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RESEARCH REPORT

Material, psychosocial, and behavioural factors in the explanation of educational inequalities in mortality in the Netherlands

Floor V A van Oort, Frank J van Lenthe, Johan P Mackenbach

Study objectives: To assess the direct and indirect contributions of material, behavioural, and psychosocial factors to the explanation of educational inequalities in mortality simultaneously.

Design: Prospective observational study (1991–1998).

Setting: General population from south east Netherlands.

Participants: 3979 men and women aged 15–74 years without severe chronic disease at baseline (1991).

Main results: Material factors (type of health insurance, financial problems, and housing tenure), psychosocial factors (life events and external locus of control), and behavioural factors (smoking habits and physical activity) together reduced the relative risk of mortality of the lowest educated group from 2.57 (95%CI 1.43 to 4.64) to 1.01 (95%CI 0.50 to 2.03). Of these three groups of factors, material factors contributed most to the educational inequalities. Part of the contribution of material factors was via psychosocial factors and part via behavioural factors. Psychosocial factors contributed to educational inequalities, partly via behavioural factors. Behavioural and psychosocial factors contributed only marginally to the explanation independent of material factors.

Conclusion: Educational inequalities in mortality were explained by material, psychosocial, and behavioural factors. Material factors contributed most to the explanation, partly via psychosocial and behavioural factors. Improving the material situation of lower educated people may substantially reduce educational inequalities in mortality, partly via the psychosocial and behavioural consequences of improved material circumstances.

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ow socioeconomic position has consistently been associated with an increased risk of mortality.[1][2] However, the mechanisms underlying this association are not completely understood. Suggested explanations include unequal distribution of health risk behaviours (for example, smoking), material factors (for example, financial difficulties), and psychosocial resources and stress related factors (for example, life events, lack of social support).[3][4] Probably these factors together can explain a large part of the inequalities in mortality. However, less is known about which of the explanations is most important. The relative importance of different (groups of) explanatory factors is still under debate. Especially the relative importance of material and psychosocial factors for the explanation of socioeconomic inequalities in mortality is not yet clear.[5] Some argue for a primarily material explanation, in which inequalities in health are the result of differential exposure to material disadvantage,[6] whereas others argue that absolute material standards cannot explain inequalities in health and that inequalities can probably be largely explained by psychosocial factors underlying the perception of relative position in the social hierarchy.[7][8] Studies that focused on only one mechanism indicate that multiple pathways almost certainly underlie the inequalities.[9–11] Furthermore, the mechanisms probably are interrelated, indicating that some mechanisms work through others rather than work independently from each other.[10–13] It is important to acknowledge these indirect pathways in the assessment of the relative importance of different explanatory mechanisms. To our knowledge no study has combined these three groups of explanatory factors (material, behavioural, psychosocial) in an attempt to explain educational inequalities in mortality.

A simplified causal model (fig 1)[3][14] suggests three pathways from level of education to mortality: through (1) material factors,[10] (2) psychosocial and stress related factors,[15] and (3) behavioural factors.[13] Material factors may affect mortality either directly or indirectly, via behavioural and via psychosocial factors.[8][10][13] Psychosocial factors may also exert a direct and an indirect effect, through behavioural factors.[8][12]

Educational inequalities in mortality can only be reduced when the causal mechanisms are understood and when important intermediate factors are identified. Therefore the aim of this paper is to simultaneously assess the direct and indirect contributions of material, psychosocial, and behavioural factors to the explanation of educational inequalities in mortality. Furthermore, we aim to point out the relative importance of the three groups of explanatory factors.

