neighbourhood discrepancy
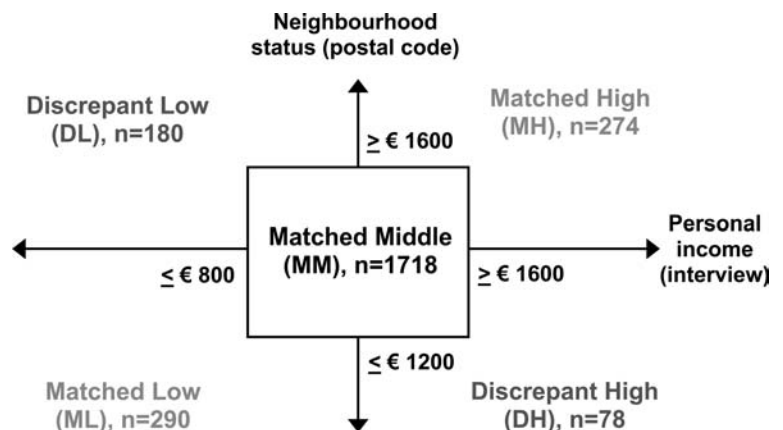
Type of household was coded as 0 = no partner in household, 1 = partner in household. *Housing tenure* was coded as 0 = tenant, 1 = owner-occupier.

Physical and mental health Physical and mental health covered a broad range of measures, in order to explore similarities and differences between outcomes. The measures include tests of physical performance, self-reported functional limitations, self-rated health, cognitive impairment, depressive symptoms, and loneliness.

Physical performance was measured by asking the respondent to put on and take off a cardigan which had been brought in by the interviewer (Magaziner et al. 1997), to walk back and forth 3 m as fast as possible, and to stand up from and sit down in a straight chair five times with arms folded (Guralnik et al. 1994). The time to perform each activity was measured in seconds. Respondents who could not perform the activity were given a score 4; those who could perform the activity were given a score 0 to 3, according to the quartile of the number of seconds needed. The scores on the three activities were summed to a total performance score, ranging from 0 (very good) to 12 (very poor).

Functional limitations were assessed by three items: "Can you climb up and down a staircase of 15 steps without stopping?", "Can you cut your own toenails?", and "Can you use your own or public transportation?". Response categories were 0 = "yes, without difficulty", 1 = "yes, with difficulty", 2 = "not able without help", and 3 = "cannot" (Van Sonsbeek 1988; Kriegsman et al. 1997). The three items were combined into one score ranging from 0 = having difficulty with none of the three activities to 9 = not able to do any of the three activities.

Self-rated health was assessed with the single-item question "How is your health in general?" which had five response categories: 1 = very good, 2 = good, 3 = fair, 4 = sometimes good, sometimes poor, and 5 = poor (Van Sonsbeek 1991).

Cognitive impairments were ascertained using the Dutch translation of the MiniMental State Exam (MMSE, Folstein et al. 1975; Launer et al. 1993). On 23 questions and tasks, respondents received one or more points when they gave the correct answer or performed the task correctly. Scores range from 0 (all answers incorrect) to 30 (unimpaired).

Depressive symptoms were ascertained using the Dutch translation of the 20-item Center for Epidemiologic Studies Depression scale (CES-D, Radloff 1977; Beekman et al. 1997). Respondents were asked to indicate how often during the preceding week they had experienced each symptom, with response categories 0 = (almost) never to 3 = (almost) always. The score range is 0 (no symptoms) to 60 (maximum number of symptoms).

The respondent's experience of *loneliness* was assessed using the De Jong Gierveld Loneliness scale, which ranges from 0 to 11 (De Jong Gierveld and Kamphuis 1985).

Perceptions

As potential mediators of the association between neighbourhood and health, perceptions of income, neighbourhood and housing were assessed.

Income satisfaction was indicated by two items: satisfaction with income level and satisfaction with living standard, each with five response categories ranging from very dissatisfied to very satisfied. Both items were summed to a score ranging from 0 to 8. *Perceived income stability* was indicated by two items: having experienced a decline in income of at least € 100 in the preceding 5 years, and expecting a decline in income, each with two response categories: 0 = yes, 1 = no. These items were summed to a score ranging from 0 to 2, with a higher score indicating greater stability.

Neighbourhood perception was measured by two items: experiencing living in the neighbourhood as pleasant and feeling safe walking outside in the evening, each with two response categories: 0 = no, 1 = yes. The two items were summed to a score ranging from 0 to 2. *Housing perception* was measured by an item asking directly about satisfaction with the home (scores 0 = dissatisfied, 1 = satisfied). *Attachment to the neighbourhood* was assessed with an item asking if the respondent wished to relocate in the near future (scores 0 = yes, 1 = no).

For all perception measures, a higher score indicates a more positive perception.

