

Socioeconomic position and later life prevalence of hypertension, diabetes and visual impairment in Nakuru, Kenya

George B. Ploubidis · Wanjiku Mathenge · Bianca De Stavola · Emily Grundy · Allen Foster · Hannah Kuper

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Abstract

Objectives We examined the extent to which the association between socioeconomic position (SEP) and later life prevalence of hypertension, diabetes and visual impairment in Nakuru, Kenya is mediated by health-related behaviour. **Methods** We used data from a community survey of 4,314 participants sampled from urban and rural areas in Nakuru, Kenya. Structural equation modelling was employed to estimate the direct and indirect—via health-related behaviour—effects of SEP on the three health outcomes. **Results** The accumulation of material resources was positively associated with hypertension and diabetes,

whereas both education and material resources had a negative association with the prevalence of visual impairment. However, the observed health inequalities were not due to variation between SEP groups in health-related behaviour. **Conclusions** The pattern of associations between education, material resources and the three health outcomes varied, suggesting that in Kenya, unlike the observed pattern of inequalities in high income countries, different dimensions of SEP provide different aspects of protection as well as risk. Smoking and alcohol use did not appear to mediate the observed associations, in contrast with countries past the epidemiologic transition.

Keywords Socioeconomic position · Education · Material resources · Hypertension · Diabetes · Kenya · Health inequalities · Visual impairment · Alcohol · Smoking

G. B. Ploubidis (✉) · E. Grundy
Department of Population Studies, Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, Room 150, Keppel Street, London WC1E 7HT, UK
e-mail: George.Ploubidis@lshtm.ac.uk

W. Mathenge
International Centre for Eye Health, Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, London, UK

B. De Stavola
Department of Medical Statistics, Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, London, UK

A. Foster
Department of Clinical Research, Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, London, UK

H. Kuper
Department of Non-Communicable Disease Epidemiology, Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, London, UK

Introduction

Extensive research has shown that socioeconomic and socio-demographic factors are associated with health outcomes and the importance of these associations for public policy is widely recognised internationally (Mackenbach et al. 2008; Marmot et al. 1991, 2002). However, only recently has the issue of health inequalities for chronic diseases started receiving attention in Africa (Sodjinou et al. 2008; Addo et al. 2009; Bovet et al. 2002), with efforts to reduce inequality and improve health facing many challenges. Among others, these include the high incidence of infectious diseases, the growing burden of chronic diseases such as coronary heart disease and stroke, which are emerging as new leading causes of death in older people (Lopez et al. 2006), inadequate health systems, and

limited human and material resources. Furthermore, little is known of the factors that determine health inequalities and the mechanisms through which they operate.

In high income countries past the epidemiologic transition (Omran 1971), theories of explanation of the association between socioeconomic position (SEP) and health essentially focus on three mechanisms (Smith et al. 1994; Ploubidis et al. 2011): The first is a neo-materialist one; suggesting that those with higher incomes are able to purchase better food, better housing, live in safer environments and have better access to health care (Kaplan et al. 1996; Lynch et al. 2000). The second emphasises behavioural or “lifestyle” factors, such as smoking, diet, alcohol consumption and appropriate use of health care, which may also vary with cognitive skill and access to information (Schrijvers et al. 1999). The third places more emphasis on psychosocial factors such as empowerment, relative social status and social integration, including exposure to stressful events that may result from low status and low autonomy in important arenas of life, such as work (Wilkinson 1997).

Despite the fact that previous studies have reported an association between SEP and various health outcomes (Addo et al. 2009; Bovet et al. 2002), the extent and pattern of health inequalities are relatively unknown and may be different to those observed in high-income countries. Furthermore, the explanatory framework that underlies health inequalities, which has been offered in countries past the epidemiologic transition (Omran 1971), has not yet been tested in Africa. The major aims of this study therefore are: (1) to investigate the associations between education and material resources with the prevalence of hypertension, diabetes and visual impairment in the older population of Nakuru, Kenya; (2) enhance the understanding of the

underlying mechanism(s) of health inequalities in the older population of Kenya, by testing the importance of the health-related behaviour pathway in the association between education and material resources with three distinct health outcomes (see Fig. 1).