METHODS

Study population

Data were collected within the framework of the prospective GLOBE study.[3] The GLOBE acronym refers to Gezondheid en LevensOmstandigheden Bevolking Eindhoven en omstreken (Health and Living Conditions of the population of Eindhoven and surroundings). In 1991 a random sample of 27 070 non-institutionalised Dutch persons (aged 15–74 years) drawn from 18 municipal population registers in south eastern Netherlands, was sent a postal questionnaire. The response rate was 70.1% (n = 18 973) and response was not substantially different for age, sex, marital status, level of urbanisation, or social class.[3] Two sub-samples of the respondents were approached for a structured interview at the respondents' home. One sub-sample overrepresented
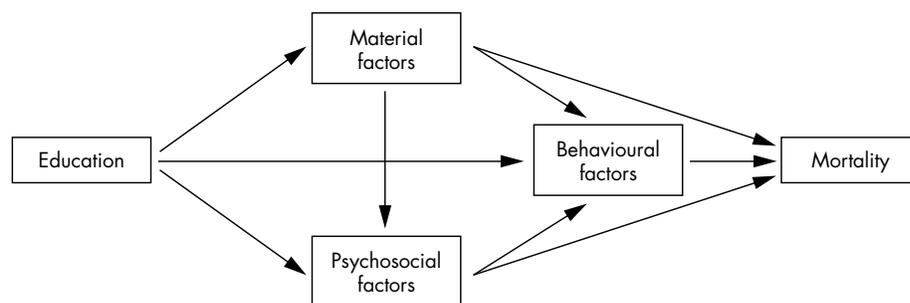
Figure 1 Simplified conceptual model with independent and indirect contributions of material factors, behavioural factors, and psychosocial factors.

people with chronic lung disease, severe heart disease, diabetes, and persistent back trouble (response 72.3%, n = 2865).[16] The other sub-sample was a random sample of respondents to the postal questionnaire (response 79.4%, n = 2802). Differential non-response only occurred in the sub-sample that overrepresented chronically ill persons, where younger and single people less often agreed to participate.[16] Altogether 1463 (26%) people with severe chronic disease in 1991 (chronic obstructive pulmonary disease, heart disease, stroke, renal disease, diabetes, cancer) were excluded as well as people with missing values on either level of education or on self reported severe chronic disease in 1991 (total excluded n = 1580, 28%); 4087 respondents were eligible for the analyses.

Level of education and mortality

Four levels of education were distinguished: primary education only (lowest), lower vocational school and lower secondary school (low), intermediate vocational school and intermediate or higher secondary school (higher), and higher vocational school and university (highest). Students were classified by their current training.

The follow up of all subjects started on 1 April 1991. We used data from the follow up until 1998. Information about all cause mortality was collected annually via municipal population registers. These registers cover the population completely and are maintained continuously with respect to deaths and changes of address.

Material, behavioural, and psychosocial factors

Categories are indicated in parentheses. Material and behavioural factors were derived from the postal questionnaire. A question on the difficulty a person had in paying bills, food, rent, electricity, and so forth during the previous year measured the extent of *financial difficulties* (no difficulties, small difficulties, and big difficulties). Other material factors were *type of health insurance* (public, private), *car owning* (yes, no), and *housing tenure* (owning, renting). Most people in the Netherlands with an income above a certain level are privately insured, while lower income groups receive public insurance, therefore type of insurance is a crude proxy for level of income

Health behaviour factors were *smoking* (current smokers, former smokers, non-smokers), *alcohol use* (excessive, moderate, abstaining), and *physical inactivity* (inactive, moderately active, active). *Excessive alcohol consumption* was defined as drinking at least six alcoholic beverages per day on more than two days per week, or four to five alcoholic beverages per day on more than four days per week.[17] *Physical activity in leisure time* was scored with number of hours per week spent on ''sport activity'' given twice as much weight as ''gardening, cycling, and walking''. Cut off points were two and five hours per week.

