REVIEW

A life-course approach to measuring socioeconomic position in population health surveillance systems

C R Chittleborough, F E Baum, A W Taylor, J E Hiller

J Epidemiol Community Health 2006;**60**:981–992. doi: 10.1136/jech.2006.048694

Measuring socioeconomic position (SEP) in population chronic disease and risk factor surveillance systems is essential for monitoring socioeconomic inequalities in health over time. Life-course measures are an innovative way to supplement other SEP indicators in surveillance systems. A literature review examined the indicators of early-life SEP that could potentially be used in population health surveillance systems. The criteria of validity, relevance, reliability and deconstruction were used to determine the value of potential indicators. Early-life SEP indicators used in cross-sectional and longitudinal studies included education level, income, occupation, living conditions, family structure and residential mobility. Indicators of early-life SEP should be used in routine population health surveillance to monitor trends in the health and SEP of populations over time, and to analyse long-term effects of policies on the changing health of populations. However, these indicators need to be feasible to measure retrospectively, and relevant to the historical, geographical and sociocultural context in which the surveillance system is operating.

See end of article for authors' affiliations

Correspondence to: C Chittleborough, Discipline of Public Health, Level 9, 10 Pulteney Street, Mail Drop 207, University of Adelaide, South Australia 5005, Australia; catherine.chittleborough@adelaide.edu.au

Accepted 23 June 2006

Chronic disease and risk factor surveillance systems collect information on populations to monitor health and its determinants. Determinants of health in surveillance systems in recent decades have traditionally been confined to behavioural risk factors such as cigarette smoking, physical inactivity and poor diet. More recently, with increased recognition that inequalities in health are associated with social, economic and environmental factors in addition to behavioural factors,[1–5] more emphasis has been placed on measurement of socioeconomic position (SEP).[6–14] We use SEP in this paper, rather than socioeconomic status or social class, as it encompasses the material and social resources that influence the position that people hold in societies.[10 15] A life-course approach, which includes indicators of early-life social circumstances, adds value to the measurement of SEP in surveillance systems.

Although it is recognised that comprehensive population health surveillance systems use data from a wide range of sources, including census data, mortality data and hospital statistics,[16] population surveys are the focus of this paper. Surveillance is characterised by continuous data collection[17] in repeated, independent, cross-sectional surveys. Its strength lies in its ability to provide trend data on the health of populations over time, and the intelligence about population groups that disproportionately experience certain health-related problems, while suggesting a basis for public health action.[18–20]

Measuring SEP in population health surveillance systems enables informed decisions to be made about the design, evaluation and monitoring of policies and interventions dealing with inequalities.[9 21 22] Continuing to refine methods of identifying and measuring risk factors for chronic diseases is valuable for understanding disease aetiology[23 24] and devising strategies other than those based on behaviour change to modify population risks. Epidemiological analysis of socioeconomic inequalities in health, including their change over time, requires improved measures of SEP in public health surveillance.[16 25]

Traditionally, surveillance systems measure the current SEP of respondents at the time the survey is conducted. The cumulative and dynamic nature of socioeconomic structures and experiences is more likely to be captured using a life-course approach,[8] which examines the long-term effects on health and disease of physical and social exposures during gestation, childhood, adolescence, young adulthood and later adult life.[26] It includes study of the biological, behavioural and psychosocial pathways that operate across a person's life course, as well as across generations, to influence health status. Life-course effects refer to how health status at any given age reflects not only contemporary conditions but also prior living circumstances for a given birth cohort, from conception onwards.[27] Several interrelated conceptual models of life-course influences on health in adulthood exist (table 1),[28–41] including the critical period, pathway and cumulative theories.

If health status observed in adulthood is the result of social and biological factors that have evolved over the life course,[42] measuring SEP at only one stage of life is inadequate to explain fully the contributions of socioeconomic factors to health status[37] and how these change over time. Indicators of SEP over the life course, particularly during early life, therefore need to be included in population health surveillance systems. The challenge remaining is to determine which specific indicators of socioeconomic circumstances at birth, through childhood,

Abbreviation: SEP, socioeconomic position

Table 1 Life-course models explaining the association between early-life circumstances and health in adulthood

Model	Description
Critical period	This model implies that there is a period of development in early life during which exposures to deprivation have long-term effects on adult health, independent of adult circumstances[28 29]—for example, the fetal origins of disease hypothesis.[30 31]
Pathway	The early-life environment sets people on life trajectories or directions that in turn affect health status over time and into adulthood.[32–34] The pathway model views early environment to be important, but only because it shapes and influences the socioeconomic trajectories of people.[35] Circumstances in early life are seen as the initial stage in the pathway to adult health but with an indirect effect, influencing adult health through social trajectories such as restricting educational opportunities, thus influencing socioeconomic circumstances and health in later life.[34]
Cumulative	The intensity and duration of exposure to unfavourable or favourable physical and social environments throughout life affects health status in a dose–response fashion.[36–40] Unfavourable circumstances throughout life are associated with the greatest risk of poor health in adulthood, whereas unfavourable circumstances at only one stage of life may be lessened by improved circumstances at another stage.[34] This accumulation of risk approach emphasises both biological and social experiences in childhood, adolescence and early adulthood, and how these biological and social risk factors combine and form pathways between early-life experiences and adult disease.[41]

adolescence and young adulthood, should be included. Several reviews have provided detailed discussion of indicators of SEP, including their strengths and limitations, and the theoretical basis of the constructs they intend to measure.[15 43–46] This paper aims to position population health surveillance within the literature of SEP and health over the life course. It reviews indicators of early-life SEP that have been used previously in longitudinal and cross-sectional studies, and examines their potential value for use in population health surveillance systems.

METHODS

A review of the literature was conducted to identify studies that examine the association of indicators of SEP during early life with health over the life course. Early life was defined as the period from birth, through childhood, adolescence and young adulthood.

Search strategy

PubMed, CINAHL, PsychInfo and Sociological Abstracts electronic databases were used to search for the international literature. The terms ''life course'' or ''lifecourse'' in addition to the MeSH headings of ''socioeconomic factors'', ''socioeconomic status'' and ''social class'' were searched for in titles and abstracts. The search was restricted to studies on humans, published in the English language. Reference lists of included studies were hand searched for publications potentially missed in electronic searches. Searches were conducted from the starting of the databases, and no studies were excluded based on study design or the specific life-course model used. The searches resulted in some studies being extracted that examined health over the life course but did not measure SEP during early life. Figure 1 shows results of the database searches, as at March 2005. A list of excluded studies is available from the corresponding author on request.

Assessment of the studies

The indicators of early-life SEP that were used in the included studies were assessed according to whether they were measured prospectively or relied on retrospective recall in either cross-sectional or longitudinal designs. The potential value of indicators for use in surveillance systems was assessed against criteria based on previous work on the value of public health indicators.[47] Specifically, in terms of validity, indicators were assessed according to whether they had a sound theoretical base for inclusion in surveillance systems, whether they measured what they were designed to measure, whether they were associated with other indicators measuring the same construct and whether they predicted what was expected in terms of health outcomes. Indicators of SEP were also assessed for their relevance in different times, places and cultures, the feasibility of measuring them in surveillance systems that necessarily rely on retrospective recall and their ability to be measured consistently over time (reliability). Summary indicators assembled from more than one individual indicator were also assessed for their ability to be deconstructed into their component parts (deconstruction).

RESULTS

Figure 1 shows details of the number of studies obtained from each database. Date of publication of the 83 included studies ranged from April 1992[48] to January 2005.[49 50] Multiple publications from the same study meant that 45 separate studies were included in the 83 publications reviewed.

Indicators of early-life SEP were grouped into six categories (education level, income, occupation, living conditions, family structure and residential mobility) that reflected experiences from birth through childhood, adolescence and early adulthood (tables 2–7).[51–129] Whereas cross-sectional studies always relied on retrospective recall, some longitudinal studies also collected early-life SEP information retrospectively.