Statistical methods

In a first step, all neighbourhood and individual characteristics and all indicators of physical and mental health were tested for differences across the five categories ML, DL, MM, DH and MH. In a second step, post-hoc comparisons were performed to test for differences (1) between those with low vs. high income levels, among those living in a high-status neighbourhood (DL vs. MH), and (2) between living in a low- vs. a high-status neighbourhood, among those with high income (DH vs. MH). Thus, for each characteristic and for each health indicator, two linear regression analyses were performed—one within the high-status neighbourhood group, the other within the high-income group. These analyses were adjusted for age and sex, because of the stratified nature of the sample.

In a third step, objective neighbourhood characteristics, individual socio-demographic characteristics, and perceptions of neighbourhood and housing were included in the original models one by one to examine the explanatory value of each of them. A characteristic is considered as a mediator when the regression coefficient in the original model is reduced by at least 10%.

Results

Non-response analysis

Of the 2,981 eligible community-living participants, a substantial number ($n = 441$, 14.8%) had missing data on the key variables neighbourhood status and, especially, on income. The subjects with incomplete data appeared to have contrasting characteristics. On the one hand, they were younger, more often homeowners, more often satisfied with their income and they more often reported a stable income than those with complete data. They also lived more often in a neighbourhood with a lower percentage of inhabitants receiving social security benefits and with a higher percentage of homeowners. On the other hand, they were more often female, reported more functional limitations, had more cognitive impairments, and more depressive symptoms. These contrasting characteristics make it difficult to anticipate any systematic effects on the results when omitting those with incomplete data.

Descriptive statistics

Among the 504 persons who reported a high income, 15.5% lived in a low-status neighbourhood (DH), and among the 757 persons living in a high-status neighbourhood, 23.8% had a low income (DL). Conversely, among the 792 persons who reported a low income, 22.7% lived in a high-status neighbourhood (DL), whereas among those 750 persons living in a low-status neighbourhood, 10.4% had a high income (DH). Of the total

sample, 7.1% were categorised as DL, and 3.1% as DH (Fig. 1).

The neighbourhood characteristics generally showed differences between low- and high-status neighbourhoods (Table 1, upper part). Compared to the high-status neighbourhoods (DL and MH), the socio-economic neighbourhood characteristics of the low-status neighbourhoods (ML and DH) showed a significantly higher percentage receiving social security benefits (27 and 28% vs. 23 and 24%) and a lower extent of homeownership (1.7 and 2.1 vs. 3.8 and 3.9). The first indicator of social integration, neighbourhood turnover, did not differ significantly between the low- and high-status neighbourhoods: the migration out of the neighbourhood was about 4% per year in each group distinguished. Also, the percentage of the population aged 65 and over did not differ significantly. The indicators of access to services did differ significantly between low- and high-status neighbourhoods: 32% (ML) and 41% (DH) of low-status neighbourhoods were located in a large city, against 17 and 30% of high-status neighbourhoods (DL and MH). Urbanisation in terms of the number of addresses per km^2 followed the same pattern. Similar percentages of the "matched" (ML and MH) neighbourhoods were located in a large city, whereas the "discrepant" (DL and DH) neighbourhoods deviated significantly—the DL towards less urbanisation, and DH towards greater urbanisation.

As opposed to the neighbourhood characteristics, the personal characteristics generally showed differences between low- and high-income groups (Table 1, lower part). The average age of the low-income sample members was significantly higher than that of the high-income sample members. Moreover, sample members in

Table 1 Neighbourhood and individual characteristics according to income–neighbourhood group[a]

	Low personal income		Matched-middle, MM	High personal income	
	Matched-low, ML ($n = 290$)	Discrepant-low, DL ($n = 180$)	($n = 1,718$)	Discrepant-high, DH ($n = 78$)	Matched-high, MH ($n = 274$)
Neighbourhood					
Socio-economic					
% Social security	27	23*	25	28**	24
Homeownership	1.7	3.8	2.7	2.1**	3.9
Social integration					
% Neighbourhood turnover	4.1	4.1	3.9	4.1	4.3
% Aged 65+	17.4	17.2	17.5	19.7	18.0
Services					
% Large city	32	17**	28	41*	30
Urbanisation	3.1	2.6**	3.0	3.4*	3.2
Individual					
Socio-demographics					
Age (SD)	73.9 (8.0)	72.8 (8.2)**	69.6 (8.3)	70.7 (9.2)**	67.4 (8.5)
% Female	71	70**	48	30	32
% Elementary school	70	48**	45	14	8
% No partner	81	61**	28	14	16
% Homeowner	14	48**	35	30**	71
# Years in neighbourhood	21.3 (18.8)	25.5 (21.3)**	23.9 (17.5)	19.9 (15.5)	19.5 (13.8)

[a]All characteristics show significant differences across the five categories ($p < 0.05$). Based on post-hoc comparison, adjusted for age and sex, the significance of the difference of the DL and DH categories with the MH category is indicated by *$p < 0.05$ and ** $p < 0.01$