The postal questionnaire provided information on life events, and the interview information on other psychosocial factors. Nine negative *life events*, among others negative change in financial position, severe disease of partner, and divorce, in the preceding year were asked for (no event, 1, 2, 3 or more events).[18] Other psychosocial factors were *long lasting difficulties* (no problems, 1, 2, 3 or more problems), *emotional social support* (thirds), *active and avoiding coping styles* (thirds), and *locus of control* (quintiles).[19 20] Long lasting difficulties were measured with an 18 item checklist covering financial problems, social deprivation, neighbourhood problems, health problems of others, and problems in relationships.[21] Emotional social support was measured with a six item Dutch questionnaire asking for the emotional support provided by the respondent's three most significant people (Cronbach's α 0.60).[22] Active and avoiding coping style were measured by the Utrechtse coping list (active coping style eight items, Cronbach's α 0.80; avoiding coping style seven items, Cronbach's α 0.68).[23] An active coping style implies that a subject generally takes action in case of problems, an avoiding coping style implies that a subject tries to stay away from any trouble and is passive in case of problems.

Statistical analyses

All analyses were weighted to make the sample representative for the original Globe respondents. Those risk factors with a significant risk for mortality ($p \leqslant 0.05$), and a negative association with level of education were selected for explanatory analyses. We calculated the hazard ratios[24] for levels of education adjusted for age and gender (reference model) and further adjusted for material factors, behavioural factors, and for psychosocial factors separately, adjusted for

Table 1 General characteristics of the study population by level of education

	Level of education			
	lowest	low	higher	highest
Number (%)	760 (19)	1554 (38)	945 (23)	828 (20)
Age (y) (SD)	57 (12)	48 (14)	40 (17)	43 (15)
% Male*	39	39	52	69
% Deceased*†	6	3	4	2

*Column percentage; †directly standardised for age and gender.

Table 2 Hazard ratios for mortality and age and gender standardised prevalence rates by level of education of material, behavioural, and psychosocial explanatory factors

| | HR | 95%CI | Level of education | | | | |
			lowest	low	higher	highest	p Value
Material factors							
Health insurance (n = 4069)							
Public	2.12	1.40 to 3.21	87	67	47	25	<0.0001
Private	1.00		13	33	53	75	<0.0001
Financial difficulties (n = 4007)							
Big difficulties	3.02	1.57 to 5.81	7	3	3	2	<0.0001
Small difficulties	1.28	0.83 to 1.97	25	16	12	9	<0.0001
No difficulties	1.00		69	81	85	90	<0.0001
Housing tenure (n = 4065)							
Rented house	1.47	1.03 to 2.10	67	46	31	31	<0.0001
Owned house	1.00		33	54	69	69	<0.0001
Behavioural factors							
Smoking (n = 4056)							
Smoker	2.32	1.44 to 3.73	44	39	32	27	<0.0001
Former smoker	1.19	0.71 to 2.00	22	30	35	32	<0.0001
Never smoker	1.00		34	31	33	42	0.0006
Physical activity (n = 4007)							
Inactive	3.14	1.77 to 5.60	16	14	13	9	0.0009
Moderately active	2.14	1.29 to 3.53	60	51	45	48	<0.0001
Active	1.00		24	34	42	42	<0.0001
Psychosocial factors							
Life events (n = 4046)							
0	1.00		47	57	54	50	0.60
1	1.62	1.12 to 2.35	33	27	30	32	0.66
2	1.67	1.00 to 2.79	14	12	12	14	0.81
≥3	2.66	1.32 to 5.35	6	4	4	3	0.007
Locus of control (n = 4016)							
Internal locus of control (q1)	1.00		7	14	23	40	<0.0001
2nd quintile	1.83	0.83 to 4.02	14	21	26	28	<0.0001
3rd quintile	1.65	0.73 to 3.70	13	17	19	15	0.25
4th quintile	1.49	0.68 to 3.26	26	24	19	11	<0.0001
External locus of control (q5)	2.19	1.03 to 4.70	39	25	13	5	<0.0001

Hazard ratios (HR) were corrected for age, gender, and level of education. Hazard ratios and percentages were weighted to make the sample representative for the original GLOBE respondents. The number of respondents varies because the number of missing values on the individual risk factors varied. p Values are for trend test by level of education.