Validity

Choosing appropriate measures of SEP should depend on how SEP is considered to be associated with health. A Marxist or Weberian influence may be reflected in the choice of social class structure or life chance indicators such as education, occupation or income.[14 15 130] Neomaterialist explanations for inequalities focus on the lack of material resources, whereas relative position on the social or occupational ladder is more important in psychosocial explanations.[27 131]

The association between the education level of respondents and that of their parents can be explained in different ways. Parents with higher education levels are likely to have a higher SEP, with better jobs, housing, neighbourhood and working conditions,[15] higher incomes, and able to finance higher levels of education for their children. Psychologically, parents with higher education levels are more likely to instil strong educational values and norms in their children. Biologically, intellectual ability and thus educational attainment may be, at least partly, inherited.[132] The influence of mother's and father's education has been shown to be different for men and women, supporting the need to include the education levels of both parents in descriptions of early-life SEP.[132]

Income relates most closely to the material resources component of SEP. It is inversely correlated with suboptimal environmental conditions such as air quality, housing facilities and overcrowding, and school, work and neighbourhood environments.[3] Occupation and employment conditions,

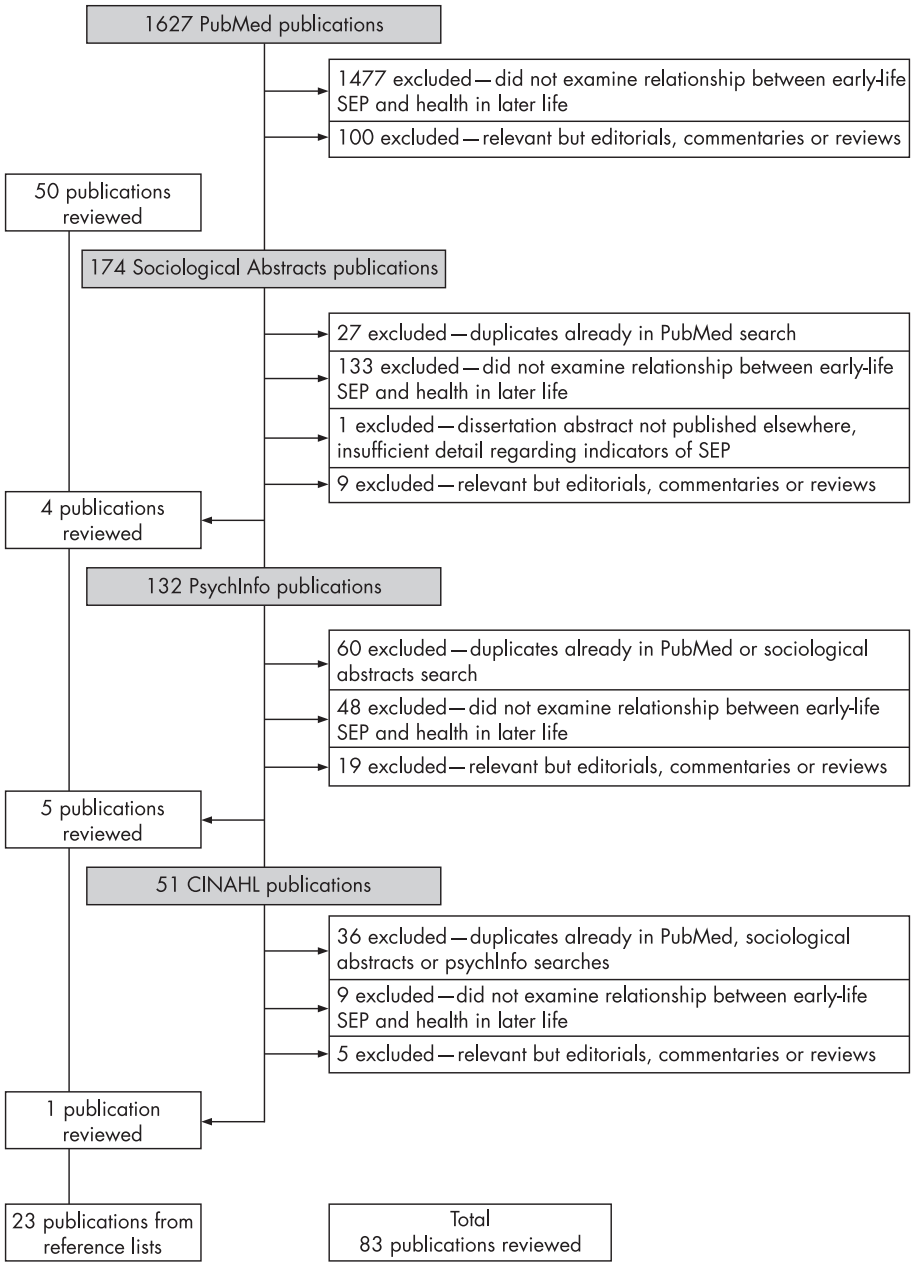

Figure 1 Results of literature searches.

reflecting both the physical and psychosocial environments in which people work, are the major link between education and income.[15] Father's occupation is associated with adult height[81 82] and early-life material circumstances.[100]

In terms of family structure, single-parent backgrounds have been associated with lower incomes and education levels.[40] Family structure questions may also be important to determine whether the respondent lived with their biological parents, step-parents or in some other arrangement. Obtaining information about education and occupation of parents may be irrelevant if respondents did not live with their parents during their early life. Number of siblings or birth order may also reflect childhood SEP, as human and material resources are likely to diminish as the family grows larger.[116] Residential mobility has been negatively correlated with home ownership, which in turn is associated with housing quality and income.[3]

Living conditions, such as car ownership, housing tenure, crowding or amenities, and indicators of family structure and residential mobility are suggested to be merely proxy measures and should not be used when information on education, income and occupation is available.[11 43] Although they are strongly correlated with SEP, they may be associated with health outcomes via causal pathways that are not related to SEP. For example, growing up in a single-parent family may be related to poor health outcomes for socio-economic reasons associated with low income, or it may be related to poorer health for psychological reasons resulting from the family breakdown.[44]

The use of various life-course models (table 1) is evident in the specific indicator chosen to measure early-life SEP. A focus on the critical period model is reflected in the measurement of SEP at the time of birth of participants.[48 116] Use of the pathways model was shown through the

Table 2 Early-life indicators of education

Indicator	Location, study design	Indicators of SEP measured	Criteria
Highest education level of paternal and maternal grandmother	Danish 1958 cohort of men[51]	P	*Validity*: Education of paents is less likely to change after young adulthood than their occupation or income
Highest education level of father	1958 British Birth Cohort[52]	P	
	USA, Longitudinal Alameda County Study[53]	R	
	USA, Cross-sectional National Survey of Midlife Development[54]	R	Low educational level of the mother is an important childhood characteristic in explaining socioeconomic inequalities in health[56]
	USA, Longitudinal Normative Aging Study[55]	R	
Highest education level of mother	Australia, Longitudinal Mater—University of Queensland Study of Pregnancy and its Outcomes[48 57]	P	*Relevance*: Relationship between education and health exists almost universally Norms and social meanings of education change over time and are different between population groups and cultures[6]
	Danish 1958 cohort of men[51]	P	
	The Netherlands, Longitudinal Study of Socio-Economic Health Differences[58]	R	
	USA, Cross-sectional National Survey of Midlife Development[54]	R	
Mother's education when participant born and aged 7 years	USA, Longitudinal National Collaborative Perinatal Project[59 60]	P	*Reliability:* Potentially affected by recall bias Education level of parents is a relatively stable indicator of SEP *Deconstruction:* Not applicable
Highest education level of parents	Slovakia, Cross-sectional survey of adolescents[61]	P	
	USA, Longitudinal CARDIA Study[62]	R	
	USA, Cross-sectional, Midwestern Public School Survey[49]	R	
	USA, Longitudinal National Survey of Children[63]	P	
Mother's and father's education level when participant aged 13 years	Brazil, Cross-sectional, Cianorte Survey of School Children[64 65]	P	
Mother's and father's education level when participant aged 10 years	Finland, Longitudinal Kuopio Ischaemic Heart Disease Risk Factor Study[66 67–70]	R	
Mother's and father's education level when participant aged 4 years	1946 British Birth Cohort[71 72]	P	
Head of household's years of completed schooling when participant aged 15 years	USA National Longitudinal Survey of Older Men[73]	R	
Participant household's highest education level	USA, Longitudinal Harvard Study of Moods and Cycles[74]	P	

P, prospectively; R, retrospectively; SEP, socioeconomic position.

