# The *Lancet* Taskforce on NCDs and economics 2

# Tackling socioeconomic inequalities and non-communicable diseases in low-income and middle-income countries under the Sustainable Development agenda

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This is the second in a Series of five papers about non-communicable diseases and economics

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**Five Sustainable Development Goals (SDGs) set targets that relate to the reduction of health inequalities nationally and worldwide. These targets are poverty reduction, health and wellbeing for all, equitable education, gender equality, and reduction of inequalities within and between countries. The interaction between inequalities and health is complex: better economic and educational outcomes for households enhance health, low socioeconomic status leads to chronic ill health, and non-communicable diseases (NCDs) reduce income status of households. NCDs account for most causes of early death and disability worldwide, so it is alarming that strong scientific evidence suggests an increase in the clustering of non-communicable conditions with low socioeconomic status in low-income and middle-income countries since 2000, as previously seen in high-income settings. These conditions include tobacco use, obesity, hypertension, cancer, and diabetes. Strong evidence from 283 studies overwhelmingly supports a positive association between low-income, low socioeconomic status, or low educational status and NCDs. The associations have been differentiated by sex in only four studies. Health is a key driver in the SDGs, and reduction of health inequalities and NCDs should become key in the promotion of the overall SDG agenda. A sustained reduction of general inequalities in income status, education, and gender within and between countries would enhance worldwide equality in health. To end poverty through elimination of its causes, NCD programmes should be included in the development agenda. National programmes should mitigate social and health shocks to protect the poor from events that worsen their frail socioeconomic condition and health status. Programmes related to universal health coverage of NCDs should specifically target susceptible populations, such as elderly people, who are most at risk. Growing inequalities in access to resources for prevention and treatment need to be addressed through improved international regulations across jurisdictions that eliminate the legal and practical barriers in the implementation of non-communicable disease control.**

### Key messages

- Health creates wealth, and health is a key contributor in achieving other Sustainable Development Goals; national and international programmes on sustainable development should address non-communicable diseases prevention and control
- Non-communicable diseases (NCDs) are neglected worldwide and expose people to health, social, and economic shocks; international and governmental programmes should protect the poor from NCDs and the worsening of their socioeconomic status
- Programmes related to universal health coverage need to address NCDs and should specifically target vulnerable populations, including middle-aged and elderly people, who are most at risk of NCDs
- Health inequalities due to NCDs within countries and between countries are increasing; international regulations and national jurisdictions should eliminate policies and practical barriers in the access to resources needed to implement universal health coverage and promote health equity

## Introduction

The UN and other international agencies advocate and seek integral approaches to the Sustainable Development Goals (SDGs),[1–8] which address existing global health inequalities through comprehensive, cross-sector strategies.[2,6,9–13] The formal targets set for the SDGs cover the economic, educational, environmental, and social pillars of sustainable development with a strong focus on equity across all goals at national and international levels.[4,6] Five SDGs set explicit targets that relate to the reduction of health inequalities both nationally and worldwide. These goals are poverty reduction, health and wellbeing for all, equitable education, gender equality, and reduction of inequalities within and between countries. These SDGs cover 78 of the 169 targets set,[4] indicating a new central role of health in development (figure 1). The prioritisation of health in the Millennium Development Goals was limited.[4,6,14]

The reduction of both poverty and health inequalities have become leading topics in the promotion of the SDGs.[2,4,6,12,14] For the first time, through the formulation of the SDGs and the 78 cross-sector targets, the UN has explicitly recognised the broad socioeconomic

determinants of health and wellbeing[9,15,16] and the strong interdependencies between socioeconomic development and health.[10,13,15–17] Reduction of health inequalities improves socioeconomic outcomes for households, and reduction of socioeconomic inequalities enhances health at the population and household level.[4,6,9,12,13,16]

Non-communicable diseases (NCDs) contribute to more than two-thirds of deaths worldwide. Four-fifths of NCDs occur in low-income and middle-income countries (LMICs), and a third of deaths from NCDs affect people younger than 60 years.[18–21] The potential to exacerbate global health inequities is augmenting as the share of premature death and disability caused by NCDs increases.[18,20] The observed inequalities in health status, access to care and medicines, and health financing reflect the accumulation of unequal lifetime exposures as well as unequal access to and quality of health systems between populations. This situation exists for antenatal care and across the lifespan, and it increases health risks associated with socioeconomic status and reduces access to timely public health measures, individual prevention, and health-care services.[22,23] Access to and coverage by prevention and treatment programmes to control NCDs have become essential in the attainment of universal health coverage (UHC) and, as such, are fundamental to the implementation of the SDGs.[13,24–27] Here we examine the interaction between health, wellbeing, and the SDGs. We position health as a primary driver towards achieving the SDGs and identify the four SDGs on poverty reduction, equitable education, gender equality, and reduction of inequalities within and between countries that are key to attaining health and wellbeing for all.

## The interaction between socioeconomic status and ill health

Populations with low economic status in high-income countries are much more likely to have a higher chronic disease burden than groups with high economic status.[17,23,28–30] Studies on the association between socioeconomic status and NCDs in low-income and middle-income countries (LMICs) are relatively scarce, and little systematic evidence exists to support this interaction between socioeconomic status and health in LMICs. Obesity is becoming increasingly common in LMICs and is affecting women and the poor in particular.[17,31–33] Wagstaff[17] describes how people living in poverty are restricted in their ability to practise healthy behaviours that promote health and are predisposed to chronic diseases and late (and hence more advanced) diagnosis. The reverse pathway is also plausible, as chronic illnesses might lead to poverty because of direct and indirect expenditures and loss of productivity.[13,27] Levesque and colleagues[34] showed that the poor commonly do not have the ability to pay for treatment of NCDs. Events related to chronic diseases might cause impoverishment through wage loss, missed schooling, or catastrophic expenditures for health care.[17,32,34] Prolonged treatment and continuous use of health services often involve costly diagnostic procedures and treatment. Continued disability and repeated acute illness related to chronic disease during economically productive years might hamper household productivity, especially in the absence of social safety nets. These mechanisms complete a vicious cycle of unhealthy behaviours and exposures in low-income populations that increase the risk of NCDs and other diseases and, in turn, worsen poverty, disparities, and illness.[17,24]

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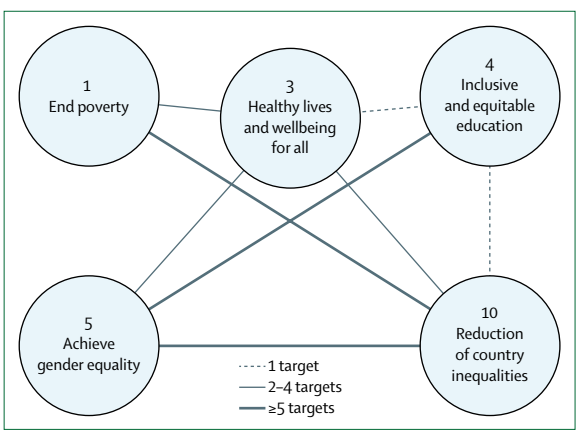


***Figure 1:*** **Targets network of the five Sustainable Development Goals related to health equalities**
Adapted from LeBlanc (2015).[4]

### *Panel 1:* Qualitative evidence on socioeconomic status and non-communicable diseases

Qualitative evidence from studies of cancer or diabetes and associated complications is limited. Chronic diseases in general has been investigated in one study only.