ML were older than those in DL neighbourhoods, and older in DH than those in MH neighbourhoods. The percent females was more than twice as high in the low-income groups (71%) as in the high-income groups (31%). Meanwhile, the percent females did not differ between both low-income groups, nor between both high-income groups. Low-income sample members more often had elementary schooling only, as opposed to the high-income sample members among whom the proportion having attained elementary school only was very low (8–14%). In addition, a significant difference existed between ML and DL sample members, the former having the highest percentage of elementary schooling only (70%). The proportions having no partner in the household followed the same pattern: low proportions among the higher-income groups (14–16%), and much higher proportions among the lower-income groups, with an additional difference between ML (81% having no partner) and DL (61% having no partner). The percentage of homeowners was highest among MH sample members (71%), followed by DL sample members (48%), who were in turn followed by DH sample members (30%), with the fewest homeowners among the ML group. Thus, differences in homeownership followed both the neighbourhood and the personal income divide. Finally, the average length of time respondents had lived in their neighbourhood was just over 20 years, and showed a significant difference for DL, where it was 25.5 years, versus all other groups.

The descriptive data show that subjects with a low income living in a high-status neighbourhood (DL) predominantly lived in non-urbanised areas with favourable characteristics. In particular, these neighbourhoods featured a relatively low percentage of inhabitants receiving social security benefits, and a high extent of homeownership. The distribution of their personal characteristics showed a relatively high level of education and a relatively high percentage of homeowners, coupled with a long history of living in the neighbourhood. Additional data (not shown in table) indicate that a relatively high percentage (70%) of the DL homeowners no longer had a mortgage. These data support our hypothesis that their income may have declined in the past, but that this was no reason for them to move out of the neighbourhood they had been connected with for many years.

By contrast, the neighbourhoods of the subjects with a high income living in low-status neighbourhoods (DH) were predominantly urban and had several unfavourable characteristics. The percent of inhabitants receiving social security benefits was relatively high, and homeownership relatively low. Furthermore, the number of addresses per km^2 was quite high, with the favourable implication of having relatively many services nearby. In their personal characteristics, they did not differ much from the high-income group who lived in high-income neighbourhoods (MH), except that the percentage of homeowners in the DH group was relatively low compared to the MH group. These data support our

hypothesis that this group lived in neighbourhoods which once had a good status, but had deteriorated over time.

Physical and mental health

The physical health indicators generally showed a gradual increase from the ML to the MH group (Table 2, upper part). The differences between the DL and MH categories were greater and more often significant than those between the DH and MH categories. The general pattern of outcomes becoming gradually more favourable also held true for the mental health indicators. A notable exception is depression: the average number of symptoms in the DH category was greater than in the DL category. Moreover, after adjustment for age and sex, the depression difference between the DL and MH categories was no longer significant, whereas the difference between the DH and MH categories remained significant.

Perception of income and neighbourhood

Income satisfaction increased gradually from the ML to the MH category (Table 2, lower part). Income stability was lowest in the DL group, although the average score did not differ significantly from those in the other groups. Satisfaction with the home was greatest in the MH group, followed by the DL group. However, home satisfaction differences were not statistically significant either. Neighbourhood satisfaction increased from the ML to the MH group, but was relatively low in the DH category. The wish to move house was greatest in the DH category, in which it differed significantly from the other groups—as many as 22% wanted to move.

Explanatory value of neighbourhood and personal characteristics

The next step is to examine neighbourhood characteristics, individual characteristics, and individual perceptions in terms of their explanatory value. For the neighbourhood characteristics, this step is to provide insight into pathways through which health may be affected. For the individual characteristics, potential confounding is examined, and for the individual perceptions, insight into their possible mediating role is provided.

Comparison within high-neighbourhood status group

In the comparison within subjects living in high-status neighbourhoods, neighbourhood characteristics did not explain any part of the associations between income and health indicators (physical health: Table 3, columns 2–4;

Table 2 Indicators of physical and mental health and perceptions of income and neighbourhood, according to income–neighbourhood group[a]

	Low personal income		Matched-middle, MM	High personal income	
	Matched-low, ML ($n = 290$)	Discrepant-low, DL ($n = 180$)	($n = 1,718$)	Discrepant-high, DH ($n = 78$)	Matched-high, MH ($n = 274$)
Physical health					
Physical performance	8.6	8.0**	7.3	7.5*	6.4
Self-reported limitations	2.5	1.8**	1.2	1.0	0.5
Self-rated health	2.7	2.4**	2.4	2.3	2.2
Mental health					
Cognitive ability	25.7	26.9**	27.1	27.4**	28.5
Depressive symptoms	11.3	8.1	7.1	8.4*	6.5
Loneliness	2.9	2.2**	1.8	2.1*	1.5
Perceptions					
Income satisfaction	5.5	6.4**	6.8	7.4**	7.8
Income stability	1.52	1.47**	1.56	1.56	1.52
% Satisfied with home	87	91	90	88	93
Neighbourhood satisfaction	1.56	1.73	1.75	1.71*	1.89
Relocation wish (%)	12	13	16	22*	15