Methods

Population and sample recruitment

Nakuru District has a population of 1.6 million, one-third of which lives in urban areas, and it is broadly representative of Kenya in terms of ethnic diversity and economic position. During January 2007 to December 2008, a sample of 100 clusters of 50 people aged ≥ 50 years were selected across Nakuru District through probability proportionate to size sampling, using the electoral roll as the sampling frame. Clusters were classed as “rural” or “urban” using the classification of the district statistical office, which considered population size and access to social amenities in its definition. Households were selected within clusters through modified compact segment sampling (Turner et al. 1996). Further details of the survey are available elsewhere (Mathenge et al. 2010). A total of 5,010 eligible subjects were selected, of whom 4,396 (88 %) were examined. Our analytic sample included 4,314 participants (86 % response) and excluded participants with missing data since they constituted less than 2 % of our data. Ethical approval was granted by the London School of Hygiene and Tropical Medicine Ethics Committee, the Kenya Medical Research Institute Ethical Committee and Nakuru District Health Management Team. Informed consent was obtained from all participants.

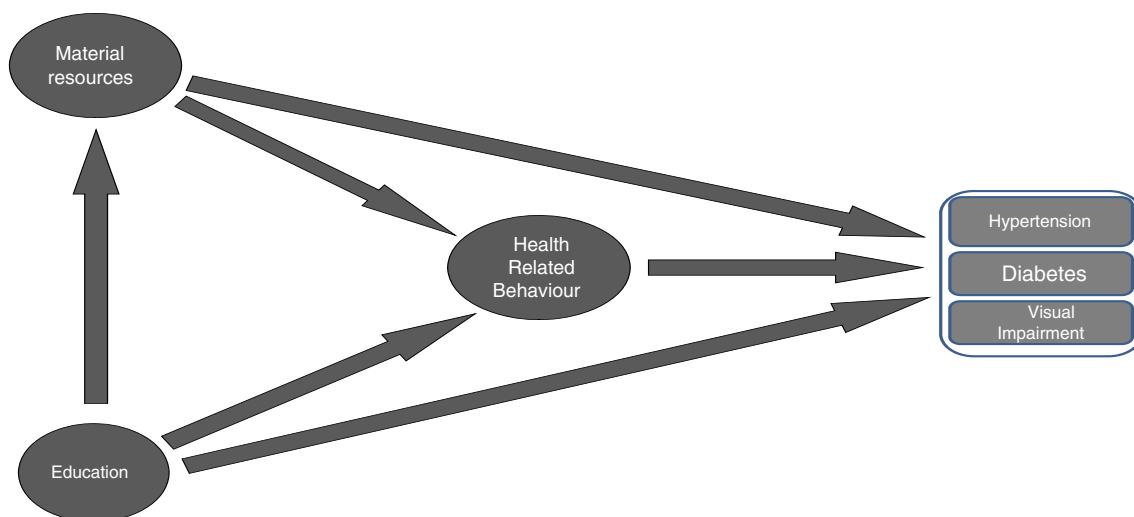


Fig. 1 Conceptual path diagram of the association between SEP indicators and the three health outcomes