A study from Kenya[36] used focus group discussions and in-depth interviews to examine the financial consequences of acute events and chronic conditions, and financial catastrophic expenditure after illness was measured. The financial burden on the poor was found to be greater from chronic diseases (as measured by expenditure per household) than from acute events. As a result, many poor people forgo treatment.

In a Sri Lankan study,[37] care-seeking for patients with diabetes was investigated in households at different income levels. Using in-depth interviews, the investigators found that the related direct and indirect costs are a high economic burden for households, especially in rural areas. Households in this study also reported not being able to pay for disease treatment as diabetes-related complications worsened.

Findings from a Chinese study[38] about the ability of families to cope with childhood cancer showed that most families reported paying for all treatment costs out of pocket, and a few families had financial difficulties as a result. Similarly, in an Indian study[39] about palliative care, families stated that not only were patients obliged to give up work as a result of illness, the caregivers also had to change work habits. Some families with a sick child had been forced to sell assets, and some children were obliged to miss school.

In a study[40] of Pakistani families needing to negotiate therapeutic options in response to a cancer diagnosis, wealth was found to be an important determinant of choosing therapeutic options. Wealthy people sought health care from allopathic doctors, and poor people accessed traditional medicine. Families struggled to pay costs and became impoverished.

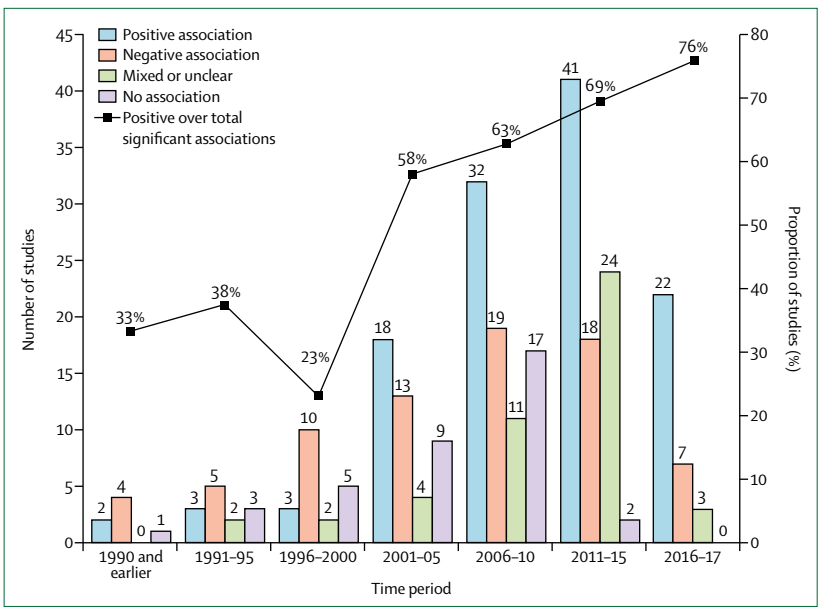


*Figure 2:* **Distribution of quantitative studies by type of association between non-communicable diseases and risk factors and poverty, over time**

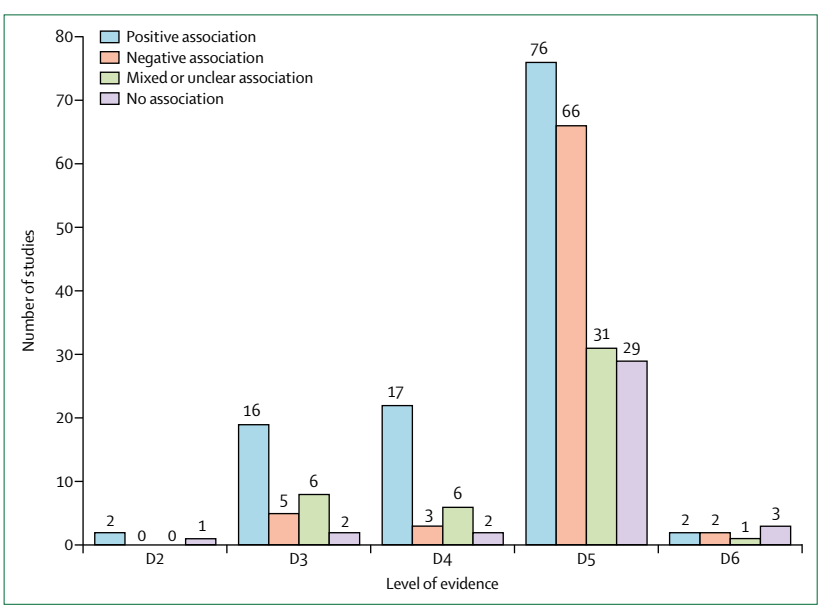


*Figure 3:* **Distribution of quantitative studies by reported direction of association between chronic diseases and risk factors with poverty, by strength of evidence**

Evidence grading criteria and evidence rating scales are available in the appendix. D1=randomised controlled trials. D2=non-randomised controlled trials. D3=uncontrolled interventions, before–after trials, and time-series studies. D4=case-control studies and cross-sectional studies with two groups or more. D5=cross-sectional studies. D6=descriptive studies.

See Online for appendix

In this Taskforce paper, we examine the interactions between socioeconomic inequalities and NCDs in LMICs, the evolution of these interactions over time, and the documented linkages between the SDGs. By summarising the characteristics of these interactions over time and presenting the strengths of the evidence, we contribute to the international and national development agenda aimed to build broad health services and a public health agenda that promotes health in the context of poverty, gender, education, inequalities, and wellbeing.[4,21]

## Socioeconomic status and NCDs: the scientific evidence

We focus on the scientific studies with strong study designs that produce the best available evidence on the temporal, probable, causal relationship between socioeconomic status and NCDs. This relationship is impossible to study in studies with weak designs, such as cross-sectional surveys. The varied quality of the 283 studies identified in this study necessitates a quality assessment. We used the system of quality assessment developed by the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) working group because it distinguishes clearly between the quality of evidence and the strength of conclusions and recommendations.[35] The GRADE system has been widely used and accepted by a representative group of methodology developers.[35] It also gives explicit, comprehensive criteria for downgrading or upgrading quality of evidence relative to other studies. This interpretation process leads to a classification of strong and weak conclusions to present to a wider audience such as policy makers and the general public. We also identified four qualitative studies reporting chronic conditions relating to cancer and diabetes and poverty impact (panel 1).