combinations of two groups of factors, and finally adjusted for all explanatory factors simultaneously. For each regression model we calculated the percentage change in hazard ratios of each level of education $(100 \times [HR_{reference\ model} - HR_{+explanatory\ factors}]/[HR_{reference\ model} - 1])$.[25][26] One of the main advantages of this method is that it can be used to estimate direct and indirect contributions of explanatory factors. One limitation is that the percentage change can be similar for different absolute changes in hazard ratios. However, all contributions were calculated relatively to the same hazard ratios, which were also presented. Therefore, we believe that this limitation has a limited effect on our results. We set the

Table 3 Hazard ratios for mortality for levels of education, crude and adjusted for material, behavioural, and psychosocial explanatory factors (n = 3979)

| | Level of education: | | lowest | | low | | higher | | highest |
			HR	95%CI	HR	95%CI	HR	95%CI	HR
Model 1	Confounders		2.57	1.43 to 4.64	1.40	0.77 to 2.53	1.57	0.83 to 2.98	1.00
Model 2	Material		1.18	0.60 to 2.33	0.81	0.42 to 1.57	1.22	0.64 to 2.35	1.00
		change*	89%		100%		61%		
Model 3	Behaviour		2.18	1.21 to 3.92	1.27	0.70 to 2.31	1.48	0.78 to 2.81	1.00
		change	25%		33%		16%		
Model 4	Psychosocial		1.94	1.03 to 3.64	1.21	0.65 to 2.25	1.45	0.76 to 2.78	1.00
		change	40%		48%		21%		
Model 5	Material + psychosocial		1.06	0.53 to 2.14	0.78	0.40 to 1.52	1.16	0.60 to 1.52	1.00
		change	96%		100%		72%		
Model 6	Material + behavioural		1.13	0.57 to 2.22	0.81	0.42 to 1.56	1.21	0.63 to 2.32	1.00
		change	92%		100%		63%		
Model 7	Behavioural + psychosocial		1.72	0.93 to 3.21	1.13	0.61 to 2.09	1.37	0.71 to 2.62	1.00
		change	54%		68%		35%		
Model 8	Material + behavioural + psychosocial		1.01	0.50 to 2.03	0.77	0.39 to 1.50	1.13	0.58 to 2.20	1.00
		change	99%		100%		77%		

Confounders were age and gender. Hazard ratios (HR) were weighted to make the sample representative for the original GLOBE respondents. Material factors: health insurance, housing tenure, financial deprivation; behavioural factors: smoking, physical activity; psychosocial factors: life events, locus of control. *Changes in hazard ratio were calculated by: $100 \times [(HR_{(+confounders)} - HR_{(+explanatory\ factors)})/(HR_{(+confounders)} - 1)]$.

change in hazard ratio at 100% when a hazard ratio was lower than 1. We did this because the interest of this study was in changes relative to the hazard ratio of the highest educated group, which by definition is 1. By comparing the models with two groups of explanatory factors and the corresponding two models with each one group of explanatory factors we were able to distinguish the independent and indirect (for example, contribution of material factors through behavioural factors) contributions. See appendix for more detailed information. We used SAS statistical software (SAS Institute, Cary, USA) for all analyses.

RESULTS

Table 1 shows general characteristics of the study population by level of education. Health insurance, financial difficulties and housing tenure (material factors), smoking and physical activity (behavioural factors) and life events, and locus of control (psychosocial factors) were associated with both mortality and level of education (table 2). These factors were included in the explanatory models. Of the nine life events death of a family member or friend, negative change in financial situation, divorce, and partner's loss of job were significantly (p<0.10) associated with mortality. Hazard
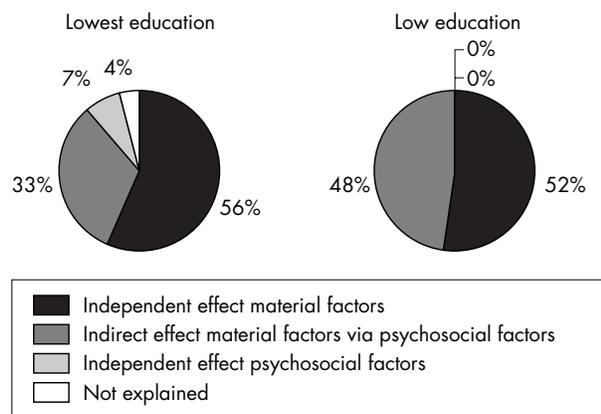