Table 3 Early-life indicators of income

Indicator	Location, study design	Indicators of SEP measured	Criteria
Family income during childhood	Australia, longitudinal Mater—University of Queensland Study of Pregnancy and its Outcomes[48 57]	P	*Validity:* Poor family financial situation is an important childhood characteristic in the explanation of socioeconomic inequalities in health[56] *Relevance*: May be affected by inflation over time, or changing criteria for definitions of poverty *Reliability*: Potentially affected by recall bias and poor response rates Timeframe or age within indicator question may affect responses, as circumstances may change throughout early life *Deconstruction*: Economic distress construct could be broken down into component parts if necessary
	USA, Woodlawn Cohort Study[75]	P	
Family income when participant aged 13 years	Brazil, Cross-sectional, Cianorte Survey of School Children[64 65]	P	
Household income when participant aged 18 years	USA, Wisconsin Longitudinal Study[76]	P	
Economic distress construct in childhood based on receipt of public assistance or welfare, inability to pay for food, rent or mortgage, not having enough money to make ends meet, or borrowing money to pay for medical expenses	USA, Longitudinal Harvard Study of Moods and Cycles[74]	R	
Degree to which family was considered wealthy	Finland, Longitudinal Kuopio Ischaemic Heart Disease Risk Factor Study[68–70]	R	
Receipt of state welfare benefits	Australia, Longitudinal Mater—University of Queensland Study of Pregnancy and its Outcomes[48 57]	P	
	1970 British Birth Cohort[77]	P	
Free school meals or on supplementary benefit	1958 British Birth Cohort[78]	P	
Household poverty status when participant born and aged 7 years	USA, Longitudinal National Collaborative Perinatal Project[59 60]	P	
Period of 6 months during child hood when family was on welfare	USA, Cross-sectional National Survey of Midlife Development[54]	R	
Number of times household income was at least 200% below poverty line	USA, Longitudinal Alameda County Study[39]	R	
Financial circumstances during childhood	The UK, Longitudinal Whitehall Study[35]	R	
	The Netherlands, Longitudinal Study of Socio-Economic Health Differences[58]	R	
	Sweden, Longitudinal level of living surveys[79]	R	

*P, prospectively; R, retrospectively; SEP, socioeconomic position.

Table 4 Early-life indicators of occupation

Indicator	Location, study design	Indicators of SEP measured	Criteria
Maternal grandfather's occupation	Australia, Longitudinal Mater—University of Queensland Study of Pregnancy and its Outcomes[80]	P	*Validity*:
Maternal and paternal grandfather's occupation	Danish 1958 cohort of men[51]	P	Father's occupation is a valid marker of socioeconomic and environmental
Father's occupation	Australia, Longitudinal Mater—University of Queensland Study of Pregnancy and its Outcomes[80]	P	circumstances in childhood.[81 82 83]
	Britain, Longitudinal Whitehall Study[35]	R	Information about past occupation could be as important as current occupation
	Danish 1958 cohort of men[51]	P	given that some occupations are less
	Finland, Helsinki University Central Hospital Cohort[84]	P	healthy than others[87]
	Finland Valmet cohort[85]	R	*Relevance*:
	The Netherlands, Longitudinal Study of Socio-Economic Health Differences[58]	R	Culturally and historically specific, cohort
	Scotland, Glasgow Alumni Cohort[86]	R	and period effects
	Longitudinal West of Scotland Collaborative Study[33 37 88 89 90–93]	R	likely to exist.[51]
	Spain, Cross-sectional study[94]	R	Cannot readily be used for groups
	Sweden, Cross-sectional Malmö Diet and Cancer Study[82]	R	outside the recognised labour force[10]
	Sweden, Cross-sectional Stockholm Heart Epidemiology Programme[28]	R	*Reliability*:
	USA, Longitudinal Alameda County Study[53]	R	Potentially affected by recall bias
	USA, Longitudinal Nurses' Health Study[95]	P	Father's occupation was recalled
	USA, Cross-sectional National Survey of Midlife Development[54]	R	accurately, reliably and by most
	USA, Longitudinal Normative Aging Study[55]	R	respondents
Father's longest held occupation	British Women's Heart and Health Study, cross-sectional[38 50 96 97 98 99]	R	Changing coding criteria need to be
	British Regional Heart Study, longitudinal[100]	R	taken into account for consistent
Father's occupation when participant born	Britain Newcastle Thousand Families Cohort Study[101 102 103]	P	measurement over time
Father's occupation when participant born and aged 7, 11 and 16 years	1958 British Birth Cohort[52 77 104 105 106]	P	*Deconstruction*:
Father's occupation when participant born and aged 3 and 6 years	New Zealand, Longitudinal Christchurch Health and Development Study[107]	P	Not applicable
Father's occupation when participant born	New Zealand, Longitudinal Dunedin Multidisciplinary Health and Development Study[108 109]	P	
Father's occupation when participant aged 4 years	1946 British Birth Cohort[71 72 110 111 112]	P	
Father's occupation when participant aged 14 years	British Household Panel Survey, cross-sectional[113]	R	
Father's occupation when participant aged 16 years	USA, Longitudinal Nurses' Health Study[95]	R	
Mother's occupation	USA, Cross-sectional National Survey of Midlife Development[54]	R	
Parents' occupation at age 15 years	Slovakia, Cross-sectional Survey of Adolescents[61]	P	
Parents' occupation when participant aged 5, 10 and 16 years	1970 British Birth Cohort[77]	P	
Occupation of parents when participant born and aged 3, 5, 7, 9, 13, 15 and 26 years	New Zealand, Longitudinal Dunedin Multidisciplinary Health and Development Study[114]	P	
Parents' occupation when participant aged 10 years	Finland, Longitudinal Kuopio Ischaemic Heart Disease Risk Factor Study[66 68–70 115]	R	
Parents' occupation when participant born and aged 7 years	USA, Longitudinal National Collaborative Perinatal Project[59 60]	P	
Head of household's occupation when participant born	Sweden, Uppsala Birth Cohort Study[116]	P	
Head of household's occupation when participant aged 5 and 10 years	Britain Newcastle Thousand Families Cohort Study[101 102 103]	P	
Head of household's occupation when participant aged 15 years	USA National Longitudinal Survey of Older Men[73]	R	
Head of household's occupation when participant aged 10–14 years	Finland, Longitudinal Census Data Study[40 117]	R	
Whether mother worked outside the home	USA, National Longitudinal Survey of Older Men[73]	R	
Father or mother unemployed when they wanted to be working	Britain, Longitudinal Whitehall Study[35]	R	
Participant's occupation at labour force entry	Sweden, Cross-sectional Stockholm Female Coronary Risk Study[118]	R	
Participant's first occupation	West of Scotland, Longitudinal Collaborative Study[37 90 91 93]	R	

P, prospectively; R, retrospectively; SEP, socioeconomic position.

Table 5 Early-life indicators of living conditions

Indicator	Location, study design	Indicators of SEP measured	Criteria
Whether family lived on a farm, and size of farm, at age 10 years	Finland, Longitudinal Kuopio Ischaemic Heart Disease Risk Factor Study[68–70]	R	*Validity*:
Number of rooms and number of people in the home	Finland, Helsinki University Central Hospital Cohort[84]	P	Overcrowding reflects childhood circumstances that
Overcrowding (ratio of people to number of rooms in household)	1970 British Birth Cohort[77]	P	may be directly or indirectly connected to health[117]
Overcrowding when participant aged 4 years	1946 British Birth Cohort[71 112]	P	Living in council housing has been shown to have a stronger association with midlife psychological distress
Overcrowding when participant aged 11 and 16 years	1958 British Birth Cohort[78]	P	among women than father's occupation and
Overcrowding when participant born and aged 13 years	Brazil, Cross-sectional Cianorte Survey of School Children[64 65]	P	overcrowding[112]
Household amenities (sole use of bathroom, toilet, hot water)	1970 British Birth Cohort[77]	P	*Relevance*:
Lack of hot water in house when participant aged 11 and 16 years	1958 British Birth Cohort[78]	P	These indicators are culturally, geographically and
Presence of toilet inside house when participant born and aged 13 years	Brazil, Cross-sectional Cianorte Survey of School Children[64 65]	P/R	historically specific
Presence of toilet inside house before age 16 years	Britain, Longitudinal Whitehall Study[35]	R	British data showed a secular change in material
Car ownership of family when participant born and aged 13 years	Brazil, Cross-sectional Cianorte Survey of School Children[64 65]	P/R	resources over time
Car ownership of family before age 16 years	Britain, Longitudinal Whitehall Study[35]	R	A 1970 cohort was more likely than a 1958 cohort to
Family access to a car during childhood	British Women's Heart and Health Study, cross-sectional[98 99]	R	own their own home, and less likely to be overcrowded
Housing tenure	1970 British Birth Cohort[77]	P	or share amenities[119]
Housing tenure when participant aged 4 years	1946 British Birth Cohort[71 112]	P	*Reliability*:
Housing tenure when participant born and aged 13 years	Brazil, Cross-sectional Cianorte Survey of School Children[64 65]	P/R	More likely to be recalled accurately than categories
Availability of piped water to house when participant born and aged 13 years	Brazil, Cross-sectional Cianorte Survey of School Children[64 65]	P/R	such as parents' education or occupation
Type of material used to build house when participant born and aged 13 years	Brazil, Cross-sectional Cianorte Survey of School Children[64 65]	P/R	Life grid methods using a temporal reference system
Childhood household amenities (living in a house with a bathroom, living in a house with a hot water supply, sharing a bedroom)	British Women's Heart and Health Study, cross-sectional[98 99]	R	have been shown to improve recall[120]
Housing conditions at birth and ages 5 and 10 years based on overcrowding, lack of hot water, shared toilet, and dampness or poor repair of house	Britain Newcastle Thousand Families Cohort Study[102 103]	P	Lifegrid method may improve reliability of recalled information
			Deconstruction
Material home conditions at age 4 years was an aggregate variable based on state of repair of house, age of house, crowding, cleanliness of house, cleanliness of participant, and condition of participant's shoes and clothes	1946 British Birth Cohort[71 72]	P	Composite or summary indicators may provide less information about the causal nature of associations between SEP and health
Life-grid method to collect retrospective personal, residential and occupational histories. Lifetime exposures to a range of generally accepted health hazards, including atmospheric pollution, residential damp, occupational fumes and dusts, physically arduous work, lack of autonomy, cigarette smoking and inadequate nutrition during childhood and adulthood were estimated from details of household, residential, occupational and smoking histories.	Britain Boyd Orr Cohort[121 122 123 124]	R	
Family amenity score in childhood up to age 10 years (presence of hot water tap and bathroom in family home, whether they shared a bedroom, car ownership)	British Regional Heart Study, longitudinal[100]	R	
Material standard of living at age 15 years (owner occupied accommodation, owned car, owned summer cottage or second house in the countryside)	Danish 1958 cohort of men[51]	P	
Housing conditions at age 0–19 years (Type of dwelling, status of home ownership, number of persons per room, telephone in dwelling, toilet or bath inside dwelling)	Norway Census data cohort[125]	P	
Characteristics of place of residence in 1939 including whether area was depressed, population density, percentage of population in manual work, proportion of population in overcrowded housing, unemployment rate in area	Britain Office for National Statistics Longitudinal Study for England and Wales[126]	P	