The quantitative information on the correlation between socioeconomic status and NCDs is diffuse, changes over time, and provides heterogeneous results from weak, cross-sectional studies, whereas the high-grade evidence (by GRADE criteria; appendix) consistently shows a positive relationship (figure 2; figure 3). The study variables and definitions used in these studies is highly diverse (panel 2; appendix), which made a formal meta-analysis impossible. However, the studies could be compared on the basis of the excess risks in the lower societal economic status study group.

19 studies, the findings of which were published between Jan 1, 2000, and Dec 31, 2017, focused on the pathway from chronic disease to poverty.[34,36,37,39,42,56–69] Two of these studies were part of larger cohort studies[56,57] and produced an intermediate level of evidence (D2 and D3 level; uncontrolled before-after or time-series studies), whereas the other studies were based on weaker cross-sectional designs (one D4-level study[62] and eleven D5-level studies[34,36,59–63,66–69]) or were purely descriptive (four D6-level studies[37,39,64,65]).

The largest body of evidence was from cross-sectional studies and suggested an effect of poverty on chronic disease occurrence (including risk exposures, occurrence of clinical diseases, and complications of disease). 202 (72%) of 283 studies could be classified as producing weak-level evidence. Three studies, one of which was a nested case-control study,[57] produced high-level (D2)

evidence, 33 studies produced similar high-level evidence (D3; uncontrolled before-after, case-cohort studies, or time-series study), and 33 studies produced evidence of slightly lower quality (D4; case-control studies). The remaining six studies produced D6 level of evidence. Findings from the D2-level studies showed a mixed or unclear association between poverty and chronic disease (studies were classified as mixed or unclear when they showed associations in different directions between different strata [eg, men and women] or among different measures of poverty [eg, education and wealth]), whereas 19 of the 33 D3-level studies showed a positive association, and 22 of the 33 D4-level studies showed a positive association. Studies with D5-level evidence showed a mix of associations (a positive association in 76 of 202 studies).

## Epidemiology of socioeconomic status and chronic conditions

We identified a substantial body of evidence in 283 articles (figure 2; figure 3; figure 4; figure 5; appendix). Almost 60% of the studies were from Asia (57 studies in India and 66 studies in China), and a substantial number of reports were from Brazil (figure 5). An increasing trend in publications by calendar year (figure 4) was accompanied by a steep increase and a more systematic use of poverty measures from 2005 to 2017, as summarised in the appendix (p 21). Again, the quantitative information on the association between poverty and disease was rather diffuse, has changed over time, and varied in quality (as defined by standard evidence criteria; figure 2; figure 3; appendix).[70,71] A formal meta-analysis was not possible because variables and definitions are considerably heterogeneous.[35] Many diverse studies on cancer and hypertension have been done in Asia, whereas very few studies have been done in Latin America. The number of studies on diabetes and obesity has increased since 2000, especially in Asia.

### Identified dimensions of socioeconomic status

Wealth indicators (including household and individual income, asset-based measures, and consumption measures) and educational attainment were used in more than half of the published reports and were thus the most frequently measured dimensions of poverty (panel 2). Household income, usually adjusted for household size, has often been assessed through proxy measures such as self-reporting on household assets or expenditures. Education can be measured and analysed by the number of years of schooling and the presence or absence of professional, college, or technical education. Other common dimensions of socioeconomic status were occupation and place of residence. Occupation is usually classified on the basis of the necessary skills or the hierarchy in society. These two dimensions (wealth and education) are often used alone or in conjunction with wealth to calculate composite indices. Place of residence has been used as a proxy for socioeconomic status when differences exist, as in rural versus urban living or for people living in neighbourhoods with differing levels of socioeconomic development.

Composite measures have been used increasingly in the past 7 years. Measures such as the Human Development Index (HDI)[41] and the Kuppuswamy's Socio-Economic Status Scale,[72] which are used to identify disadvantaged social groups, were found mostly in studies after 2005. Ethnicity and social groups have also been used to measure poverty levels of the population. All studies reviewed assessed the dimensions of socioeconomic status through self-reporting.

The qualitative studies are summarised in panel 1. These studies covered a limited number of chronic conditions yet provide rich descriptions of how families become indebted because of an NCD or cope with debt. The coping strategies included health-seeking behaviour and maintaining livelihoods despite the NCD.

## Socioeconomic status and NCDs: strength of evidence

Our findings are predominantly based on quantitative estimates from 279 of 283 studies, with the qualitative

***Panel 2*: Definitions of poverty status, chronic diseases, and association measures**

**Measures of poverty**

Education and income are the two most common dimensions of poverty. These poverty measures have all been self-reported, either at the individual or household level. Education is usually reported as number of school years completed or as the highest qualification attained. The local Human Development Index is reported in a study from Brazil,[41] and Abegunde and Stanciole[42] reported health-care expenditures, non-health-care expenditures, labour income, transfers income, and workdays lost by household members in Russia.

**Measures of chronic disease**

19 studies include cancer (all types) and stroke as diseases and include body-mass index (BMI) and hypertension as risk factors. Two studies do not state any specific disease but measure presence of disease[41] and mortality from disease.[43] Two studies on stroke report late outcomes after stroke (ie, disability after stroke, according to the modified Rankin Scale[44] and 3 year survival[45]). Cancer outcomes are mainly reported in terms of fatality.[46–49] Treatment outcomes are investigated in one study,[41] disease incidence in a second study,[50] and quality of life 1 year after surgery in a third study.[51] Clinical outcomes in all studies are based on in-service records. In the three studies on risk factors, BMI, and hypertension, the risk factors in their populations were measured directly.[52–54] The one study[42] on the chronic disease to poverty pathway relies on self-reports from people with a chronic condition.

**Measures of the poverty–disease association**

Odds ratios,[44,47] relative risk measures,[43,46,54,55] and hazard ratios[45] were the most common measures. In two cohort studies from Mumbai,[48,49] age-standardised relative survival (calculated as the ratio of the observed survival to expected survival in a group of people in the general population similar to the diseased group with similar age distribution) was used to indicate the excess risk of dying from the disease. For studies looking at risk factors, prevalence is the measure used as the outcome variable.[52,53] In the Brazilian study[41] on outcomes after leukaemia, investigators looked at a variety of measures, including complete remission rate, overall survival rate, and leukaemia-free survival rate.