Table 1 Descriptive statistics of all variables in the model: rural areas

	Gender		Ethnicity			Age					
Men	1,399	47.3 %	Kikuyu	1,823	61.6 %	Mean	64.7				
Women	1,560	52.7 %	Kalenjin	929	31.4 %	SD	10.7				
Missing	0	0 %	Other	207	7.0 %						
			Missing	0	0 %						
	Concrete Wall		Tiled roof		Toilet		Sofa		Radio		
No	2,611	88.3 %	2,920	98.7 %	2,873	97.1 %	229	7.7 %	459	15.5 %	
Yes	334	11.3 %	25	0.8 %	72	2.4 %	2,717	91.8 %	2,487	84.0 %	
Missing	13	0.4 %	14	0.5 %	13	0.4 %	13	0.4 %	13	0.4 %	
	TV		Fridge		Phone		Cupboard		Sewing machine		
No	2,070	70 %	2,901	98.0 %	1,869	63.2 %	440	14.9 %	2,622	88.6 %	
Yes	876	29.6 %	45	1.5 %	1,077	36.4 %	2,506	84.7 %	324	10.9 %	
Missing	2,946	0.4 %	13	0.4 %	13	0.4 %	13	0.4 %	13	0.4 %	
	Table		Bike		Car		Education				
No	131	4.4 %	1,820	61.5 %	2,819	95.3 %	Primary	1,425			48.3 %
Yes	2,815	95.1 %	1,125	38.0 %	127	4.3 %	Secondary	209			7.1 %
Missing	13	0.4 %	13	0.5 %	13	0.4 %	College/Uni	160			5.4 %
							None	1,159			39.2 %
							Missing	6			0.2 %
	Alcohol		Smoking		Hypertension		Diabetes		Visual impairment		
Never	1,113	37.6 %	2,065	69.8 %	No	1,566	52.9 %	2,808	94.9 %	2,582	88.5 %
Former	1,346	45.5 %	636	21.5 %	Yes	1,379	46.6 %	145	4.9 %	330	11.2 %
Current	490	16.6 %	243	8.2 %	Missing	14	0.5 %	6	0.2 %	15	0.3 %
Missing	10	0.3 %	15	0.5 %							

Measures

Participants were interviewed by trained nurses. Information was collected on smoking, alcohol use demographic data, education and assets (building materials of the house—type of walls, roof, floor and toilet; ownership of household assets—radio, TV, fridge, phone, cupboard, sofa set, sewing machine, table, bicycle and vehicle; animal ownership—cows, sheep/goats). A nurse recorded the blood pressure of participants three times on the right arm of the participant, at least 5 min apart using the Omron digital automatic blood pressure monitor (model HEM907) after an initial period of 5 min of rest. The average of the last two readings was used as the measures of systolic and diastolic blood pressure (to nearest 1 mmHg). If there were large differences between the two readings (more than 10 mmHg systolic and 5 mm diastolic) or if both readings were extremely high, a fourth reading was taken and this was recorded as the study BP. A random finger-prick blood sample was taken to measure glucose (Accutrend GC system) and cholesterol levels (Accutrend GC system). These

machines were both calibrated once per week using control solutions, and each time a new pack of strips was used. In addition, detailed ophthalmic measures were taken, including visual acuity which was measured using log-MAR. According to WHO standards, participants with normal or near normal vision were classified as not being visually impaired. Visual impairment was defined as visual acuity $<6/18$ in the better eye with available correction; hypertension as systolic blood pressure (SBP) ≥ 140 mmHg or diastolic blood pressure (DBP) ≥ 90 mmHg, previous diagnosis by a physician or current use of antihypertensive medication; and diabetes as previous diagnosis by a physician, reported current medication or diet control for diabetes, or random blood glucose level ≥ 11.1 mmol/L (Tables 1 and 2).

Statistical analysis

A structural model for the variables depicted in Fig. 1 was formulated with all direct and indirect effects estimated simultaneously. We employed a formal—model-based—

Table 2 Descriptive statistics of all variables in the model: urban areas

	Gender		Ethnicity			Age					
Men	707	49.2 %	Kikuyu	937	65.2 %	Mean	60.8				
Women	730	50.8 %	Kalenjin	86	6.0 %	SD	9.6				
Missing	0	0 %	Other	414	28.8 %						
			Missing	0	0 %						
	Concrete Wall		Tiled roof		Toilet		Sofa		Radio		
No	614	42.7 %	1,178	82.0 %	1,039	72.3 %		125	8.7 %		
Yes	815	56.7 %	257	17.9 %	396	27.6 %		1,308	91.0 %		
Missing	8	0.6 %	2	0.1 %	2	0.1 %		4	0.3 %		
	TV		Fridge		Phone		Cupboard		Sewing machine		
No	498	34.7 %	1,147	79.8 %	403	28.0 %	72	2.3 %	1,098	76.4 %	
Yes	935	65.1 %	286	19.9 %	1,030	71.7 %	1,361	97.4 %	335	23.3 %	
Missing	4	0.4 %	4	0.3 %	4	0.3 %	4	0.3 %	4	0.3 %	
	Table		Bike		Car				Education		
No	28	1.9 %	740	51.5 %	1,242	86.4 %		Primary	624	43.4 %	
Yes	1,405	97.8 %	693	48.2 %	191	13.3 %		Secondary	252	17.5 %	
Missing	4							College/Uni	263	18.3 %	
								None	295	20.5 %	
								Missing	3	0.2 %	
	Alcohol		Smoking		Hypertension		Diabetes		Visual impairment		
Never	590	41.1 %	1,002	69.7 %	No	619	43.1 %	1,292	88.9 %	1,304	92.8 %
Former	589	41.0 %	331	23.0 %	Yes	812	56.5 %	142	9.9 %	98	6.8 %
Current	255	17.7 %	98	6.8 %	Missing	6	0.4 %	3	0.2 %	7	0.4 %
Missing	3	0.2 %	6	0.4 %							