P, prospectively; R, retrospectively; SEP, socioeconomic position.

measurement of SEP at a particular age during childhood or adolescence—for example, education of parents, father's occupation and housing conditions when participant was aged 4 years.[71] Measurement of SEP—for example, father's occupation—at several ages[37 52 114] supports a cumulative life-course model, recognising that information on past occuoation of parents and respondents may be as important as current occupation.[61] Existing data sets were sometimes also used opportunistically to examine life-course hypotheses. In these cases, the selection of specific ages for measuring SEP was less likely to be guided by any particular life-course model.

Validity, in terms of expected associations with health outcomes,[46] has been shown for many indicators of early-life SEP, with lower levels of SEP generally associated with adverse health outcomes. Parental education has been associated with psychosocial and cognitive functioning,[66 115] dental health,[64] pulmonary function,[62] self-reported general health,[58] cardiovascular mortality[53] and risky behaviours during adolescence.[61] Financial situation during childhood has been associated with self-reported general health in adulthood.[58] Conditions of overcrowding and type of housing material at birth have been associated with poor dental health during adolescence.[64] Occupational class of the parents, most commonly of the father, has been associated with cardiovascular risk factors,[88 94 96] risky behaviours during adolescence,[61] self-reported limiting longstanding illness,[101] self-reported general health,[58 104] psychosocial functioning,[115] depression,[59] persistent smoking,[52] obesity,[102 110] insulin resistance[38 97] and diabetes,[84] and overall,[71] cardiovascular,[33 37 53] stomach cancer and respiratory mortality.[89] Growing up in a single-parent household has been associated with behavioural, emotional and physical health problems.[133] Residential instability in childhood has predicted an increased risk of lifetime major depression, although it is recognised that simply counting the number of geographical moves during childhood overlooks the context in which the transitions occurred and the resources available at those times.[60] Geographical relocation to a more advantaged area before the age of 25 years was associated with increased risk of developing diabetes, hypertension, dyslipidaemia and coronary heart disease.[129] Lifetime exposure to an urban environment was associated with increased body mass index, blood glucose and blood pressure in a Cameroon population survey.[128]

Relevance

Not all indicators of early-life SEP are relevant for all population groups, at all times and in all places. Occupational coding cannot always be used for groups outside the recognised labour force,[10] such as those who are unemployed, students or retired. Using father's occupation alone, without mother's occupation, is less relevant in more recent times in many countries, because women are increasingly likely to be in the work force.[111 134] In addition, associations between early-life SEP and health outcomes in later life were not always found to be consistent for men and women. For example, parental occupation has been shown to be associated with self-reported limiting longstanding illness at age 50 years[101] and cardiovascular risk factors[94] among men, but not among women.

Although education level of parents is a relatively stable indicator of SEP over the adult life course of people, social norms and meanings of education change over time, and within and between population groups and cultures[6]; hence, caution is required in the interpretation of this indicator in surveillance systems. For example, although completion of high school was not necessary for many trade and professional positions in the first half of the 20th century, it is now considered to be essential for almost any career or employment, at least in many of the developed countries. This has implications for comparing people in different age cohorts, as those with the same educational level are unlikely to have experienced similar occupational opportunities. The effects of inflation and changing criteria for definitions of poverty also need to be taken into account when comparing the relationship of absolute income during early life with health over time.

Indicators such as whether the family lived on a farm, type of material used to build the house and amenities in the household are also culturally, geographically and historically specific, depend on the level of economic development of the country and would not be universally appropriate measures of early-life SEP. Home and car ownership, for example, have different socioeconomic meanings in different places and at different times. Car ownership was shown to be a stronger marker of advantage in childhood for older than younger cohorts in the UK.[135] Although home ownership is traditionally considered to be an indicator of advantage, rates of home ownership that are low (eg, in Switzerland) or declining (eg, in New Zealand) are not necessarily indicative of poorer SEP.[136] Family size and structure are also historically and culturally specific. In Sweden early last century, for example, the more advantaged groups had a higher proportion of families with many children, whereas today, larger families are more common among disadvantaged groups.[116]

Some indicators of early-life SEP, such as overcrowding and family size, may seem more relevant for health outcomes of certain infectious diseases because they indicate levels of hygiene and ease of transmission of infections.[29] Such indicators may still be relevant in chronic disease surveillance systems as indirect measures of social disadvantage that are associated with increased risk of chronic conditions.

Reliability

Previous studies have shown high response rates with retrospective data on childhood social class based on father's occupational class obtained for 86% of all women in a British cohort,[97] 92% in the Alameda County Study,[53] 95% of men in the British Regional Heart Study,[100] 96% in the Kuopio Ischaemic Heart Disease Risk Factor Study[115] and 98% of the Boyd Orr cohort.[121] Parental education has also been shown to be well recalled, missing for only 6% of respondents in the study[62] and 5% in the Kuopio Ischaemic Heart Disease Risk Factor Study.[115] Studies have also found recalled information to be accurate, with 83% exact agreement or agreement within 1 unit of difference between recalled and historical records of father's occupation,[120] and 81% agreement in recall of father's occupation between twin pairs.[137] Several publications were not explicit about the proportion of respondents with missing data for early-life SEP indicators.[28 63 73 80 94] Others stated that respondents with missing data on early life were excluded from analyses.[35 64 65 82 94 138] Respondents with missing data for father's occupation were sometimes classified according to their father's education level instead.[53] Missing data on early-life SEP are not necessarily a problem, unless those with missing data differ systematically from those with complete data. Women with data on both adult and child social class in the British Women's Heart and Health Study were younger, less likely to be current smokers and had smaller waist:hip ratios than those who had missing data.[38] In the Whitehall Study, missing data were overall more common among those from the lowest employment grade.[35]

Using education of parents as an indicator of childhood SEP is advantageous because their education is less likely to change than occupation or income after young adulthood.[1] This may be less true, however, for younger cohorts, and for

women, who may return to study after child bearing. This has implications for the use of different ages when asking questions on early-life SEP. For example, retrospectively asking adult respondents about their mother's education level when they were born, compared with when they were aged 4, 7 or 13 years, may yield different results.

A life-grid method was shown to improve retrospective recall of early-life information. This method includes cross-referencing any changes in SEP with important dates in the respondent's life, such as marriages, births and deaths, and also with important external events such as wars or coronations.[122]

Deconstruction

Summary measures of early-life SEP, such as the economic distress construct[74] or childhood household amenities,[50 98] can be broken down into their component parts. Although it is important to consider using multiple indicators of SEP, used in their aggregate form, it is difficult to distinguish exactly which components are associated with the health outcome,[46] which is not helpful for informing specific policy and interventions. Summary indicators may consist of several components but may not incorporate all dimensions of SEP. The economic distress construct, for example, covers income-related disadvantage but does not include any measures related to occupation or education. In addition, single indicators have greater ability than composite indicators in identifying the magnitude of, and trends in, mortality differentials.[139]

CONCLUSION

As surveillance is designed to monitor the prevalence of many different health outcomes among populations of different age and cultural groups, it would be ideal to include as many indicators of early-life SEP as possible. It is recommended that education, income and occupation indicators of early-life SEP, which directly reflect the resource and status-based constructs of SEP be included as priority. If time and space in surveillance questionnaires permit, more proxy indicators of SEP related to living conditions, family structure and residential mobility could also be included to provide further insight into the pathways between SEP and health over the life course.