[a]All characteristics show significant differences across the five categories ($p < 0.05$). Based on post-hoc comparison, adjusted for age and sex, the significance of the difference of the DL and DH categories with the MH category is indicated by *$p < 0.05$ and ** $p < 0.01$

mental health: Table 3, columns 5–7). Some individual characteristics did explain part of these associations. Physical performance had an age- and sex-adjusted regression coefficient of −1.12 ($p < 0.01$), which was substantially reduced by schooling (B = −0.89, $p < 0.01$) and income satisfaction (B = −0.70, $p < 0.05$). Nevertheless, in each case the coefficient remained significant. For functional limitations, the same individual characteristics reduced the regression coefficient (age- and sex-adjusted B = −0.82, $p < 0.01$): inclusion of schooling into the model reduced it to −0.55 ($p < 0.01$), and inclusion of income satisfaction reduced it to −0.52 ($p < 0.01$). Moreover, inclusion of partner status reduced the original coefficient to −0.66 ($p < 0.01$). For self-rated health (age- and sex-adjusted B = −0.24, $p < 0.01$), inclusion of income satisfaction even reduced the coefficient to non-significance (B = −0.11).

The age- and sex-adjusted regression coefficient of cognitive ability on income was highly significant (B = 1.37, $p < 0.01$). This coefficient was substantially reduced only by inclusion of level of schooling into the model (B = 0.97, $p < 0.01$). The age- and sex-adjusted regression coefficient of depressive symptoms on income was not significant (B = −1.23), although it became so with some extensions of the original model. The third mental health indicator, loneliness, had a significant age- and sex-adjusted regression coefficient on income (B = −0.74). No neighbourhood characteristics reduced this coefficient by more than 10%, but several individual characteristics did. The greatest reductions were shown after inclusion of partner status (B = −0.35, n.s.) and income satisfaction (B = −0.39, n.s.) into the model. In addition, schooling and housing tenure reduced the coefficient of loneliness on income to −0.59 ($p < 0.05$) and −0.66 ($p < 0.01$) respectively.

Comparison within high-income group

In the comparison within high-income subjects, several neighbourhood characteristics explained the association between neighbourhood status and health (Table 3, columns 8–13). The regression coefficient of physical performance on neighbourhood status, adjusted for age and sex, was −0.63 ($p < 0.05$; Table 3, columns 8–10). This coefficient was reduced by more than 10% when the socio-economic neighbourhood characteristic of percentage receiving social security was included into the model (B = −0.53, n.s.). Four individual characteristics reduced the coefficient by more than 10% each: schooling (B = −0.55, $p < 0.05$), housing tenure (B = −0.48, n.s.), income satisfaction (B = −0.54, n.s.), and neighbourhood satisfaction (B = −0.55, $p < 0.05$). The regression coefficients of the two other physical health indicators were not significant in the original model, and extensions of this model did not change this.

Regarding the mental health indicators (Table 3, columns 11–13), the regression coefficient of cognitive ability on neighbourhood status (B = 0.84, $p < 0.01$) was not reduced by any of the neighbourhood or individual characteristics. By contrast, the regression coefficient of depressive symptoms on neighbourhood status (B = −1.9, $p < 0.05$) was reduced by more than 10% for all neighbourhood characteristics except neighbourhood turnover, with resulting regression coefficients ranging from a non-significant −1.1 after inclusion of the percentage receiving social security benefits to −1.7 ($p < 0.05$) after inclusion of the percentage of persons aged 65 and over. Moreover, the regression coefficient of depressive symptoms on neighbourhood status was reduced by more than 10% for six of the nine individual characteristics: schooling (B = −1.7, $p < 0.05$), housing

Table 3 Explanatory value of neighbourhood and individual characteristics (*italics* reduction of the regression coefficient $|B_b - B_a| > 10\%$)