estimation of the indirect effects (mediation) of the effect of education and material resources on the three binary health outcomes that were jointly modelled in order to account for their intercorrelations. This allowed us to estimate the extent to which the effects of education and material resources on health are due to the latent summary of smoking and alcohol use. This would not be possible using standard multiple regression models, since the estimated effect of education and material resources on the three health outcomes would be simply adjusted for each other, therefore neglecting the indirect perspective. (De Stavola et al. 2006) According to our conceptual model in Fig. 1, education was entered as an exogenous variable, whereas latent summary variables for the accumulation of material resources and health-related behaviour were specified as intermediate variables. The accumulation of material resources as latent summary variable was derived from combining several assets. Previous work conducted in this setting showed that household assets were closely related to household per capita expenditure and household self-rated wealth (Kuper et al. 2008) and therefore the

assets-based latent variable can be thought of as a wealth indicator.

The summary of health-related behaviour was derived combining indicators of smoking status and alcohol use, with high scorers being those who excessively drank alcohol and smoke. Both latent variable measurement models were estimated as unidimensional confirmatory factor analysis (CFA) models appropriate for the combination of binary ordinal and continuous indicators. The latent variables specified within the CFA models comprise common (shared) variance between the observed indicators and exclude their unique (not shared) variance as random error. The latent summaries can be thought of as accurate representations of material resources and health-related behaviour, since one of the properties of latent variable measurement models is their ability to capture unobserved heterogeneity (Rabe-Hesketh and Skrondal 2008). Mother tongue was classified as “Kikuyu” and “Kalenjin” and “Others” and used to represent “Ethnicity”. Age in years and gender were included as confounders. All models were estimated with the weighted least squares, mean and

Table 3 Model parameters, 95 % confidence intervals and standardised model parameters: rural areas