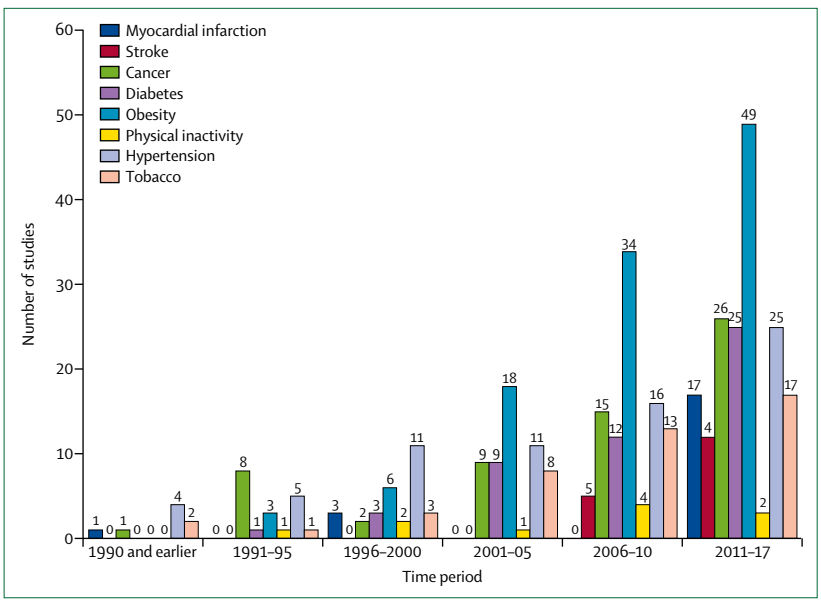


*Figure 4:* **Distribution of studies on poverty and non-communicable diseases or risk factors studied over time**

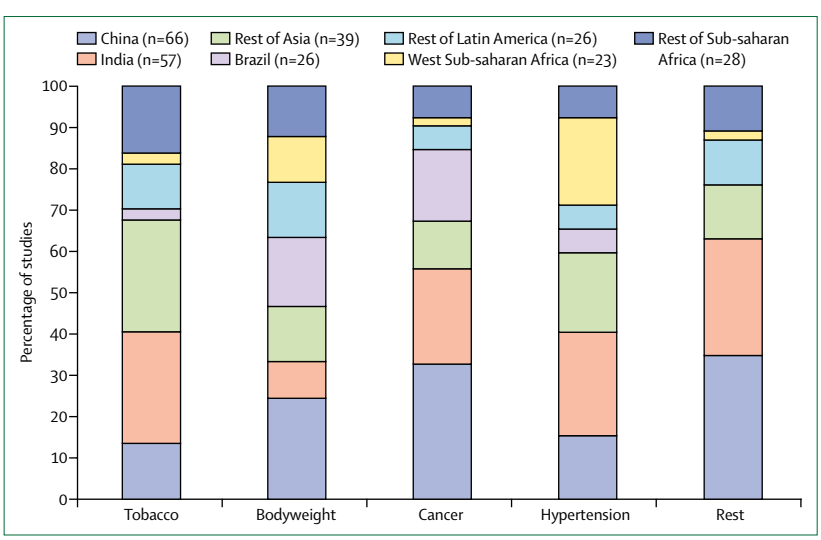


*Figure 5:* **Regional distribution of studies of the four most reported NCDs and all other NCDs**
NCDs=non-communicable diseases.

studies, as summarised in panel 1. The quantitative studies were subjected to an adapted evidence-grading scheme[71] from the scientific literature.[70] Most of the data describes the pathway from socioeconomic status to NCDs, whereas 11 studies focus on the pathway from chronic disease to poverty. Cross-sectional study designs are used in 202 (72%) of the 279 studies. Many of the cross-sectional studies are population-based surveys using the WHO STEPS method.[73–76] Study designs have become more sophisticated with time: case-control studies, cohort studies, and time-series studies make up 25% of the identified studies. Findings from early quantitative studies show the mixed association between socioeconomic status and NCDs (by quality of evidence; figure 2; figure 3). The increasing trend in observations of a positive association between socioeconomic status and NCDs since 2000 is shown in figure 2. The early studies identifying a negative association were published before 2000, and the trend in reporting a negative association has decreased in the past decade. The high-level evidence (most of which was produced in studies after 2000) shows a consistent positive relationship between socioeconomic status and NCDs (figure 2).

### Population selection bias

The associations between poverty and chronic conditions depend on the sampling framework showing possible selection bias in the studies. A positive association between poverty and chronic conditions or their risk factors was found in 73 (38%) of the 194 studies that sampled data from a general population. Likewise, a positive association between poverty and NCDs or their risk factors was found in 32 (74%) of the 43 studies involving representative samples of health-service users (appendix).

## Strong evidence: clustering of socioeconomic status and NCDs

A temporal relationship between chronic disease and poverty can be investigated in studies with strong designs. Studies with strong designs in this Taskforce paper include mainly cohort studies and one nested case-control study. Data from one of these studies[42] show a positive association between chronic disease and poverty in one study group, whereas of the other 24 studies[41,43–47,50,53,54,56,77–87] examining the pathway from poverty to chronic disease, a positive association was found in 18 studies, mixed or unclear associations were found in seven studies[56,41,43–48,53,54,77–80,83–86] (a positive association was found in four of these studies), and a negative association was found in one study[47] (table 1; table 2).

To accommodate the heterogeneity in study outcome measures and still arrive at a summary outcome, we used the excess risk ratio as a general, unadjusted, and crude comparative measure for the studies with strong evidence (table 2). We defined this ratio as the unadjusted ratio between the measure for chronic condition and the socioeconomic measure (calculated for the lowest and highest socioeconomic status category value) for any given health variable. The unadjusted crude excess risk ratios are shown by study sample size in table 2. Given the limitations of this approach, almost all studies show a positive relationship between poverty and chronic disease. In the study[54] with the largest sample size, the excess risk ratio between chronic disease mortality and body-mass index (BMI) and mortality is relatively small but positive, whereas the sample size is much smaller in the study[45] with the