	Physical health, discrepant personal income effects (DL vs. MH)[#]			Mental health, discrepant personal income effects (DL vs. MH)[#]			Physical health, discrepant neighbourhood effects (DH vs. MH)[§]			Mental health, discrepant neighbourhood effects (DH vs. MH)[§]		
	Performance $B_b=-1.12^{**}$	Functional limitations $B_b=-0.82^{**}$	Self-rated health $B_b=-0.24^{**}$	Cognitive ability $B_b=1.37^{**}$	Depressive symptoms $B_b=-1.23$	Loneliness $B_b=-0.74^{**}$	Performance $B_b=-0.63^{*}$	Functional limitations $B_b=-0.26$	Self-rated health $B_b=-0.08$	Cognitive ability $B_b=0.84^{**}$	Depressive symptoms $B_b=-1.9^{*}$	Loneliness $B_b=-0.54^{*}$
	B_a	B_a	B_a	B_a	B_a	B_a	B_a	B_a	B_a	B_a	B_a	B_a
Neighbourhood												
% Social security	−1.12**	−0.85**	−0.26**	1.38**	−1.50*	−0.74**	−0.53	−0.19	−0.05	0.93**	−1.1	−0.41
Homeownership	−1.12**	−0.81**	−0.24**	1.38**	−1.22	−0.74**	−0.65*	−0.26	0.02	0.75**	−1.2	−0.19
% Neighbourhood turnover	−1.09**	−0.83**	−0.25**	1.35**	−1.34	−0.79**	−0.62*	−0.27	−0.09	0.84**	−1.9*	−0.61*
Individual												
% Aged 65+	−1.06**	−0.85**	−0.26**	1.36**	−1.36	−0.70**	−0.66**	−0.24	−0.09	0.83**	−1.7*	−0.54*
% Large city	−1.12**	−0.85**	−0.26**	1.37**	−1.58*	−0.81**	−0.57*	−0.22	−0.07	0.84**	−1.5	−0.46
Urbanisation	−1.12**	−0.87**	−0.26**	1.24**	−1.80*	−0.74**	−0.60*	−0.23	−0.08	0.86**	−1.6*	−0.51*
Socio-demographics												
Schooling	−0.89**	−0.55**	−0.24*	0.97**	−1.50	−0.59*	−0.55*	−0.24	−0.05	0.76**	−1.7*	−0.49*
Partner status	−1.06**	−0.66**	−0.28**	1.35**	−0.51	−0.35	−0.61*	−0.26	−0.07	0.81**	−2.0*	−0.61*
Housing tenure	−1.06**	−0.76**	−0.21*	1.35**	−0.98	−0.66**	−0.48	−0.27	−0.003	0.78**	−1.2	−0.24
Years in neighbourhood	−1.10**	−0.82**	−0.25**	1.36**	−1.40	−0.79**	−0.63*	−0.25	−0.08	0.83**	−1.8*	−0.54*
Perceptions												
Income satisfaction	−0.70*	−0.52**	−0.11	1.39**	−0.23	−0.39	−0.54	−0.25	−0.05	0.79**	−1.4	−0.36
Income stability	−1.15**	−0.82**	−0.22*	1.45**	−1.10	−0.70**	−0.61*	−0.25	−0.08	0.82**	−1.9	−0.56*
Housing satisfaction	−1.10**	−0.81**	−0.22*	1.38**	−1.09	−0.70**	−0.60*	−0.24	−0.06	0.85**	−1.6*	−0.45
Neighbourhood satisfaction	−1.11**	−0.80**	−0.24*	1.38**	−1.19	−0.73**	−0.55*	−0.20	−0.06	0.84**	−1.5	−0.41
Relocation wish	−1.14**	−0.82**	−0.25**	1.39**	−1.33	−0.77**	−0.62	−0.24	−0.07	0.82**	−1.7*	−0.49*

[#] B_b = regression coefficient of health indicator on income, adjusted for age and sex; B_a = regression coefficient of health indicator on income, adjusted for age, sex, and neighbourhood or individual characteristic

[§] B_b = regression coefficient of health indicator on neighbourhood status, adjusted for age and sex; B_a = regression coefficient of health indicator on neighbourhood status, adjusted for age, sex, and neighbourhood or individual characteristic

tenure (B = −1.2, n.s.), income satisfaction (B = −1.4, n.s.), housing satisfaction (B = −1.6, $p < 0.05$), neighbourhood satisfaction (B = −1.5, n.s.) and relocation wish (B = −1.7, $p < 0.05$). The reductions in the regression coefficient of loneliness on neighbourhood status (B = −0.54, $p < 0.05$) largely followed a similar pattern, with resulting regression coefficients ranging from −0.19 (n.s.) after inclusion of neighbourhood homeownership to −0.46 (n.s.) after inclusion of the percentage of neighbourhoods in a large city. Age homogeneity, urbanisation, schooling, and relocation wish did not substantially reduce the regression coefficient of loneliness.

Discussion

This study examined how discrepancies between personal income level and income status of the neighbourhood affect physical and mental health. From a life course perspective, it was hypothesised that discrepancies could develop when older adults, who at midlife had high incomes and lived in a matching neighbourhood, experienced either a substantial income decline or a deterioration of their neighbourhood. Examination of the personal and neighbourhood characteristics in the discrepant groups supported the distinction between the two hypothesised discrepancies. It was established that a substantial proportion (10.2%) of the older population live in such discrepant environments.

Among those who lived in a high-status neighbourhood but had low incomes (DL), almost all health indicators showed poorer health as compared to those who lived in matched-high neighbourhoods. The one exception was depressive symptoms, which did not show significant differences. The health differences were substantially reduced when accounting for personal characteristics such as schooling and income satisfaction. However, these differences were not reduced to nonsignificance, except for the indicator self-rated health. The evidence, then, suggests that older adults whose income had declined but who still lived in their high-status neighbourhoods had poorer physical functioning, poorer cognitive ability, and felt more lonely than those whose income had not declined. A notable characteristic of the DL group was that the majority of homeowners lived in a mortgage-free house. Thus, even though their income was low, their wealth was relatively high. The persistence of health differences shows the stronger effect of income as compared to wealth.