	Hypertension	Diabetes	Visual Impairment	Health-related behaviour	Material resources
Gender	0.010 (-0.155 to 0.156) 0.022	-0.368 (-0.671 to 0.079) -0.154	-0.011 (-0.217 to 0.209) -0.058	-2.145 (-2.327 to 2.038) -0.735	-0.080 (-0.137 to 0.033) -0.043
Age	0.019 (0.015 to 0.024) 0.206	0.013 (0.007 to 0.020) 0.144	0.051 (0.045 to 0.057) 0.492	0.001 (-0.004 to 0.006) 0.001	-0.004 (-0.008 to 0.003) -0.066
Ethnicity	0	0	0	0	0
Kikuyus	-0.151 (-0.238 to 0.043) -0.065	-0.337 (-0.492 to 0.117) -0.141	0.218 (0.065 to 0.343) 0.031	0.218 (0.131 to 0.473) 0.074	-0.268 (-0.367 to 0.256) -0.177
Kalenjins	0.061 (-0.084 to 0.215) 0.016	0.087 (-0.13 to 0.329) 0.017	0.150 (-0.122 to 0.408) 0.035	0.286 (0.180 to 0.416) 0.045	-0.220 (-0.359 to 0.145) -0.080
Other	-0.056 (-0.116 to -0.001) -0.052	-0.219 (-0.33 to 0.107) 0.281	0.063 (-0.008 to 0.139) 0.078		
Health-related behaviour					
Material resources					
Direct	0.226 (0.138 to 0.290) 0.163*	0.313 (0.185 to 0.431) 0.258	-0.173 (-0.266 to 0.075) 0.107	-0.257 (-0.347 to 0.116) 0.074	
via Health-related behaviour	0.014 (-0.004 to 0.030) 0.010	0.056 (0.016 to 0.096) 0.039	-0.016 (-0.042 to 0.010) -0.010		
Education					
None	0	0	0	0	0
Primary (Direct)	-0.038 (-0.138 to 0.069) -0.017	0.067 (-0.096 to 0.234) 0.043	-0.168 (-0.306 to 0.031) -0.087	-0.034 (-0.142 to 0.072) -0.003	0.352 (0.282 to 0.419) 0.249
via Health-related behaviour	0.002 (-0.006 to 0.009) 0.001	0.007 (-0.021 to 0.035) 0.001	-0.002 (-0.011 to 0.006) -0.001		
via Material	0.079 (0.051 to 0.108) 0.037	0.110 (0.066 to 0.154) 0.064	-0.061 (-0.106 to -0.016) -0.023		
via Smoking/Alcohol & Material	0.005 (-0.001 to 0.011) 0.003	0.020 (0.007 to 0.033) 0.010	0.006 (-0.014 to 0.002) 0.001		
Secondary (Direct)	-0.024 (-0.228 to 0.192) -0.005	-0.057 (-0.388 to 0.281) -0.018	-0.106 (-0.499 to 0.286) -0.055	-0.161 (-0.377 to 0.075) -0.026	0.714 (0.609 to 0.839) 0.255
via Health-related behaviour	0.009 (-0.007 to 0.025) 0.002	0.035 (-0.012 to 0.082) 0.007	-0.010 (-0.028 to 0.008) -0.001		
via Material	0.161 (0.105 to 0.217) 0.039	0.223 (0.138 to 0.308) 0.066	-0.124 (-0.212 to -0.035) -0.024		
via Smoking/alcohol and material	0.010 (-0.001 to 0.022) 0.003	0.040 (0.014 to 0.066) 0.010	-0.012 (-0.028 to 0.005) 0.001		
College/Uni (Direct)	-0.073 (-0.287 to 0.145) -0.016	0.100 (-0.259 to 0.441) 0.026	-0.164 (-0.678 to 0.361) -0.041	0.074 (-0.181 to 0.335) 0.016	1.061 (0.937 to 1.268) 0.336
via Health-related behaviour	-0.004 (-0.0017 to 0.009) -0.001	-0.016 (-0.065 to 0.032) -0.005	0.005 (-0.011 to 0.020) 0.001		
via Material	0.239 (0.155 to 0.323) 0.052	0.332 (0.221 to 0.433) 0.087	-0.184 (-0.317 to -0.050) -0.031		
via Health-related behaviour and material	0.015 (-0.002 to 0.032) 0.004	0.060 (0.022 to 0.098) 0.013	-0.017 (-0.041 to 0.006) 0.001		