Analysis of the relationships between SEP over the life course and health is difficult, because complex socioeconomic factors are reduced to measurable indicators that may only ever produce an approximation of these relationships. As their name suggests, indicators are only indicative of a construct that cannot be measured exactly.[47] Examination of the theoretical background of the indicators shows that some indicators, such as education, occupation and income, measure the construct of SEP more directly than others, such as family structure and residential mobility. These proxy indicators, however, are correlated with SEP and are shown to be associated with health in later life, sometimes showing a stronger association than occupation.[112]

All of the indicators assessed in this review have been used in quantitative studies. There may be other indicators of early-life SEP that could be elucidated from qualitative investigations to provide further insights into the meanings of SEP over the life course and its relationship with health. This review has also focused on individual-level indicators. Apart from the characteristics of area of residence during childhood used in a British study,[126] no area-level indicators were used in the reviewed studies to measure early-life SEP. Although area-level measures of socioeconomic disadvantage—for example, proportion of people unemployed or families on a low income in a suburb—may provide contextual explanations for geographical inequalities in health, its measurement in surveillance systems could be problematic owing to the ecological fallacy whereby the area-level SEP does not correspond to the SEP of a person.[6 46]

Data on SEP during childhood obtained in surveillance systems, either through face-to-face or telephone interviews, must rely on retrospective reports from participants. This relies on the memory of participants, with respondents perhaps reporting an inflated or deflated view of their early-life SEP, or not being able to remember at all. Such

Table 6 Early-life indicators of family structure

Indicator	Location, study design	Indicator of SEP measured	Criteria
Family structure at age 15 years	USA, National Longitudinal Survey of Older Men[73]	R	*Validity*:
Family size	1946 British Birth Cohort[112]	P	Family structure, used to
	1958 British Birth Cohort[78]	P	distinguish families with
	Sweden, Level of Living Surveys, longitudinal[79]	R	two parents from single-
	Sweden, Cross-sectional Stockholm Female Coronary Risk Study[118]	R	parent families, and living
	USA, Woodlawn Cohort Study[75]	P	conditions in the parental
Number of younger siblings	USA, longitudinal National Survey of Children[63]	P	home, such as number of
Marital status of parents	USA, Longitudinal National Survey of Children[63]	P	siblings and crowding, may
Mother's marital status at participant's birth	Sweden, Uppsala Birth Cohort Study[116]	P	influence adult SEP, and thus health in adulthood[117]
Ever in lone-parent family before participant aged 16 years	British Household Panel Survey, cross-sectional[113]	R	*Relevance*:
Single parent family when participant aged 11 and 16 years	1958 British Birth Cohort[78]	P	Historical context and cohort effects need to be taken into account
Lived with both biological parents (or not) until age 16 years	USA, Cross-sectional National Survey of Midlife Development[54]	R	*Reliability*:
Parental divorce or separation during childhood	Sweden, Level of Living Surveys, longitudinal[79]	R	More likely to be recalled accurately than categories such as parents' education
Parental divorce or separation before participant aged 26 years	1946 British Birth Cohort[112]	P	or occupation
Parental divorce or death before participant aged 16 years	1958 British Birth Cohort[113 127]	P	Time frame or age within indicator question may affect responses as
Birth order	Brazil, Cross-sectional Cianorte survey of school children[64 65]	R	circumstances may change
	1946 British Birth Cohort[72 112]	P	throughout early life
	Sweden, Cross-sectional Stockholm Female Coronary Risk Study[118]	R	*Deconstruction*:
	Sweden, Uppsala Birth Cohort Study[116]	P	Not applicable

P, prospectively; R, retrospectively; SEP, socioeconomic position.

Table 7 Early-life indicators of residential mobility

Indicator	Location, study design	Indicator of SEP measured	Criteria
Exposure to urban environment during first 5 years of life	Cameroon, Essential Non-communicable Diseases Health Intervention Project, cross-sectional[128]	R	*Validity*: The number of moves may not be an adequate representation of the context in which moving occurred or the resources available at different geographic locations[60]
Lifestage timing of migration	Hong Kong, Cardiovascular Risk Factor Prevalence Study, cross-sectional[129]	R	
Number of residential moves since birth when participant aged 7 years	USA, Longitudinal National Collaborative Perinatal Project[60]	P	
Number of times address changed	USA, Longitudinal National Survey of Children[63]	P	*Relevance*: Culturally and historically specific
	USA, Woodlawn Cohort Study[75]	P	
Number of years at current address	USA, Longitudinal National Survey of Children[63]	P	*Reliability*: More likely to be recalled accurately than categories such as parents' education or occupation Time frame or age within indicator question may affect responses as circumstances may change throughout early life *Deconstruction*: Not applicable

P, prospectively; R, retrospectively; SEP, socioeconomic position.

misclassification may reduce the strength of associations. Early-life socioeconomic circumstances are shown to be recalled with high accuracy and among most respondents. Several studies, however, did not provide details on the proportion of respondents who had missing data on early-life SEP indicators. There may be as much evidence for poor recall of early-life information as there is for successful recall, but it is not as widely published. Simply excluding respondents with missing data on early-life from analyses may introduce bias if this group is different in terms of socioeconomic experience and health characteristics than the group that does not have missing data. A temporal reference system, or life grid,[120] can improve recall, although this may be difficult to apply in surveillance systems that use computer-assisted telephone interviewing and are limited by restrictions on interview length.

Choice of indicators of early-life SEP for use in surveillance systems need to consider time (position in history) and space (geographical and sociocultural context),[63] and also the life-course theories and aetiological pathways relevant to the health outcomes being investigated. For example, measuring early-life SEP at age 10 years may not be as appropriate as measurement at the time of birth in the critical period model. Application of the cumulative model will include measurement of SEP at several stages across the life course. Indicators of SEP are also likely to be differentially relevant to various health outcomes and different age, sex or ethnic population groups. The continuous data collection feature of surveillance is advantageous for monitoring changes in SEP in the population over time and among different population groups. In addition, as surveillance systems rely on retrospective recall, the indicators chosen will depend on how well they perform in terms of recall and response rates, which may vary between different settings and data collection methods. Whereas some indicators, such as education level of parents, may be valid because they are less likely to change after young adulthood than occupation or income, other indicators, such as occupation of parents or material circumstances during childhood, may be more easily and accurately recalled, and thus may be more appropriate for use in surveillance systems in particular settings, at certain times and for specific population groups.

Using a life-course approach in surveillance brings into focus the notion that economic, social and educational policies targeted at children and young people have health effects that are manifested far into the future.[73] Surveillance systems have the potential to monitor these long-term effects. Although information about causal pathways linking early-life SEP, adult SEP and health in adulthood has come predominantly from longitudinal cohort studies, surveillance data can be combined with these insights as a basis for policy making and monitoring the effects of policies and interventions among different population groups, cohorts or generations. For example, comparisons in terms of health over the life course could be made between groups or cohorts who were and were not exposed to certain health, education and economic policies, such as provision of free milk or nutritious lunches at school, a system of free tertiary education or different taxation structures. Surveillance data collected consistently and continuously over the long term to monitor trends also act as a warning system about risk factors and chronic conditions emerging in different population groups. Taking into consideration the historical, geographical and sociocultural context when choosing indicators of early-life SEP for use in surveillance systems will provide useful information on the socioeconomic life journey of people and how this is associated with the changing health of populations over time.

What this paper adds

This paper adds a comprehensive review of early-life socioeconomic position (SEP) indicators that could be considered for use in population health surveillance systems. The review assesses indicators used in previous studies according to validity, relevance, reliability and deconstruction criteria, and suggests that indicators of early-life SEP need to be relevant to the historical, geographical and sociocultural context in which the surveillance system is operating, and able to be measured retrospectively.

Policy implications

Potential to monitor the health effects of economic, social and educational policies over the long term exist if indicators of socioeconomic position over the life course are included in population health surveillance systems.

Authors' affiliations
C R Chittleborough, J E Hiller, Discipline of Public Health, University of Adelaide, Adelaide, South Australia
F E Baum, Department of Public Health, Flinders University of South Australia, Bedford Park, South Australia
A W Taylor, Population Research and Outcome Studies Unit, Department of Health, Adelaide, South Australia

Competing interests: None.