| | Study design | Exposure variable | Outcome variable | Association measure | Magnitude of association measure |
|---|---|---|---|---|---|
| Yan et al (2017)[85] | Retrospective cohort | Socio-economic status | Stroke mortality, all-cause mortality | Percentage survivors, adjusted HR | HR low social economic status score *vs* high status score: stroke mortality 2·127 (95% CI 1·427–3·171); all-cause mortality 2·127 (95% CI 1·220–3·710): |
| Yu and Sloan (2017)[86] | Multiple birth cohorts | Household income | Stroke event | Multi-variate analyses; age-period-cohort analyses | HR natural log household income 0·0002 (SE 0·0011) |
| Rasouli et al (2017)[84] | Cohort | Profession, education, economic status | Death from colorectal cancer | Proportional HR: worker *vs* others; school certificate; rich *vs* poor status | Manual worker *vs* other jobs HR 2·09 (95% CI 1·22–3·58); school certificate HR 0·61 (95% CI 0·39–0·92); rich social economic status HR 0·51 (95% CI 0·31–0·82) |
| Moradi et al (2016)[83] | Cohort | Education (literate *vs* non-literate) | Death from stomach cancer | Proportional HR | OR 0·51 (95% CI 0·24–0·93) |
| Huang et al (2015)[82] | Cohort | Education, household expenditure, technology use | BMI and calories consumption | Multivariate analysis: no education *vs* higher education | Beta coefficient: men 0·666 (SE 0·158); women –1·322 (SE 0·152) |
| Chen et al (2015)[77] | Cohort | Residence, socioeconomic deprivation, education, occupation, annual income | Mortality | Multivariate adjusted HR for elementary school *vs* higher education | HR 1·88 (95% CI 1·05–3·36) |
| Elwell-Sutton et al (2013)[78] | Cohort | Income, education, occupation | Hypertension, diabetes | Concentration Index; Healthy Inequity Index; multivariate analysis | Independent contribution of low-income status in Concentration Index and Healthy Inequity Index (SE at p<0·05 level) |
| Fagundes et al (2006)[41] | Cohort | Direct measurement of HDI of place of living | Direct measurement of treatment outcomes from records, use of Hidac, complete remission rate, survival rate, leukaemia-free survival rate | Relative risk for HDI <0·660 | RR: use of Hidac 0·130 (p<0·01); complete remission rate 0·523; survival 1·472; leukaemia-free survival 3·659 (p<0·01) |
| Forde et al (2012)[79] | Matched control prospective cohort study | Education, household income | Obesity | OR for obesity in multivariate analysis | OR 1·27 (95% CI 1·03–1·57); p=0·03 |
| Ginsburg et al (2013)[80] | Cohort | Residential mobility, maternal education, asset wealth index | Obesity | Socioeconomic status in multivariate analysis | Beta-coefficient 0·42 (SE 0·13) for women; not significant for men |
| Hou et al (2008)[53] | Cohort | Self-reported monthly household income and educational level based on years of school | Direct measurement of BMI and blood pressure, standardised prevalence for overweight and obesity | OR | OR (compared with low educated women): medium-educated women 0·64 (95% CI 0·52–0·79); highly educated women 0·50 (95% CI 0·36–0·68) |
| Khan et al (2015)[56] | Dynamic cohort | Self-reported monthly household income and educational level based on years of school; asset score | Death from chronic disease, by verbal autopsy | OR and Concentration Index | OR for lower-quintile income group compared with higher-quintile group: 1·26 (95% CI 0·92–1·69) |
| Li and Yu (2002)[46] | Cohort (case-cohort design) | Self-reported annual income | Death due to lung cancer | Rate ratio | Rate ratio compared to high average year income: middle-income 2·1 (95% CI 0·94–4·67); low-income 6·22 (95% CI 1·87–20·7) |
| Liu and Zhu (2014)[57] | Case-control study; time-series study | Household income | Diabetes | Beta coefficient in multivariate analysis | Beta coefficient 6·3% decrease in annual income for people with diabetes as compared with people who do not have diabetes |
| Liu et al (2007)[44] | Cohort | Self-reported educational levels from illiteracy through university | Self-reported post-stroke disability according to modified Rankin Scale | OR | OR for lower educational level 0·686 (95% CI 0·570–0·825) |
| Sauvaget et al (2008)[54] | Cohort | Self-reported educational level, occupation, and standard of living | Direct measurement of BMI | $\chi^2$ for trend in multivariate adjusted relative risk for various BMI categories in low, middle, and high socioeconomic status | p value for trend: low socioeconomic status 0·008; middle socioeconomic status 0·0097; high socioeconomic status 0·1402 |

(Table 1 continues on next page)

largest excess risk ratio between income and chronic disease survival. This indicates the presence of confounders in this type of analysis. A more formal meta-analysis is not possible because of the very different measures used, the lack of reported uncertainty ranges, and the variety in multiple confounders. It is striking that the excess risk ratios range from –0·17 for a weak association (but including other positive outcomes in the same study) to 0·97 (a strong positive association). Education measures were included in 15 studies, and socioeconomic measures were included in 15 studies.

In summary, although this excess ratio for socioeconomic status is largely indicative, we found a consistent positive relationship between socioeconomic status and NCDs that probably varies by orders of

| | Study design | Exposure variable | Outcome variable | Association measure | Magnitude of association measure |
|---|---|---|---|---|---|
| (Continued from previous page) | | | | | |
| Xu et al (1996)[47] | Nested case control | Self-reported educational levels from illiteracy through university and income per person | Direct measurement of recorded death from cancer | OR | OR for income: <¥15 per person 1 (reference group); ¥15–19·9 per person 1·2 (95% CI 0·8–1·8); ¥20–26·9 per person 1·6 (1·1–2·2); ¥27–39·9 per person 1·8 (1·2–2·6); >¥40 per person 1·7 (1·2–2·5); OR for education: no education 1 (reference group); primary school 1·1 (0·8–1·6); junior middle school 1 (0·7–1·6); high school 0·8 (0·5–1·3); college 0·8 (0·5–1·5) |
| Yu et al (1993)[50] | Cohort | Self-reported educational level (highest level attended) and income (total income of household) | Record reviewof oesophageal cancer incidence | Age-adjusted and sex-adjusted relative risks | RR: for any education 0·82 (95% CI 0·71–0·94); any income 1·05 (0·94–1·18) |
| Zhou et al (2006)[45] | Cohort | Self-reported taxable gross income per month, educational levels from illiteracy through university | Record review of death within 3 years of stroke | Age-adjusted and sex-adjusted adjusted HR | HR for education: illiteracy 0·96 (95% CI 0·46–2·00); primary school 1·25 (0·57–2·72); junior high school 0·77 (0·34–1·74); senior high school 1·05 (0·41–2·71); technical training 1·99 (0·71–5·61); university degree 1 (reference group); HR for occupation: unemployed 6·27 (2·97–13·21); manual worker 5·23 (2·88–9·49); non-manual worker 1 (reference group); HR for income: ¥0 5·37 (3·19–9·03); <¥1000 2·22 (1·36–3·63); ≥¥1000 1 (reference group) |
| Koch et al (2010)[43] | Cohort | Self-reported annual household income and educational levels from years of schooling | All-cause adult mortality, including those mortality from chronic diseases | Adjusted RR of death | Adjusted RR for education (p<0·01): elementary 1 (reference group); high school 0·67 (0·53–0·85); college 0·30 (0·17–0·53); <¥4200 annual income 1 (reference group); ¥4200–6000 annual income 0·86 (0·69–1·06); ¥6000–10 000 annual income 1·11 (0·88–1·40); >¥10 000 annual income 1·05 (0·84–1·31) |
| Yang et al (2010)[81] | Cohort | Self-reported annual household income and educational levels from years of schooling | QOL scores 1 year after surgery | Beta coefficient from multiple regression analysis | 3·135 increase in QOL score from low to high socioeconomic level (p<0·01) |