Figure 2 (A) Independent and indirect contributions of material factors and psychosocial factors to the explanation of the mortality hazard ratios of levels of education. The highest educated people were reference group. (B) Independent and indirect contributions of material factors and behavioural factors to the explanation of the mortality hazard ratios of levels of education. The highest educated people were reference group. (C) Independent and indirect contributions of psychosocial factors and behavioural factors to the explanation of the mortality hazard ratios of levels of education. The highest educated people were reference group. See appendix for the calculation of the independent and indirect contributions of and psychosocial and behavioural factors.
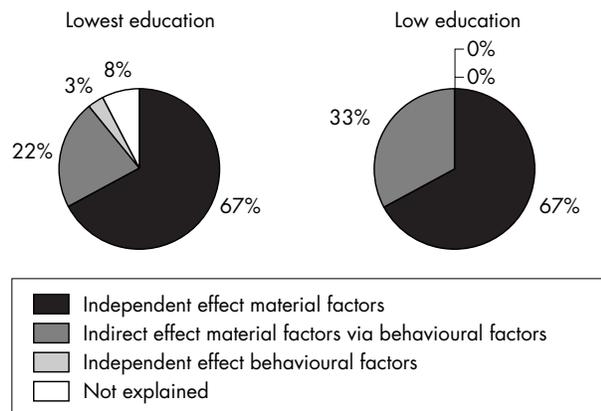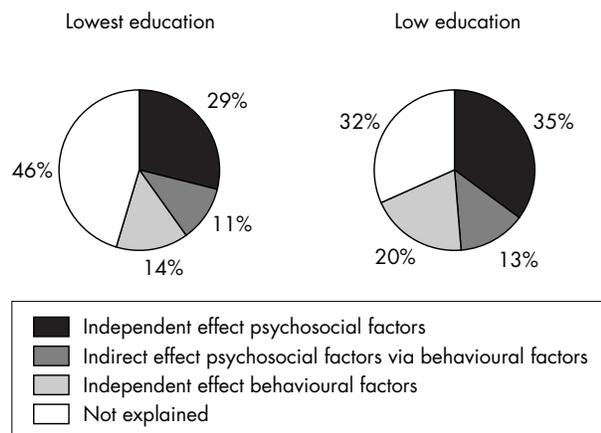
ratios and prevalence rates by level of education for other explanatory factors are available on request.

Compared with the highest educational level the risk of mortality was increased in all levels of education, although not statistically significant for all levels of education (table 3, model 1), with the highest risk in the lowest educated group (HR 2.57; 95% CI 1.43 to 4.64). Adjustment for material factors lowered the hazard ratios most (model 2), followed by psychosocial factors (model 4) and then behavioural factors (model 3).

Adjustment for material and psychosocial factors simultaneously (table 3, model 5) lowered the hazard ratios 7% to 9% more than adjustment for material factors only. This indicated that part of the contribution of material factors was through psychosocial factors (10% to 48%, fig 2A) and that the independent contribution of psychosocial factors was small but higher than the independent contribution of behavioural factors (0% to 11%, fig 2A).

Adjustment for material and behavioural factors simultaneously (table 3, model 6) lowered the risk by an additional 2% to 3% compared with adjustment for material factors only. This indicated that part of the contribution of material factors goes through behavioural factors and that the independent contribution of behavioural factors was very small (0% to 3 %, fig 2B). Furthermore, figure 2B shows that the independent contribution of material factors was higher than the indirect contribution through behavioural factors (47% to 67% compared with 14% to 33%).