REFERENCES

1 **Kaplan G**, Keil J. Socioeconomic factors and cardiovascular disease: a review of the literature. *Circulation* 1993;**88**:1973–98.
2 **Graham H**, Kelley M. *Health inequalities: concepts, frameworks and policy*. London: Health Development Agency, 2004.
3 **Evans G**, Kantrowitz E. Socioeconomic status and health: the potential role of environmental risk exposure. *Annu Rev Public Health* 2002;**23**:303–31.
4 **Turrell G**, Mathers C. Socioeconomic status and health in Australia. *Med J Aust* 2000;**172**:434–8.
5 **Thacker S**, Buffington J. Applied epidemiology for the 21st century. *Int J Epidemiol* 2001;**31**:320–5.
6 **Berkman L**, Macintyre S. The measurement of social class in health studies: old measures and new formulations. *IARC Sci Publ* 1997;**138**:51–64.
7 **Davey Smith G**. Socioeconomic differentials. In: Kuh D, Ben-Shlomo Y, eds. *A life course approach to chronic disease epidemiology*. New York: Oxford University Press, 1997.
8 **Duncan G**, Daly M, McDonough P, *et al*. Optimal indicators of socioeconomic status for health research. *Am J Public Health* 2002;**92**:1151–7.
9 **Grundy E**, Holt G. The socioeconomic status of older adults: how should we measure it in studies of health inequalities? *J Epidemiol Community Health* 2001;**55**:895–904.
10 **Krieger N**, Williams D, Moss N. Measuring social class in US public health research: concepts, methodologies, and guidelines. *Annu Rev Public Health* 1997;**18**:341–78.
11 **Kunst A**, Mackenbach J. *Measuring socioeconomic inequalities in health*. Copenhagen: World Health Organization, 1994.
12 **Lindelöw M**. *Sometimes more equal than others: how health inequalities depend on the choice of welfare indicator*. Oxford: The World Bank Centre for Study of African Economies, Oxford University, 2004.
13 **Macintyre S**, McKay L, Der G, *et al*. Socio-economic position and health: what you observe depends on how you measure it. *J Public Health Med* 2003;**25**:288–94.
14 **Oakes J**, Rossi P. The measurement of SES in health research: current practice and steps toward a new approach. *Soc Sci Med* 2003;**56**:769–84.
15 **Lynch J**, Kaplan G. Socioeconomic position. In: Berkman L, Kawachi I, eds. *Social epidemiology*. New York: Oxford University Press, 2000.
16 **Thacker S**, Stroup D. Future directions for comprehensive public health surveillance and health information systems in the United States. *Am J Epidemiol* 1994;**140**:383–97.
17 **Campostrini S**. Surveillance systems and data analysis: continuously collected behavioural data. In: McQueen D, Puska P, eds. *Global behavioral risk factor surveillance*. New York: Kluwer Academic, 2003.
18 **Braveman P**. Monitoring equity in health and healthcare: a conceptual framework. *J Health Popul Nutr* 2003;**21**:181–92.
19 **Tennant S**, Szuster F. *Nationwide monitoring and surveillance question development: diabetes mellitus*. Adelaide: Public Health Information Development Unit, 2003.
20 **Teutsch S**, Churchill R. *Principles and practice of public health surveillance*, 2nd edn. New York: Oxford University Press, 2000.
21 **Australian Institute of Health and Welfare, Commonwealth Department of Health and Aged Care**. *Workshop on health inequalities in Australia: data collection, information development and monitoring*. Canberra: AIHW, 2000.
22 **Turrell G**, Oldenburg B, McGuffog I, *et al*. *Socioeconomic determinants of health: towards a national research program and a policy and intervention agenda*. Canberra: Queensland University of Technology, School of Public Health, Ausinfo, 1999.
23 **Susser E**. Eco-epidemiology: thinking outside the black box. *Epidemiology* 2004;**15**:519–20.
24 **Greenland S**, Gago-Dominguez M, Castelao J. The value of risk-factor (''black-box'') epidemiology. *Epidemiology* 2004;**15**:529–35.
25 **Krieger N**. Refiguring ''race'': epidemiology, racialized biology and biological expressions of race relations. *Int J Health Serv* 2000;**30**:211–16.
26 **Ben-Shlomo Y**, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *Int J Epidemiol* 2002;**31**:285–93.
27 **Kawachi I**, Subramanian S, Almeida-Filho N. A glossary for health inequalities. *J Epidemiol Community Health* 2002;**56**:647–52.
28 **Hallqvist J**, Lynch J, Bartley M, *et al*. Can we disentangle life course processes of accumulation, critical period and social mobility? An analysis of disadvantaged socio-economic positions and myocardial infarction in the Stockholm Heart Epidemiology Program. *Soc Sci Med* 2004;**58**:1555–62.
29 **Galobardes B**, Lynch JW, Davey Smith G. Childhood socioeconomic circumstances and cause-specific mortality in adulthood: systematic review and interpretation. *Epidemiol Rev* 2004;**26**:7–21.
30 **Barker D**. *Fetal and infant origins of adult disease*. London: BMJ, 1992.
31 **Barker DJ**, Gluckman PD, Godfrey KM, *et al*. Fetal nutrition and cardiovascular disease in adult life. *Lancet* 1993;**341**:938–41.
32 **Bartley M**, Sacker A, Schoon I. Social and economic trajectories and women's health. In: Kuh D, Hardy R, eds. *A life course approach to women's health*. Oxford: Oxford University Press, 2002.
33 **Davey Smith G**, Hart C. Life-course socioeconomic and behavioral influences on cardiovascular disease mortality: the Collaborative Study. *Am J Public Health* 2002;**92**:1295–8.
34 **Graham H**. Building an inter-disciplinary science of health inequalities: the example of lifecourse research. *Soc Sci Med* 2002;**55**:2005–16.
35 **Singh-Manoux A**, Ferrie JE, Chandola T, *et al*. Socioeconomic trajectories across the life course and health outcomes in midlife: evidence for the accumulation hypothesis? *Int J Epidemiol* 2004;**33**:1072–9.
36 **Ciocco A**, Klein H, Palmer C. Child health and the selective service physical standards. *Public Health Rep* 1941;**56**:2365–75.
37 **Davey Smith G**, Hart C, Blane D, *et al*. Lifetime socioeconomic position and mortality: prospective observational study. *BMJ* 1997;**314**:547–52.
38 **Lawlor D**, Ebrahim S, Davey Smith G. Socioeconomic position in childhood and adulthood and insulin resistance: cross sectional survey using data from British Women's Heart and Health Study. *BMJ* 2002;**325**:805–9.
39 **Lynch J**, Kaplan G, Shema S. Cumulative impact of sustained economic hardship on physical, cognitive, psychological, and social functioning. *N Engl J Med* 1997;**337**:1889–95.
40 **Pensola T**, Martikainen P. Cumulative social class and mortality from various causes of adult men. *J Epidemiol Community Health* 2003;**57**:745–51.
41 **Kuh D**, Ben-Shlomo Y, eds. Introduction: a life course approach to the aetiology of adult chronic disease. *A life course approach to chronic disease epidemiology*. New York: Oxford University Press, 1997.
42 **Davey Smith G**, Lynch J. Life course approaches to socioeconomic differentials in health. In: Kuh D, Ben-Shlomo Y, eds. *A life course approach to chronic disease epidemiology*. 2nd edn. Oxford: Oxford University Press, 2004.
43 **Galobardes B**, Shaw M, Lawlor DA, *et al*. Indicators of socioeconomic position (part 1). *J Epidemiol Community Health* 2006;**60**:7–12.
44 **Galobardes B**, Shaw M, Lawlor DA, *et al*. Indicators of socioeconomic position (part 2). *J Epidemiol Community Health* 2006;**60**:95–101.
45 **Krieger N**. A glossary for social epidemiology. *J Epidemiol Community Health* 2001;**55**:693–700.
46 **Liberatos P**, Link BG, Kelsey JL. The measurement of social class in epidemiology. *Epidemiol Rev* 1988;**10**:87–121.
47 **Flowers J**, Hall P, Pencheon D. Public health indicators. *Public Health* 2005;**119**:239–45.
48 **Najman J**, Bor W, Morrison J, *et al*. Child developmental delay and socio-economic disadvantage in Australia: a longitudinal study. *Soc Sci Med* 1992;**34**:829–35.
49 **Goodman E**, McEwen BS, Huang B, *et al*. Social inequalities in biomarkers of cardiovascular risk in adolescence. *Psychosom Med* 2005;**67**:9–15.
50 **Lawlor DA**, Morton SM, Nitsch D, *et al*. Association between childhood and adulthood socioeconomic position and pregnancy induced hypertension: results from the Aberdeen children of the 1950s cohort study. *J Epidemiol Community Health* 2005;**59**:49–55.
51 **Osler M**, Andersen AM, Batty GD, *et al*. Relation between early life socioeconomic position and all cause mortality in two generations. A longitudinal study of Danish men born in 1953 and their parents. *J Epidemiol Community Health* 2005;**59**:38–41.
52 **Jefferis BJ**, Power C, Graham H, *et al*. Effects of childhood socioeconomic circumstances on persistent smoking. *Am J Public Health* 2004;**94**:279–85.
53 **Beebe-Dimmer J**, Lynch JW, Turrell G, *et al*. Childhood and adult socioeconomic conditions and 31-year mortality risk in women. *Am J Epidemiol* 2004;**159**:481–90.
54 **Combs Y**. Midlife health of African-American women: cumulative disadvantage as a predictor of early senscence. *Res Sociol Health Care* 2002;**20**:123–35.
55 **Cupertino A**. The impact of life course socioeconomic status on cardiovascular disease and overall mortality. *Diss Abstr Int* 2001;**62**:1614.
56 **van Lenthe FJ**, Schrijvers CT, Droomers M, *et al*. Investigating explanations of socio-economic inequalities in health: the Dutch GLOBE study. *Eur J Public Health* 2004;**14**:63–70.
57 **Bor W**, Najman J, Andersen M, *et al*. Socioeconomic disadvantage and child morbidity: an Australian longitudinal study. *Soc Sci Med* 1993;**36**:1053–61.
58 **van de Mheen H**, Stronks K, Mackenbach J. A lifecourse perspective on socio-economic inequalities in health: the influence of childhood socio-economic conditions and selection processes. In: Bartley M, Blane D, Davey Smith G, eds. *The sociology of health inequalities*. Oxford: Blackwell, 1998.
59 **Gilman S**, Kawachi I, Fitzmaurice G, *et al*. Socioeconomic status in childhood and the lifetime risk of major depression. *Int J Epidemiol* 2002;**31**:359–67.
60 **Gilman SE**, Kawachi I, Fitzmaurice GM, *et al*. Socio-economic status, family disruption and residential stability in childhood: relation to onset, recurrence and remission of major depression. *Psychol Med* 2003;**33**:1341–55.
61 **Geckova A**, van Dijk J, Groothoff J, *et al*. Socio-economic differences in health risk behaviour among Slovak adolescents. *Soz Praventivmed* 2002;**47**:233–9.
62 **Jackson B**, Kubzansky L, Cohen S, *et al*. A matter of life and breath: childhood socioeconomic status is related to young adult pulmonary function in the CARDIA study. *Int J Epidemiol* 2004;**33**:271–8.
63 **Wheaton B**, Clarke P. Space meets time: integrating temporal and contextual influences on mental health in early adulthood. *Am Sociol Rev* 2003;**68**:680–706.