* Significant associations are highlighted

Significant parameters are highlighted in bold

Table 4 Standardised model parameters: urban areas

	Hypertension	Diabetes	Visual impairment	Health-related behaviour	Material resources
Gender	0.166 (−0.089 to 0.421) 0.081	0.059 (−0.322 to 0.440) 0.029	0.313 (−0.102 to 0.728) 0.135	2.583 (− 2.815 to − 2.351) − 0.816	0.033 (−0.036 to 0.102) 0.014
Age	0.029 (0.022 to 0.035) 0.263 *	0.018 (0.008 to 0.028) 0.167 *	0.063 (0.051 to 0.075) 0.511 **	−0.010 (−0.018 to 0.001) −0.042	− 0.008 (− 0.012 to − 0.003) − 0.111
Ethnicity	0	0	0	0	0
Kikuyus	0.027 (−0.248 to 0.302) 0.006	−0.241 (−0.639 to 0.158) −0.031	0.459 (0.097 to 0.821) 0.049	− 0.347 (− 0.510 to − 0.183) − 0.043	−0.092 (−0.256 to 0.073) −0.021
Kalenjins	0.075 (−0.040 to 0.190) 0.033	− 0.195 (− 0.340 to − 0.150) − 0.057	0.144 (−0.263 to 0.551) 0.023	− 0.321 (− 0.496 to − 0.146) − 0.102	0.009 (−0.072 to 0.089) −0.003
Other	−0.030 (−0.109 to 0.048) −0.035	0.014 (−0.104 to 0.133) 0.023	0.091 (−0.034 to 0.217) 0.128		
Health-related behaviour					
Material resources					
Direct	0.299 (0.183 to 0.415) 0.217	0.562 (0.404 to 0.719) 0.249	0.184 (−0.013 to 0.380) 0.113	− 0.209 (− 0.362 to − 0.057) − 0.061	
via Health-related behaviour	0.006 (− 0.014 to 0.027) 0.004	−0.003 (−0.032 to 0.026) −0.002	−0.019 (−0.057 to 0.018) −0.012		
Education					
None	0	0	0	0	0
Primary (Direct)	0.160 (−0.009 to 0.329) 0.075	0.085 (−0.184 to 0.353) 0.031	−0.118 (−0.358 to 0.122) −0.02	0.026 (−0.194 to 0.247) −0.007	0.440 (0.301 to − 0.579) 0.305
via Health-related behaviour	−0.001 (−0.008 to 0.006) −0.001	−0.001 (−0.004 to 0.005) −0.002	0.002 (−0.019 to 0.024) 0.002		
via Material	0.132 (0.078 to 0.185) 0.066	0.247 (0.178 to 0.317) 0.122	0.081 (−0.003 to 0.165) −0.007		
via Health-related behaviour and material	0.003 (−0.005 to 0.010) 0.001	−0.001 (−0.012 to 0.009) −0.005	−0.008 (−0.022 to 0.005) −0.006		
Secondary (direct)	−0.190 (−0.027 to 0.406) −0.065	−0.208 (−0.549 to 0.133) −0.081	0.058 (−0.344 to 0.460) 0.044	0.011 (−0.183 to 0.205) −0.012	0.821 (0.626 to 1.016) 0.428
via Health-related behaviour	0.001 (−0.006 to 0.005) 0.001	−0.001 (−0.003 to 0.003) −0.003	0.001 (−0.017 to 0.019) 0.004		
via Material	0.246 (0.156 to 0.335) 0.093	0.462 (0.349 to 0.574) 0.172	0.151 (−0.008 to 0.309) 0.010		
via Health-related behaviour and Material	0.005 (−0.009 to 0.019) 0.001	−0.002 (−0.022 to 0.018) −0.007	−0.016 (−0.344 to 0.460) −0.008		
College/Uni (direct)	−0.150 (−0.421 to 0.121) −0.061	−0.271 (−0.600 to 0.058) −0.097	−0.424 (−0.852 to 0.005) −0.141	0.064 (−0.214 to 0.342) 0.008	1.260 (0.969 to 1.550) 0.682
via Health-related behaviour	−0.002 (0.010 to 0.006) −0.001	0.001 (−0.007 to 0.009) 0.002	0.006 (−0.021 to 0.033) 0.003		
via Material	0.377 (0.247 to 0.506) 0.148	0.708 (0.551 to 0.865) 0.274	0.231 (−0.007 to 0.240) −0.015		
via Health-related behaviour and material	0.008 (−0.013 to 0.029) 0.001	−0.004 (−0.035 to 0.027) −0.010	−0.024 (−0.062 to 0.014) −0.013		

Significant parameters are highlighted in bold

* $P < 0.05$; ** $P < 0.001$

variance adjusted (WLSMV) estimator, with the “complex” command of the Mplus 6.12 software (Muthen and Muthen 1998–2010). Within this framework, regressions between predictors and continuous latent variables are modelled as linear regressions, whereas the regressions of the three binary health outcomes on all predictors and mediators are modelled as probit regressions. Model fit was assessed with the comparative fit index (CFI), the Tucker Lewis index (TLI) and the root mean square error of approximation (RMSEA). We note that for the CFI and TLI, values >0.90 are indicative of acceptable fit, and values >0.95 indicative of good fit, whereas for the RMSEA values <0.08 are indicative of acceptable and values <0.06 of good fit (Bollen 1989).