HR=hazard ratio. HDI=Human Development Index. QOL=quality of life. BMI=body-mass index. OR=odds ratio. RR=relative risk.

***Table 1:*** **Characteristics of high-grade evidence follow-up studies on chronic disease and poverty**

magnitude because of different confounders in each of the individual studies.

## Conclusions

A positive relationship between socioeconomic status and chronic conditions in LMICs is found in most studies with strong design, which confirms that the epidemiology of poverty and NCDs in LMICs now converges with the abundance of study findings from high-income countries.[29,30,88,89]

In general, up to the year 2000 (but also since 2000), the scientific literature on LMICs has provided mixed information and reflected changing country conditions worldwide. However, there is a general lack of robustness in the scientific literature because of weak and often inconclusive study findings that are limited by the cross-sectional nature of the evidence. Since 2000, study quality has been improving, and the number of longitudinal designs has been increasing. Studies with a strong design include one nested case-control study and 21 cohort studies. Case-control studies are most feasible in resource-constrained settings, and obesity and hypertension seem to be the most obvious and feasible conditions to study because they are easy to measure.

With this first comprehensive review, we succeeded in identifying studies even without a primary objective related to socioeconomic status and NCDs. Some limitations exist because we excluded scientific literature that was not written in English (we did not expect the findings from those studies to influence our conclusions). We included many articles from national-level Indian journals that did not present high-level evidence on the relationship between poverty and chronic disease. We excluded articles in Portuguese, Russian, Polish, and Chinese.

Definitions of the terms related to socioeconomic status and disease conditions varied widely. Many poverty measures are relative concepts, change over time, and could address household or individual characteristics. Only one study[52] addressed socioeconomic status and disease conditions at both the community and individual levels, and no study addressed social or economic capital measures.

We also could not differentiate our findings by population strata (eg, by gender or by rural and urban differentials) that might modify the relationship between health conditions and socioeconomic status. Further limitations are small sample sizes and the lack of addressing potential collinearity because of education, wealth, and occupation. Additionally, access to treatment was not assessed although this was an important factor. The excess risk ratios in table 2 do not

| | Risk in poor groups | Risk in non-poor groups | Excess risk ratio* | Study sample size |
|---|---|---|---|---|
| Khan et al (2015)[56] | Incidence of death from chronic disease in the lower-quintile income group | Incidence of death from chronic disease in the higher-quintile income group | 0·2231 | >100 000 |
| Sauvaget et al (2008)[54] | Incidence rate of death per person-years of follow-up in the low-socioeconomic status category | Incidence rate of death per person-years of follow-up in the high-socioeconomic status category | 0·1858 | 75 868 |
| Elwell-Sutton et al (2013)[78] | Probability of not getting hypertension treatment in lowest education group | Probability of not getting hypertension treatment in highest education group | 0·268 | 30 499 |
| Yu et al (1993)[50] | Age-adjusted and sex-adjusted relative risk of oesophageal cancer incidence in category of no income | Age-adjusted and sex-adjusted relative risk of oesophageal cancer incidence in category of any education | 0·18 | 12 693 |
| Yu et al (1993)[50] | Age-adjusted and sex-adjusted relative risk of oesophageal cancer incidence in category of no education | Age-adjusted and sex-adjusted relative risk of oesophageal cancer incidence in category of any income | –0·05 | 12 693 |
| Koch et al (2010)[43] | Adjusted relative risk of death for elementary education | Adjusted relative risk of death for college education | 0·7 | 11 600 |
| Koch et al (2010)[43] | Adjusted relative risk of death for annual household income <US$4200 | Adjusted relative risk of death for annual household income >US$10 000 | –0·05 | 11 600 |
| Yeole et al (2000)[48] | Observed 5 year probability of death due to head and neck cancer in no education category | Observed 5 year probability of death due to head and neck cancer in education >12 years category | 0·132 | 6311 |
| Yu and Sloan (2017)[86] | HR for stroke in low household income group | HR for stroke in high household income group | Non-significant (<0·01) | 1736; 3486 |
| Huang et al (2015)[82] | HR for obesity in two cohorts of men with no education | HR for obesity group in two cohorts of men with higher education | 0·7333 | 2492; 2599 |
| Huang et al (2015)[82] | HR for obesity in two cohorts of women with no education | HR for obesity group in two cohorts of women with higher education | –0·2435 | 2665; 2903 |
| Chen et al (2015)[87] | Incidence of death after stroke in highest socioeconomic deprivation group | Incidence of death after stroke in lowest socioeconomic deprivation group | 0·6048 | 2978 |
| Hou et al (2008)[53] | Odds of being overweight or obese in low-educated women category | Odds of being overweight or obese in highly educated women category | 0·5741 | 2924 |
| Hou et al (2008)[53] | Odds of being overweight or obese in women with income <¥1000 category | Odds of being overweight or obese in woment with income >¥3000 category | 0·3497 | 2924 |
| Hou et al (2008)[53] | Odds of being overweight or obese in low-educated men category | Odds of being overweight or obese in highly educated men category | 0·1692 | 2164 |
| Hou et al (2008)[53] | Odds of being overweight or obese in men with income <¥1000 category | Odds of being overweight/obese in in men with income >¥3000 category | –0·1698 | 2164 |
| Xu et al (1996)[47] | Odds of lung cancer incidence in income <¥15 per person category | Odds of lung cancer incidence in income >¥40 per person category | –0·0898 | 1862 |
| Xu et al (1996)[47] | Odds of lung cancer incidence in no education category | Odds of lung cancer incidence in college education category | 0·6360 | 1862 |
| Xu et al (1996)[47] | Odds of stomach cancer incidence in no education category | Odds of stomach cancer incidence in college education category | 0·8328 | 1862 |
| Yeole et al (2001)[78] | Observed 5 year probability of death due to colorectal cancer for no education category | Observed 5 year probability of death due to colorectal cancer for >12 years education category | 0·0077 | 1767 |
| Forde et al (2012)[79] | Odds ratio intervention on BMI in group with primary education and lowest household income | Odds ratio intervention on BMI in group with secondary education and lowest household income | 0·2683 | 1273 |
| Zhou et al (2006)[45] | Odds of death after stroke in illiteracy category | Odds of death after stroke in university degree education category | 0·9195 | 806 |
| Zhou et al (2006)[45] | Odds of death after stroke in ¥0 income category | Odds of death after stroke in >¥1000 income category | 0·9720 | 806 |
| Yan et al (2017)[85] | Odds of stroke and all-cause mortality in group with low social economic status score | Odds of stroke and all-cause mortality in group with high social economic status score | 0·5298; 0·5298 | 471 |
| Liu et al (2007)[44] | Odds of poor outcome after stroke in illiteracy category | Odds of poor outcome after stroke in university education category | 0·8389 | 434 |
| Rasouli et al (2017)[84] | HR for death in colorectal cancer patients among manual workers, illiterate, poor economic status | HR for death in colorectal cancer patients among others, certificate or lower, rich social economic status | 0·5215; 0·4357; 0·3995 | 335 |
| Li and Yu (2002)[46] | Odds of death due to lung cancer in low average year income category | Odds of death due to lung cancer in high average year income category | 0·8264 | 316 |
| Moradi et al (2016)[83] | Odds of death from stomach cancer in non-literate group | Odds of death from stomach cancer in literate group | 0·3995 | 202 |
| Fagundes et al (2006)[41] | Odds ratio for survival after leukaemia treatment in HDI <0·660 category | Odds ratio for survival after leukaemia treatment in HDI >0·660 category | 0·3206 | 123 |