These findings are consistent with the vast literature on the detrimental effect of a low income on aspects of health. The contribution of this study to this literature is that it shows that this effect exists even when only neighbourhoods of high status are considered. An alternative interpretation is based not on the detrimental effect of a low income but rather on the discrepancy between income and neighbourhood itself. Even though we were considering high-status neighbourhoods, the neighbourhoods with a relatively high variety of income

levels among its inhabitants may be more heterogeneous in other respects as well. Some authors have suggested that heterogeneity itself may affect health (Kawachi and Kennedy 1997; Marmot and Wilkinson 2001; Lopez 2004). A recent study by Hou and Myles (2005) suggests that better-off neighbourhoods are socially more homogeneous, offering their inhabitants better opportunities for helpful social relationships. The importance of social relationships as a mediator in neighbourhood effects is also stressed by Sampson et al. (2002) and Krause (2003). Although we included neighbourhood characteristics which were intended to indicate social integration, these characteristics did not differentiate very well. A valuable next step in examining the health effects of discrepant neighbourhoods would be to focus explicitly on social networks.

Interestingly, Hou and Myles (2005) found that the less advantaged profited from living among the more advantaged. This contrast with our findings may be explained by our focus on older adults, whereas Hou and Myles (2005) studied people aged 12 and over. Being (relatively) poor in later life differs from poverty earlier in the life course. The discrepant group we identified most probably consists of people who used to have income levels comparable to that of their neighbours. Becoming poorer than a reference group—and knowing this will remain so—may be more stressful than being poorer and possibly trying to change that for the better.

Among the older subjects who had a high income but lived in a low-status neighbourhood (DH), one physical health indicator and all three mental health indicators showed poorer health as compared to those who lived in matched-high neighbourhoods. Both neighbourhood and individual characteristics mediated the difference in physical health, especially the percentage of inhabitants receiving social security, personal housing tenure, and income satisfaction. As to mental health, both neighbourhood and individual characteristics also mediated differences in depressive symptoms and loneliness. Among these, extent of homeownership in the neighbourhood as well as personal housing tenure were shown to be the strongest mediators, followed by neighbourhood satisfaction. This evidence suggests that older persons with a high income whose neighbourhood had deteriorated had poorer physical functioning and felt more depressed and lonely. Their poorer health could be attributed to—predominantly socio-economic—neighbourhood characteristics and to personal characteristics, predominantly satisfaction with income, housing and neighbourhood.

These findings correspond to the emerging literature on neighbourhood-based health differences among older citizens (Krause 2003; Glass and Balfour 2003). The contribution of this study is twofold. First, it shows that such health differences exist even among older persons enjoying the benefits of a high income. Second, it points to possible pathways through which health is affected. These pathways include both objective and subjective factors.

In contrast to the findings for depressive symptoms and loneliness, none of the neighbourhood and individual characteristics explained the association of cognitive ability with neighbourhood status, even in part. This evidence suggests that older persons with a high income whose neighbourhood had deteriorated had poorer cognitive ability than those whose neighbourhood had not deteriorated. A tentative interpretation reverses the direction of causality. Cognitively impaired persons may be more likely to remain living in a discrepant neighbourhood, because they no longer have the competence to move elsewhere (Boyle et al. 2002).

Several limitations of this study need to be discussed. First and foremost, postal code areas do not necessarily coincide with neighbourhoods. In our study, they are likely to be larger. In particular in the DL group with its predominantly non-urban character, one four-digit postal code may cover a complete village, thus levelling out all neighbourhood-based socio-economic information. By consequence, the impact of neighbourhood characteristics may have been underestimated in the comparison with the MH group, which is located predominantly in urban areas, where postal codes delimit more homogeneous neighbourhoods.

A further limitation is the relatively small number of subjects, especially in the DH group. One reason for this is the substantial number of subjects excluded because of missing data, mostly on personal income. Our non-response analysis shows that the excluded subjects were better off in terms of both objective socio-economic neighbourhood characteristics and personal income satisfaction, but that they had poorer health. It is difficult to infer if this would have influenced the findings in a specific direction. The small number in some groups was also a reason for not making adjustment for covariates other than age and sex, because inclusion of a larger number of covariates in one model might lead to insufficient power. This precluded, however, that we were able to account for interrelations between mediating factors. On the other hand, some authors warn against over-adjustment for individual characteristics, because these characteristics may be determined as much by the place as they are by the person (Macintyre and Ellaway 2003).

A third limitation is that our calculation of income may be too high for subjects with a partner in the household. We found a very low percentage having no partner among incomes defined as high and, vice versa, a very high percentage having no partner among incomes defined as low. However, partner status is highly correlated with age and sex, and our comparisons were adjusted for these factors. Moreover, in the comparison within the high-income group, partner status mediated the effect of neighbourhood on health for some variables, but not for others.