Adjustment for psychosocial and behavioural factors simultaneously (table 3, model 7) showed a 14% to 35% further lowering than adjustment for psychosocial factors only, indicating both independent effects of behavioural and psychosocial factors and also an indirect contribution of psychosocial factors through behavioural factors. Figure 2C shows that both independent contributions of psychosocial and behavioural factors were higher than the indirect contribution of psychosocial factors through behavioural factors.

Finally the full model (table 3, model 8) with material, behavioural, and psychosocial factors shows a complete explanation of the hazard ratios of the two lowest educated groups and a large proportion (77%) explained of the hazard ratio of the second highest group.

DISCUSSION

Educational inequalities in mortality were explained by material, psychosocial, and behavioural factors. Material factors contributed most to the explanation, partly via psychosocial and via behavioural factors. Part of the contribution of psychosocial factors was via behavioural factors. Behavioural and psychosocial factors contributed little to the explanation of educational inequalities in mortality independent of material factors.

Methodological considerations

Several methodological remarks can be made with regard to the data used. In the first place, selection bias may have occurred as we excluded 28% of the subjects from analyses. We compared the selected subjects to the respondents of the interviews and the respondents of the postal questionnaire on mortality rate, level of education, age, gender, and the explanatory factors. The three populations were similar with regard to all factors except for the mortality rate. As expected in our selection, in which people with severe chronic disease were excluded, the mortality rate was lower than in the other two groups. As this was the case for all levels of education, we do not expect it has strongly affected our results. Furthermore, results may be different for men and women. We carried out the analyses separately for men and women,

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Key points

- Low educational attainment, a marker of low socio-economic position, has consistently been associated with an increased risk of mortality. The mechanisms underlying this association are not completely understood. Multiple pathways (material, behavioural, and psychosocial) almost certainly underlie the inequalities and these pathways probably are interrelated.
- The relative importance of different pathways in the explanation of educational inequalities in mortality is not well known.
- Material factors contribute most to the explanation of mortality inequalities.
- Part of the contribution of material factors was through psychosocial factors and to a lesser extent through behavioural factors. Part of the contribution of psychosocial factors was via behavioural factors.
- Behavioural and psychosocial factors contributed little to the explanation independent of material factors.

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however the limited sample size has serious limitations to the interpretation of these results. Careful interpretation suggests that selected explanatory factors for the explanatory models would have been very similar for men and women. Furthermore, in men material factors seem to be more important for the explanation than in women, and in women in general less of the inequalities was explained by the selected explanatory factors.

Furthermore, the data were self reported, several variables were proxies, selection mechanisms may not have been sufficiently excluded, and both the study population and the follow up time were limited in size. Because of the limited size of the population and the follow up time there is considerable statistical uncertainty in the hazard ratios and thus also in the percentages calculated from the hazard ratios. Therefore the percentages change should not be interpreted as absolute numbers, but as indication of relative importance.

Finally our results depend on the selection of explanatory factors used in this study. We based the selection of explanatory factors on literature,[9][15][27][28] and made a well balanced selection of probably the most important explanatory factors from the three different groups. With regard to work related factors we decided not to include them as only 45% of the respondents were employed in 1991, and work related factors were only weakly related to mortality. Work related factors may be more important for other health outcomes, and probably they will be more important in populations with a large proportion of employed people.[29–31] Inclusion of more or other explanatory factors (for example, quality of housing, dietary intakes, area characteristics) may result in different estimates of the contributions of material, behavioural, and psychosocial factors to the explanation of educational inequalities in mortality, however we do not expect major changes in the conclusions. To establish whether the explanatory factors included in this study

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Policy implication

Successful interventions to improve the material circumstances of lower educated people are probably the best strategy for reducing educational inequalities in mortality.

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adequately cover the material, behavioural, and psychosocial pathways, future research with more extensive databases should attempt to reproduce our results.