Results

The accumulation of material resources CFA model fitted the data, CFI = 0.97, TLI = 0.96, RMSEA = 0.04 and all standardised factor loadings representing the association between the observed assets and the latent summary were satisfactory (range 0.74–0.88). Similarly, the CFA model for alcohol use and smoking had good fit, CFI = 0.95, TLI = 0.94, RMSEA = 0.06, and both standardised loadings were satisfactory (0.68 and 0.73, respectively). We used these measurement models to develop the components of the conceptual model of Fig. 1. We estimated models stratified by area of residence due to the large differences in the prevalence and distribution of hypertension, diabetes and visual impairment that have been reported between urban and rural areas in Africa (Mathenge et al. 2010). In Tables 3 and 4, we present the estimated model parameters, their corresponding 95 % confidence intervals as well as standardised parameters derived from the path analytic model.

In rural areas, the summary variable representing health-related behaviour had a negative association with the prevalence of diabetes, $b = -0.219$ (-0.330 to -0.107), but was not associated with the prevalence of hypertension or visual impairment. The latent indicator of accumulated material resources was positively associated with the prevalence of hypertension, $b = 0.226$ (0.138 – 0.290) and with the prevalence of diabetes, $b = 0.313$ (0.185 – 0.431), but was negatively associated with the prevalence of visual impairment, $b = -0.173$ (-0.266 to -0.075) and with smoking and alcohol use, $b = -0.257$ (-0.347 to -0.160). We observed a positive indirect effect (via health-related behaviour) on the prevalence of diabetes $b = 0.056$ (0.016 – 0.096). However, we did not observe a significant indirect effect of material resources on either the prevalence of hypertension or visual impairment. Education was not associated with any of the three outcomes, or with

smoking and alcohol use, but had, as expected, a strong graded association with the accumulation of material resources (higher educational level, more material resources), which was reflected in the significant indirect—via material resources—associations with the three outcomes.

In urban areas, the latent summary variable representing health-related behaviour was not associated with the prevalence of hypertension, diabetes and visual impairment. The accumulation of material resources was positively associated with the prevalence of hypertension, $b = 0.299$ (0.183 – 0.415) and with the prevalence of diabetes, $b = 0.562$ (0.404 – 0.719), as well as with health-related behaviour, $b = -0.209$ (-0.362 to -0.057), but not with visual impairment, $b = 0.184$ (-0.013 to 0.380). On the contrary, we did not observe a significant indirect effect of material resources on the three health outcomes. Education was not associated with the prevalence of hypertension and diabetes, but had a negative association with the prevalence of visual impairment. It was not associated with smoking and alcohol use, but, as in rural areas, had a strong graded association with the accumulation of material resources (higher educational level, more material resources), which was reflected in the significant indirect—via material resources—associations with the prevalence of hypertension and diabetes. It appears that better education leads to the accumulation of material resources, and in urban areas this relates to higher prevalence of hypertension and diabetes, while education has a direct protective effect against visual impairment.

Discussion

We found evidence of later life health inequalities in both rural and urban areas of Nakuru, Kenya, but the pattern of these inequalities varied between the SEP indicators and the three health outcomes considered here, suggesting that different dimensions of SEP provide different aspects of protection as well as risk. Furthermore, it appears that the measures of health-related behaviour we employed here do not mediate the association between SEP and the three health outcomes, suggesting that at least one important dimension of social causation theory does not adequately account for the pattern of inequalities observed in urban and rural areas of Nakuru, Kenya. Education was, as expected, positively associated with the accumulation of material resources, which in our study we believe largely reflects household consumption (Kuper et al. 2008). However, the pattern of direct effects of education and material resources with health was not consistent and varied by outcome. Education was not directly associated with the prevalence of hypertension and diabetes in either urban or rural areas and had a weak negative association

with visual impairment only in rural areas. However, accumulated material resources were positively associated with hypertension and diabetes in both urban and rural areas, indicating that diseases of affluence are more common among people with higher SEP. This finding is in contrast with the pattern observed in high-income countries (Booth and Hux 2003), but consistent with findings in low-/mid-income countries in other world regions (Mendez et al. 2003), in other countries in Africa (Addo et al. 2009) as well as in historical European populations (Razzell and Spence 2006). We speculate that the observed difference in the pattern of health inequalities in Kenya compared to high-income countries which are past the epidemiologic transition is that participants with higher income and those living in urban areas are able to afford processed foods high in fats and salts and also experience a decrease in the level of physical activity since they are more likely to own a car and be employed in an office-based job (Razzell and Spence 2006; Kerry et al. 2005). These lifestyle differences not captured in our data may contribute to higher levels of obesity, which is a well known risk factor for both hypertension and diabetes (Kaplan 1989; Mokdad et al. 2003; Sorof and Daniels 2002; Stepan et al. 2001).