A final limitation is the cross-sectional nature of our data. Although longitudinal data are available in the Longitudinal Aging Study Amsterdam, the lack of earlier research on discrepancies between income and neighbourhood warrants a first exploration using only cross-sectional data. Nevertheless, this limits our possibilities to disentangle cause and effect. For example, we defined personal perceptions of income and neighbourhood as mediators of the association between income or neighbourhood and health. However, these perceptions may actually be a consequence of the poor health observed. More thorough examination of underlying mechanisms should be carried out in longitudinal data.

Previous research examining the influence of neighbourhood status on health often has used multilevel analysis, where the higher level of neighbourhood status is adjusted for the lower level of personal income. These analyses, although using advanced methods, have not produced unequivocal results (Kawachi and Berkman 2003). One reason for the equivocal results may be that adjustment is performed without a conceptual clarification of the effects at the levels distinguished (Blakely and Woodward 2000). We have shown that a conceptualisation of life course effects in terms of the concordance and discrepancy of neighbourhood and personal income status may be instrumental in this respect.

In conclusion, the findings from our study indicate that discrepancy between neighbourhood and personal income status affects the physical and mental health of older persons. Our findings further indicate that effects of discrepant personal income are only partly mediated by other personal characteristics, and that effects of discrepant neighbourhood status are mediated by specific neighbourhood characteristics as well as by older persons' perceptions of their neighbourhood and their income. Our findings suggest that it is worthwhile to devote further study to the precursors and consequences of discrepancies between neighbourhood and personal income status.

References

Balfour JL, Kaplan GA (2002) Neighborhood environment and loss of physical function in older adults: evidence from the Alameda County Study. Am J Epidemiol 155:507–515

Beekman ATF, Deeg DJH, Van Limbeek J, Braam AW, De Vries MZ, Van Tilburg W (1997) Criterion validity of the Center for Epidemiologic Studies Depression scale (CES-D): results from a community based sample of older subjects in the Netherlands. Psychol Med 27:231–235

Blakely T, Woodward A (2000) Ecological effects in multi-level studies. J Epidemiol Community Health 54:367–374

Boyle P, Norman P, Rees P (2002) Does migration exaggerate the relationship between deprivation and limiting long-term illness? A Scottish analysis. Social Sci Med 55:21–31

Braam GPA (2001) Ouderen sterk onderbelicht in armoedeonderzoek (Older adults neglected in poverty research). Tijdschr Gerontol Geriatr 32:146–149

Brown V (1995) The effects of poverty environments on elders' subjective well-being: a conceptual model. Gerontologist 35:541–548

Deeg DJH, Knipscheer CPM, Van Tilburg W (eds) (1993) Autonomy and well-being in the aging population: concepts and design of the Longitudinal Aging Study Amsterdam. NIG Trendstudies no 7. Netherlands Institute of Gerontology, Bunnik

Deeg DJH, Van Tilburg T, Smit JH, De Leeuw ED (2002) Attrition in the Longitudinal Aging Study Amsterdam: the effect of differential inclusion in side studies. J Clin Epidemiol 55:319–328

De Jong Gierveld J, Kamphuis FH (1985) The development of a Rasch-type loneliness-scale. Appl Psychol Measure 9:289–299

Den Dulk CJ, Van de Stadt H, Vliegen JM (1992) Een nieuwe maatstaf voor stedelijkheid: de omgevingsadressendichtheid (A new measure for degree of urbanization: the address density of the surrounding area). Maandstat Bevolking 40:14–27

Fauth RC, Leventhal T, Brooks-Gunn J (2004) Short-term effects of moving from public housing in poor to middle-class neighborhoods on low-income, minority adults' outcomes. Social Sci Med 59:2271–2284

Fisher KJ, Li FZ, Michael Y, Cleveland M (2004) Neighborhood-level influences on physical activity among older adults: a multilevel analysis. J Aging Phys Activity 12:45–63

Folstein MF, Folstein SE, McHugh PR (1975) "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 12:89–198

Glass TA, Balfour JL (2003) Neighborhoods, aging, and functional limitations. In: Kawachi I, Berkman LF (eds) Neighborhoods and health. Oxford University Press, Oxford, pp 303–334

Golant SM (2003) Conceptualizing time and behavior in environmental gerontology: a pair of old issues deserving new thought. Gerontology 43:538–548

Grundy E, Holt G (2001) The socioeconomic status of older adults: how should we measure it in studies of health inequalities? J Epidemiol Community Health 55:895–904

Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Scherr PA, Wallace RB (1994) A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol Med Sci 49:M85–94

Hou F, Myles J (2005) Neighbourhood inequality, neighbourhood affluence and population health. Social Sci Med 60:1557–1569

Huisman M, Kunst AE, Mackenbach J (2003) Socioeconomic inequalities in morbidity among the elderly; a European overview. Social Sci Med 57:861–873

Kawachi I, Berkman LF (2003) Introduction. In: Kawachi I, Berkman LF (eds) Neighborhoods and health. Oxford University Press, Oxford, pp 1–19

Kawachi I, Kennedy BP (1997) Socioeconomic determinants of health: health and social cohesion: why care about income inequality? Br Med J 314:1037