64 **Nicolau B**, Marcenes W, Hardy R, *et al*. A life-course approach to assess the relationship between social and psychological circumstances and gingival status in adolescents. *J Clin Periodontol* 2003;**30**:1038–45.
65 **Nicolau B**, Marcenes W, Bartley M, *et al*. A life course approach to assessing causes of dental caries experience: the relationship between biological, behavioural, socio-economic and psychological conditions and caries in adolescents. *Caries Res* 2003;**37**:319–26.
66 **Turrell G**, Lynch J, Kaplan G, *et al*. Socioeconomic position across the lifecourse and cognitive function in late middle age. *J Gerontol B Psychol Sci Soc Sci* 2002;**57B**:S43–51.
67 **Gilman S**, Abrams D, Buka S. Socioeconomic status over the life course and stages of cigarette use: initiation, regular use, and cessation. *J Epidemiol Community Health* 2003;**57**:802–8.
68 **Lynch JW**, Everson SA, Kaplan GA, *et al*. Does low socioeconomic status potentiate the effects of heightened cardiovascular responses to stress on the progression of carotid atherosclerosis? *Am J Public Health* 1998;**88**:389–94.
69 **Lynch J**, Kaplan G, Cohen R, *et al*. Childhood and adult socioeconomic status as predictors of mortality in Finland. *Lancet* 1994;**343**:524–7.
70 **Lynch J**, Kaplan G, Salonen J. Why do poor people behave poorly? Variation in adult health behaviours and psychosocial characteristics by stages of the socioeconomic lifecourse. *Soc Sci Med* 1997;**44**:809–19.
71 **Kuh D**, Hardy R, Langenberg C, *et al*. Mortality in adults aged 26–54 years related to socioeconomic conditions in childhood and adulthood: post war birth cohort study. *BMJ* 2002;**325**:1076–80.
72 **Richards M**, Wadsworth ME. Long term effects of early adversity on cognitive function. *Arch Dis Child* 2004;**89**:922–7.
73 **Hayward MD**, Gorman BK. The long arm of childhood: the influence of early-life social conditions on men's mortality. *Demography* 2004;**41**:87–107.
74 **Wise L**, Krieger N, Zierler S, *et al*. Lifetime socioeconomic position in relation to onset of perimenopause. *J Epidemiol Community Health* 2002;**56**:851–60.
75 **Ensminger ME**, Juon HS, Fothergill KE. Childhood and adolescent antecedents of substance use in adulthood. *Addiction* 2002;**97**:833–44.
76 **Singer B**, Ryff CD. Hierarchies of life histories and associated health risks. *Ann N Y Acad Sci* 1999;**896**:96–115.
77 **Schoon I**, Sacker A, Bartley M. Socio-economic adversity and psychosocial adjustment: a developmental-contextual perspective. *Soc Sci Med* 2003;**57**:1001–15.
78 **Power C**, Li L, Manor O. A prospective study of limiting longstanding illness in early adulthood. *Int J Epidemiol* 2000;**29**:131–9.
79 **Lundberg O**. The impact of childhood living conditions on illness and mortality in adulthood. *Soc Sci Med* 1993;**36**:1047–52.
80 **Najman J**, Aird R, Bor W, *et al*. The generational transmission of socioeconomic inequalities in child cognitive development and emotional health. *Soc Sci Med* 2004;**58**:1147–58.
81 **Rona RJ**. Genetic and environmental factors in the control of growth in childhood. *Br Med Bull* 1981;**37**:265–72.
82 **Rosvall M**, Ostergren PO, Hedblad B, *et al*. Life-course perspective on socioeconomic differences in carotid atherosclerosis. *Arterioscler Thromb Vasc Biol* 2002;**22**:1704–11.
83 **Kuh D**, Ben-Shlomo Y, eds. *A life course approach to chronic disease epidemiology*. New York: Oxford University Press, 1997.
84 **Eriksson JG**, Forsen TJ, Osmond C, *et al*. Pathways of infant and childhood growth that lead to type 2 diabetes. *Diabetes Care* 2003;**26**:3006–10.
85 **Brunner EJ**, Kivimaki M, Siegrist J, *et al*. Is the effect of work stress on cardiovascular mortality confounded by socioeconomic factors in the Valmet study? *J Epidemiol Community Health* 2004;**58**:1019–20.
86 **Okasha M**, McCarron P, McEwen J, *et al*. Childhood social class and adulthood obesity: findings from the Glasgow Alumni Cohort. *J Epidemiol Community Health* 2003;**57**:508–9.
87 **Fuchs V**. Reflections on the socio-economic correlates of health. *J Health Econ* 2004;**23**:653–61.
88 **Blane D**, Hart C, Davey Smith G, *et al*. Association of cardiovascular disease risk factors with socioeconomic position during childhood and during adulthood. *BMJ* 1996;**313**:1434–8.
89 **Davey Smith G**, Hart C, Blane D, *et al*. Adverse socioeconomic conditions in childhood and cause specific adult mortality: prospective observational study. *BMJ* 1998;**316**:1631–5.
90 **Hart CL**, Davey Smith G, Blane D. Inequalities in mortality by social class measured at 3 stages of the lifecourse. *Am J Public Health* 1998;**88**:471–4.
91 **Heslop P**, Davey Smith G, Macleod J, *et al*. The socioeconomic position of employed women, risk factors and mortality. *Soc Sci Med* 2001;**53**:477–85.
92 **Macleod J**, Davey Smith G, Heslop P, *et al*. Are the effects of psychosocial exposures attributable to confounding? Evidence from a prospective observational study on psychological stress and mortality. *J Epidemiol Community Health* 2001;**55**:878–84.
93 **Hart C**, Davey Smith G, Blane D. Social mobility and 21 year mortality in a cohort of Scottish men. *Soc Sci Med* 1998;**47**:1121–30.
94 **Regidor E**, Banegas JR, Gutierrez-Fisac JL, *et al*. Socioeconomic position in childhood and cardiovascular risk factors in older Spanish people. *Int J Epidemiol* 2004;**33**:723–30.
95 **Rich-Edwards JW**, Colditz GA, Stampfer MJ, *et al*. Birthweight and the risk for type 2 diabetes mellitus in adult women. *Ann Intern Med* 1999;**130**:278–84.
96 **Ebrahim S**, Montaner D, Lawlor DA. Clustering of risk factors and social class in childhood and adulthood in British women's heart and health study: cross sectional analysis. *BMJ* 2004;**328**:861–5.
97 **Lawlor D**, Davey Smith G, Ebrahim S. Life course influences on insulin resistance: findings from the British Women's Heart and Health Study. *Diabetes Care* 2003;**26**:97–103.
98 **Lawlor DA**, Ebrahim S, Davey Smith G. The association of socio-economic position across the life course and age at menopause: the British Women's Heart and Health Study. *BJOG* 2003;**110**:1078–87.
99 **Lawlor DA**, Davey Smith G, Ebrahim S. Association Bbetween childhood socioeconomic status and coronary heart disease risk among postmenopausal women: findings from the British Women's Heart and Health Study. *Am J Public Health* 2004;**94**:1386–92.
100 **Wannamethee SG**, Whincup PH, Shaper G, *et al*. Influence of fathers' social class on cardiovascular disease in middle-aged men. *Lancet* 1996;**348**:1259–63.
101 **Adams J**, White M, Pearce M, *et al*. Life course measures of socioeconomic position and self reported health at age 50: prospective cohort study. *J Epidemiol Community Health* 2004;**58**:1028–9.
102 **Parker L**, Lamont D, Unwin N, *et al*. A lifecourse study of risk for hyperinsulinaemia, dyslipidaemia and obesity (the central metabolic syndrome) at age 49–51 years. *Diabetes Med* 2003;**20**:406–15.
103 **Lamont D**, Parker L, White M, *et al*. Risk of cardiovascular disease measured by carotid intima-media thickness at age 49–51: lifecourse study. *BMJ* 2000;**320**:273–8.
104 **Hertzman C**, Power C, Matthews S, *et al*. Using an interactive framework of society and lifecourse to explain self-rated health in early adulthood. *Soc Sci Med* 2001;**53**:1575–85.
105 **Parsons TJ**, Power C, Manor O. Fetal and early life growth and body mass index from birth to early adulthood in 1958 British cohort: longitudinal study. *BMJ* 2001;**323**:1331–5.
106 **Jefferis BJ**, Power C, Graham H, *et al*. Changing social gradients in cigarette smoking and cessation over two decades of adult follow-up in a British birth cohort. *J Public Health (Oxford)* 2004;**26**:13–18.
107 **Fergusson D**, Swain-Campbell N, Horwood J. How does childhood economic disadvantage lead to crime? *J Child Psychol Psychiatry* 2004;**45**:956–66.
108 **Thomson WM**, Poulton R, Milne BJ, *et al*. Socioeconomic inequalities in oral health in childhood and adulthood in a birth cohort. *Community Dent Oral Epidemiol* 2004;**32**:345–53.
109 **Thomson WM**, Poulton R, Kruger E, *et al*. Socio-economic and behavioural risk factors for tooth loss from age 18 to 26 among participants in the Dunedin Multidisciplinary Health and Development Study. *Caries Res* 2000;**34**:361–6.
110 **Langenberg C**, Hardy R, Kuh D, *et al*. Central and total obesity in middle aged men and women in relation to lifetime socioeconomic status: evidence from a national birth cohort. *J Epidemiol Community Health* 2003;**57**:816–22.
111 **McLaren L**, Kuh D. Women's body dissatisfaction, social class, and social mobility. *Soc Sci Med* 2004;**58**:1575–84.
112 **Kuh D**, Hardy R, Rodgers B, *et al*. Lifetime risk factors for women's psychological distress in midlife. *Soc Sci Med* 2002;**55**:1957–73.
113 **Benzeval M**, Dilnot A, Judge K, *et al*. Income and health over the lifecourse: evidence and policy implications. In: Graham H, ed. *Understanding health inequalities*. Buckingham: Open University Press, 2000.
114 **Poulton R**, Caspi A, Milne B, *et al*. Association between children's experience of socioeconomic disadvantage and adult health: a life-course study. *Lancet* 2002;**360**:1640–5.
115 **Harper S**, Lynch J, Hsu W-L, *et al*. Life course socioeconomic conditions and adult psychosocial functioning. *Int J Epidemiol* 2002;**31**:395–403.
116 **Modin B**. Birth order and mortality: a life-long follow-up of 14,200 boys and girls born in early 20th century Sweden. *Soc Sci Med* 2002;**54**:1051–64.
117 **Pensola T**, Martikainen P. Life-course experiences and mortality by adult social class among young men. *Soc Sci Med* 2004;**58**:2149–70.
118 **Wamala S**, Lynch J, Kaplan G. Women's exposure to early and later life socioeconomic disadvantage and coronary heart disease risk: the Stockholm Female Coronary Risk Study. *Int J Epidemiol* 2001;**30**:275–84.
119 **Schoon I**, Bynner J, Joshi H, *et al*. The influence of context, timing, and duration of risk experiences for the passage from childhood to midadulthood. *Child Dev* 2002;**73**:1486–504.
120 **Berney LR**, Blane DB. Collecting retrospective data: accuracy of recall after 50 years judged against historical records. *Soc Sci Med* 1997;**45**:1519–25.
121 **Holland P**, Berney L, Blane D, *et al*. Life course accumulation of disadvantage: childhood health and hazard exposure during adulthood. *Soc Sci Med* 2000;**50**:1285–95.
122 **Blane D**, Berney L, Davey Smith G, *et al*. Reconstructing the life course: health during early old age in a follow-up study based on the Boyd Orr cohort. *Public Health* 1999;**113**:117–24.
123 **Blane D**, Higgs P, Hyde M, *et al*. Life course influences on quality of life in early old age. *Soc Sci Med* 2004;**58**:2171–9.
124 **Blane D**, Berney L, Montgomery S. Domestic labour, paid employment and women' health: analysis of life course data. *Soc Sci Med* 2001;**52**:959–65.
125 **Naess O**, Claussen B, Thelle DS, *et al*. Cumulative deprivation and cause specific mortality. A census based study of life course influences over three decades. *J Epidemiol Community Health* 2004;**58**:599–603.
126 **Curtis S**, Southall H, Congdon P, *et al*. Area effects on health variation over the life-course: analysis of the longitudinal study sample in England using new data on area of residence in childhood. *Soc Sci Med* 2004;**58**:57–74.
127 **Hope S**, Power C, Rodgers B. The relationship between parental separation in childhood and problem drinking in adulthood. *Addiction* 1998;**93**:505–14.
128 **Sobngwi E**, Mbanya JC, Unwin NC, *et al*. Exposure over the life course to an urban environment and its relation with obesity, diabetes, and hypertension in rural and urban Cameroon. *Int J Epidemiol* 2004;**33**:769–76.
129 **Schooling M**, Leung GM, Janus ED, *et al*. Childhood migration and cardiovascular risk. *Int J Epidemiol* 2004;**33**:1219–26.