BMI=body-mass index. HDI=Human Development Index. HR=hazard ratio. *Excess risk ratio=(risk in poor – risk in non-poor)/risk among poor. Values for the excess risk ratio range from –1 to 1, with –1 denoting all risk among the non-poor and 1 denoting all risk for poor (Abegunde and Stanciole [2008],[42] Yang et al [2010],[81] Chen and Meltzer [2008],[52] and Ginsburg et al [2013][80] are excluded because variables were continuous).

***Table 2:*** **High-grade follow-up studies by health risk, poverty status, and excess risk ratio, ranked by sample size**

consider heterogeneity. Excess risk computations are a crude, descriptive, associative measure of an existing relationship between socioeconomic status and NCDs that can be used consistently across studies. Further explorations of this relationship should include characteristics of existing health systems to understand how health systems can affect disparities in NCDs.

## Relevance

This systematically collected evidence on the interaction between socioeconomic status and NCDs in LMICs could stimulate further efforts in setting international and national agendas. These joint agendas should contribute to changes in health and education programmes and research of social safety nets and pro-poor health-financing mechanisms.

The increase in number of studies coincided with the increase in available resources for development and increases in education levels in most countries, especially in India, China, and Brazil. Fast economic development and rapid urbanisation are occurring in Asia, South America, and, to a lesser extent, in Africa. China, India, and Brazil share this rapid epidemiological transition and the resulting double burden.[53,90,91] These countries might move further through a health transition, accompanied by greater urbanisation and lifestyle changes.[92] The poor, with shorter life expectancies and bearing the brunt of undernutrition, malnutrition, childhood diseases, and pregnancy-related conditions, are likely to be most affected by NCDs.

Our review of the peer-reviewed scientific literature has led to a better understanding of the negative effects of socioeconomic status on NCDs in LMICs. Known mechanisms and interventional programmes to interrupt the harmful consequences of socioeconomic status are within the domains of poverty alleviation, social security systems, general educational programme development, global public health, health financing, health education, and health promotion, but they are also within the domains of prevention activities in relation to physical activity, food quality and intake, and other lifestyle factors. Investigators must differentiate between effects on people who are already poor or ill to better understand self-reinforcing effects. Broad intervention studies, including those involving social safety nets, health financing, specific health-systems innovations, and broad strategies to tackle NCDs, should be designed to better address their distributional effects in addition to overall average outcomes and effects on target populations. This would identify further evaluation research and strategies that could contribute to more general and international health-development approaches and to a public health and health-services agenda that promotes health and wellbeing in the broader context of poverty reduction, equitable education, gender equality, and reduction of national and international inequalities.[21]

## Towards comprehensive national SDG policies

The collective body of research from longitudinal studies of the link between socioeconomic status and NCDs in LMICs provides high-grade evidence in support of positive associations between low social and economic status and NCDs. To end poverty in LMICs through elimination of its causes under the SDG agenda,[21] NCDs programmes should be included in the development agenda. International development efforts and national governments should mitigate social and health shocks to protect the poor from major health-related events (diseases, injuries, infections, natural, and externally inflicted disasters such as flooding, job loss, and famines), worsening their already disadvantaged socioeconomic conditions and their susceptible health status. SDG programmes related to UHC of NCDs should target susceptible populations, which include middle-aged and elderly people who are most at risk of NCDs. Further effort should be made towards capturing groups that are likely to be further disadvantaged, such as women and people living in rural areas. The inequalities in access to health resources need to be addressed through international regulations and through regulations within national jurisdictions and health systems. These should eliminate the legal and practical barriers in the implementation of UHC of NCDs in all countries. The sustained reduction of inequalities in poverty, education, gender, and health, both within and between countries, will promote worldwide equality in health and wellbeing and further enhance both socioeconomic and human development.

**Contributors**

LWN wrote the first and the final versions of this Taskforce paper, supervised the paper, did the article selection and data extraction, and guided and supervised the overall completion process of the paper. DHP had the original idea of the study, wrote the study proposal, and contributed to the writing of this Taskforce paper. TK contributed to the design of the study and participated in the updates of the paper. DM, JKA, AJM, SA, and JK did the article review and contributed to the writing of this Taskforce paper in all its stages. AT contributed to the design of the study, assessed the extraction results focusing on methods and analytics, and contributed to the paper in all its stages.

**Declaration of interests**

We declare no competing interests.

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**References**

1 Division for Sustainable Development, UN. Global sustainable development report. Advanced unedited edition in the Global Sustainable Development Report. New York: United Nations, 2015.

2 Evans DB, Marten R, Etienne C. Universal health coverage is a development issue. *Lancet* 2012; **380:** 864–65.

3 Gable S, Lofgren H, Rodarte I. Trajectories for sustainable development goals framework and country applications. Washington, DC: International Bank for Reconstruction and Development, The World Bank, 2015.