Knipscheer CPM, De Jong Gierveld J, Van Tilburg TG, Dykstra PA (eds) (1995) Living arrangements and social networks of older adults. VU University Press, Amsterdam

Kobetz E, Daniel M, Earp JA (2003) Neighborhood poverty and self-reported health among low-income, rural women, 50 years and older. Health Place 9:263–271

Krause N (1996) Neighborhood deterioration and self-rated health in later life. Psychol Aging 11:342–352

Krause N (2003) Neighborhoods, health, and well-being in late life. Annu Rev Gerontol Geriatr 23:223–249

Kriegsman DMW, Deeg DJH, Van Eijk JTM, Penninx BWJH, Boeke AJP (1997) Do disease specific characteristics add to the explanation of mobility limitations in patients with different chronic diseases? A study in The Netherlands. J Epidemiol Community Health 51:676–685

Launer LJ, Dinkgreve MHAM, Jonker C, Hooijer C, Lindeboom J (1993) Are age and education independent correlates of the Mini-Mental State Exam performance of community-dwelling elderly? J Gerontol Psychol Sci 48:271–277

Lopez R (2004) Income inequality and self-rated health in US metropolitan areas: a multi-level analysis. Social Sci Med 59:2409–2419

Macintyre S, Ellaway A (2003) Neighborhoods and health: an overview. In: Kawachi I, Berkman LF (eds) Neighborhoods and health. Oxford University Press, Oxford, pp 20–42

Macintyre S, Ellaway A, Cummins S (2002) Place effects on health: how can we conceptualise, operationalise and measure them? Social Sci Med 55:125–139

Magaziner J, Zimmerman SI, Gruber-Baldini AL, Hebel JR, Fox KM (1997) Proxy reporting in five areas of functional status. Comparison with self-reports and observations of performance. Am J Epidemiol 146:418–428

Marmot M, Wilkinson RG (2001) Psychosocial and material pathways in the relation between income and health: a response to Lynch et al. Br Med J 322:1233–1236

Mollenkopf H, Marcellini F, Ruoppila I, Széman Z, Tacken M, Wahl H-W (2004) Social and behavioural science perspectives on out-of-home mobility in later life: findings from the European project MOBILATE. Eur J Ageing 1:45–53

Patel KV, Eschbach K, Rudkin LL, Peek MK, Markides KS (2003) Neighborhood context and self-rated health in older Mexican Americans. Ann Epidemiol 13:620–628

Radloff LS (1977) The CES-D scale: a self-report depression scale for research in the general population. Appl Psychol Measures 1:385–401

Robert SA (2002) Community context and aging—future research issues. Res Aging 24:579–599

Robert SA, Li LW (2002) Age variation in the relationship between community socioeconomic status and adult health. Res Aging 23:233–258

Rowles GD, Ravdal H (2002) Aging, place and meaning in the face of changing circumstances. In: Weiss RS, Bass SA (eds) Challenges of the third age. Oxford University Press, New York, pp 81–114

Sampson RJ, Morenoff JD, Gannon-Rowley T (2002) Assessing neighbourhood effects: social processes and new directions in research. Annu Rev Sociol 28:443–478

Schiepers JMP (1988) Huishoudensequivalentiefactoren volgens de budgetverdelingsmethode (Household equivalence factors using the budget distribution method). Sociaal-Econ Maandstat suppl 2:28–36

Simonsick EM, Phillips CL, Skinner EA, Davis D, Kasper JD (1995) The daily lives of disabled older women. In: Guralnik JM, Fried LP, Simonsick EM, Kasper JD, Lafferty ME (eds) The Women's Health and Aging Study: health and social characteristics of older women with disability. National Institute on Aging, Bethesda, MD, pp 50–69

Statistics Netherlands (1993) Wijk- en buurtregister 1993 (District and neighbourhood registry 1993). Statistics Netherlands, Voorburg/Heerlen

Thomése F, Van Tilburg T, Knipscheer CPM (2003) Continuation of exchange with neighbors in later life: the importance of the neighborhood context. Personal Relation 10:535–550

Van Sonsbeek JLA (1988) Methodische en inhoudelijke aspecten van de OESO-vragenlijst betreffende langdurige beperkingen in het lichamelijk functioneren (Methodological and substantial aspects of the OECD questionnaire regarding long-term limitations in physical functioning). Maandber Gezondheid (CBS) 88/6:4–17

Van Sonsbeek JLA (1991) Het eigen oordeel over de gezondheid; methodische effecten bij het gezondheidsoordeel in gezondheidsenquêtes (The self-rating of health: methodological effects of the rating of health in health interview surveys). Maandber Gezondheid (CBS) 91/9:15–23

Wainwright NWJ, Surtees PG (2004) Places, people, and their physical and mental functional health. J Epidemiol Community Health 58:333–339

Walters K, Breeze E, Wilkinson P, Price GM, Bulpitt CJ, Fletcher A (2004) Local area deprivation and urban-rural differences in anxiety and depression among people older than 75 years in Britain. Am J Publ Health 94:1768–1774