130 **Susser I**. Social theory and social class. *IARC Scientific Publications* 1997;**138**:41–50.
131 **Lynch J**, Davey Smith G, Kaplan G, *et al*. Income inequality and mortality: importance to health of individual income, psychosocial environment, or material conditions. *BMJ* 2000;**320**:1200–4.
132 **Baxter J**. How much does parental education explain educational attainment of males and females in Australia? *Negotiating the Life Course Discussion Paper Series*. Australian National University; Canberra, 2002.
133 **Harper C**, Cardona M, Bright M, *et al*. *Health determinants Queensland 2004: at a glance*. Brisbane: Public Health Services and Health Information Centre, Queensland Health, 2004.
134 **Australian Bureau of Statistics**. *Australian social trends 2005*. Canberra: ABS, 2005.
135 **Ellaway A**, Macintyre S, McKay L. The historical specificity of early life car ownership as an indicator of socioeconomic position. *J Epidemiol Community Health* 2003;**57**:277–8.
136 **Oswald A**. *The housing market and Europe's unemployment: a non-technical paper*. Warwick, UK: Department of Economics, University of Warwick, 1999.
137 **Krieger N**, Okamoto A, Selby JV. Adult female twins' recall of childhood social class and father's education: a validation study for public health research. *Am J Epidemiol* 1998;**147**:704–8.
138 **van de Mheen H**, Stronks K, Looman C, *et al*. Does childhood socioeconomic status influence adult health through behavioural factors? *Int J Epidemiol* 1998;**27**:431–7.
139 **Hayes L**, Quine S, Taylor R, *et al*. Socio-economic mortality differentials in Sydney over a quarter of a century, 1970–94. *Aust N Z J Public Health* 2002;**26**:311–17.