To test this hypothesis, we estimated a path analytic model where an indicator of obesity was added as a mediator of the association between material resources and the three health outcomes. Similarly with previous studies in Africa (Sodjinou et al. 2008), accumulated material resources were positively associated with obesity, which as expected had a positive association with the prevalence of hypertension and diabetes. Both indirect effects were statistically significant and stronger in urban areas, confirming that the positive association between material resources, hypertension and diabetes is partly due to obesity. However, the independent to obesity and other lifestyle factors, direct associations between the accumulation of material resources, hypertension and diabetes remained significant. We postulate that this finding could be due to the effects of high salt intake and physical activity on hypertension and diabetes (Law et al. 1991; Weinberger 1996; Batty et al. 2002; Healy et al. 2007).

Both education and the accumulation of material resources had a negative association with the prevalence of visual impairment, a finding consistent with what has been reported in high income countries (Wu et al. 2010) and also in studies on Africa (Dandona and Dandona 2001). Participants with high income have better access to health-care facilities, which is crucial for cataract blindness—the leading cause of blindness in Kenya (Mathenge et al. 2007)—that can be treated with a simple surgery. Educated participants are more likely to be aware of the availability of such procedures and are therefore more likely to be treated and are also more likely to be able to read and so

seek treatment earlier to preserve their vision. However, this was evident only in urban areas, where perhaps access to health-care services is easier. Furthermore, SEP has been associated with the prevalence of other eye diseases that can potentially lead to blindness, such as trachoma which has been linked to poor sanitation (Pruss and Mariotti 2000).

The observed later life health inequalities were not due to variation between different SEP groups in the measures of health-related behaviour employed in our study. Education was not associated with smoking and alcohol use in both urban and rural areas, a finding in contrast with what has been widely reported in high income countries, where smoking and alcohol use are strongly socially patterned (Smith et al. 1994). The accumulation of material resources was weakly associated with health related lifestyle choices in both urban and rural areas, indicating that similarly to the pattern observed in countries after the epidemiologic transition, low income, represented here by the accumulation of material resources, is associated with smoking and alcohol use. However, the smoking and alcohol use summary variable was not consistently associated with the three health outcomes as was expected, since in urban areas it had a positive association with diabetes, with the pattern reversed in rural areas, indicating that at least for the time being the lifestyle explanation of health inequalities is not applicable in pre-epidemiologic transition countries.

The strengths of this study include the availability of a population-based sample and of observer measured health indicators for hypertension, diabetes and visual impairment. Furthermore, an appropriate modelling strategy was employed that allowed us to formally estimate direct and indirect effects of education and material resources on the three health outcomes. A major limitation is the lack of measures of psychosocial factors such as empowerment, relative social status, social integration and exposure to stressful events that are thought to mediate the association between SEP and health (Lynch et al. 2000; Wilkinson 1997) and the reliance on relatively crude measures of smoking and alcohol use in order to approximate health-related behaviour. Although we statistically adjusted for confounders such as age, gender ethnicity and stratified by area of residence, our results rely on correct specification of the model and may be influenced by unknown unmeasured confounders (Hernan et al. 2002). Another limitation is the cross-sectional nature of the study. It is plausible that previously diagnosed disease may influence behavioural patterns and to some extent attenuate our parameter estimates. Future longitudinal studies are needed to investigate the mechanism that underlies the association between SEP and health in Africa, particularly since major lifestyle changes occur as a result of rapidly urbanised populations. Studies that will include detailed

dietary and physical activity information are particularly needed to investigate the role of obesity in the pattern of health inequalities and further disentangle the positive association between SEP indicators and the prevalence of hypertension and diabetes.

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