Comparison with other studies

The results of our analyses agree with results found by others. Like in other studies we have found that behavioural factors explain a substantial proportion of the inequalities,[9 11 32] however material factors contribute most,[29] psychosocial factors contribute partly through behavioural factors,[25] and material factors contribute partly through behavioural factors.[13 29] A substantial part of the contribution of material factors was not through the behavioural and psychosocial pathways. A large direct effect of these material factors on mortality is biologically not very plausible. Social and physical environmental factors (possibly related to circumstances in the youth of the older people of the study population) may be pathways by which material factors are related to mortality,[33 34] and should be further explored. Another interesting finding is that the material, behavioural, and psychosocial factors explained most of the excess risk of the lowest educated groups, but a substantial part of the excess risk in the second highest educated group was not explained. The people in the higher educated group are younger and the causes of death are therefore probably different from those in the lower educated groups. Other explanatory factors may be needed to explain the excess risk in the higher educated group.

Results and current theories

There has been a vigorous debate on the relative importance of material and psychosocial factors to the explanation of inequalities in health.[5 6 8 35] The ''(neo)materialist'' explanation suggests that inequalities result from macro level forces (for example, economic and social policies), that lead to a differential exposure to material disadvantage.[6 35] On the other hand advocates of the psychosocial explanations argue that relative material disadvantage is likely to be more important for the explanation of health inequalities than absolute disadvantage, because health inequalities are found in rich countries as well as in poorer countries and there is little relation between average income and life expectancy in richer countries.[8] Our study provides empirical evidence that is of relevance to this discussion although not all material and psychosocial factors are the same: it suggests that material factors contribute importantly to the explanation of health inequalities, and that their contribution is much larger than that of a set of psychosocial factors. Although our results therefore support the ''(neo)materialist'' view, our results also support the psychosocial view in the sense that psychosocial factors seem to form an important pathway by which material factors exert their effect on health inequalities, and that psychosocial factors also contribute to the explanation independently from material factors. Most importantly the results indicate that both should be taken into account simultaneously in attempts to explain educational inequalities in mortality.

Implications

Reducing socioeconomic inequalities in health are an important challenge for health policy worldwide.[36] In several countries, including the Netherlands, committees have given recommendations and targets for policy intended to reduce inequalities in health.[37–39] Recommended interventions include topics related to socioeconomic position, material factors, behavioural factors, psychosocial factors, and health-care services.[38 39] Our results indicate that successful interventions to improve the suboptimal material situation of people are probably the best strategy for reducing educational inequalities in mortality. Interventions on adverse behavioural and psychosocial factors should take into account that these factors are partly a result of suboptimal material conditions.

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APPENDIX

The calculation of independent and indirect contributions was as follows. For each combination of two groups of explanatory factors three models were assessed. For example for material factors and psychosocial factors:

(1) Educational level + confounders + material factors

(2) Educational level + confounders + psychosocial factors

(3) Educational level + confounders + material factors + psychosocial factors

The independent contribution of psychosocial factors was determined by the percentage change of the hazard ratios for educational level attributable to the inclusion of psychosocial factors (model 3) to a model already containing material factors (model 1). Thus the independent contribution of psychosocial factors is calculated as the percentage reduction of the hazard ratios of model 3 minus the percentage reduction of the hazard ratios of model 1. The overlap between material and psychosocial factors was then calculated by subtraction of the independent contribution of psychosocial factors from the total contribution of psychosocial factors (model 2). This overlap was defined as the indirect contribution of material factors through psychosocial factors. The independent contribution of material factors was calculated by subtraction of the overlap from the total contribution of material factors (model 1). Identically we assessed the independent (from material factors) contribution of behavioural factors, the independent (from behavioural factors) contribution of material factors, and the contribution of material factors through behavioural factors and the independent (from psychosocial factors) contribution of behavioural factors, the independent (from behavioural factors) contribution of psychosocial factors, and the contribution of psychosocial factors through behavioural factors.

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