4 LeBlanc D. Towards integration at last? The sustainable development goals as a network of targets. DESA Working Paper No 141. Washington, DC: Department of Economic & Social Affairs, 2015.

5 UN. Transforming our world: the 2030 agenda for sustainable development. New York, NY: United Nations, 2015.

6 Chan M. Health in the 2030 Agenda for Sustainable Development. Geneva: World Health Organization, 2016.

7 Thomas JC, Silvelstre E, Salentine S, Reynolds H, Smith J. What systems are essential to achieving the sustainable development goals and what will it take to marshal them? *Health Policy Plan* 2016; **31:** 1445–47.

8 World Bank. Global monitoring report: development goals in an era of demographic change. Washington, DC: World Bank, International Monetary Fund, 2016.

9 Commission on Social Determinants of Health. Closing the gap in a generation. Health equity through action on the social determinants of health. Geneva: World Health Organization, 2008.

10 Cumper G. Social and organizational constraints on health development. *J Trop Med Hyg* 1982; **85:** 47–55.

11 Hill PS, Buse K, Brolan CE, Ooms G. How can health remain central post-2015 in a sustainable development paradigm? *Global Health* 2014; **10:** 18.

12 Kim JY. Time for even greater ambition in global health. *Lancet* 2013; **382:** e33–34.

13 Nugent RA, Bertram MY, Jan S, et al. Investing in non-communicable disease prevention and management to advance the Sustainable Development Goals. *Lancet* 2018; published online April 4. http://dx.doi.org/10.1016/S0140-6736(18)30667-6.

14 Stuckler D, Basu S, McKee M. Drivers of inequality in Millennium Development Goal progress: a statistical analysis. *PLoS Med* 2010; **7:** e1000241.

15 Jamison DT, Summers LH, Alleyne G, et al. Global health 2035: a world converging within a generation. *Lancet* 2013; **382:** 1898–955.

16 Marmot M, Allen JJ. Social determinants of health equity. *Am J Public Health* 2014; **104** (suppl 4)**:** S517–19.

17 Wagstaff A. Poverty and health sector inequalities. *Bull World Health Organ* 2002; **80:** 97–105.

18 Strong K, Mathers C, Leeder S, Beaglehole R. Preventing chronic diseases: how many lives can we save? *Lancet* 2005; **366:** 1578–82.

19 UN. Prevention and control of non-communicable disease. New York, NY: United Nations, 2010.

20 WHO. Preventing chronic diseases: a vital investment. WHO global report. Geneva: World Health Organization, 2005.

21 WHO. Health in 2015: from MDGs to SDGs. Geneva: World Health Organization, 2015.

22 Beaglehole R, Bonita R, Horton R, et al. Priority actions for the non-communicable disease crisis. *Lancet* 2011; **377:** 1438–47.

23 Case A, Lubotsky D, Paxson C. Economic status and health in childhood: the origins of the gradient. *Am Econ Rev* 2002; **92:** 1308–44.

24 Allen L, Williams J, Townsend N, et al. Socioeconomic status and non-communicable disease behavioural risk factors in low-income and lower-middle-income countries: a systematic review. *Lancet Glob Health* 2017; **5:** e277–89.

25 Beaglehole R, Bonita R. Economists, universal health coverage, and non-communicable diseases. *Lancet* 2016; **387:** 848.

26 Clark H. NCDs: a challenge to sustainable human development. *Lancet* 2013; **381:** 510–11.

27 Jan S, Laba T-L, Essue BM, et al. Action to address the household economic burden of non-communicable diseases. *Lancet* 2018; published online April 4. http://dx.doi.org/10.1016/S0140-6736(18)30323-4.

28 Lynch J, Smith GD. A life course approach to chronic disease epidemiology. *Annu Rev Public Health* 2005; **26:** 1–35.

29 Bartley M, Fitzpatrick R, Firth D, Marmot M. Social distribution of cardiovascular disease risk factors: change among men in England 1984–1993. *J Epidemiol Community Health* 2000; **54:** 806–14.

30 Bartley M, Sacker A, Firth D, Fitzpatrick R. Understanding social variation in cardiovascular risk factors in women and men: the advantage of theoretically based measures. *Soc Sci Med* 1999; **49:** 831–45.

31 Suhrcke M, Nugent RA, Stuckler D, Rocco L. Chronic disease: an economic perspective. London: Oxford Health Alliance, 2006.

32 van Doorslaer E, O'Donnell O, Rannan-Eliya RP, et al. Catastrophic payments for health care in Asia. *Health Econ* 2007; **16:** 1159–84.

33 van Doorslaer E, O'Donnell O, Rannan-Eliya RP, et al. Effect of payments for health care on poverty estimates in 11 countries in Asia: an analysis of household survey data. *Lancet* 2006; **368:** 1357–64.

34 Levesque JF, Haddad S, Narayana D, Fournier P. Affording what's free and paying for choice: comparing the cost of public and private hospitalizations in urban Kerala. *Int J Health Plann Manage* 2007; **22:** 159–74.

35 Berkman ND, Lohr KN, Ansari MT, et al. Grading the strength of a body of evidence when assessing health care interventions: an EPC update. *J Clin Epidemiol* 2015; **68:** 1312–24.

36 Chuma J, Gilson L, Molyneux C. Treatment-seeking behaviour, cost burdens and coping strategies among rural and urban households in Coastal Kenya: an equity analysis. *Trop Med Int Health* 2007; **12:** 673–86.

37 Perera M, Gunatilleke G, Bird P. Falling into the medical poverty trap in Sri Lanka: what can be done? *Int J Health Serv* 2007; **37:** 379–98.

38 Olinto MT, Nacul LC, Gigante DP, Costa JS, Menezes AM, Macedo S. Waist circumference as a determinant of hypertension and diabetes in Brazilian women: a population-based study. *Public Health Nutr* 2004; **7**: 629–35.

39 Emanuel N, Simon MA, Burt M, et al., Economic impact of terminal illness and the willingness to change it. *J Palliat Med* 2010; **13:** 941–44.

40 Tovey P, Broom A. Cancer patients' negotiation of therapeutic options in Pakistan. *Qual Health Res* 2007; **17:** 652–62.

41 Fagundes EM, Rocha V, Glória AB, et al. De novo acute myeloid leukemia in adults younger than 60 years of age: socioeconomic aspects and treatment results in a Brazilian university center. *Leuk Lymphoma* 2006; **47**: 1557–64.

42 Abegunde DO, Stanciole AE. The economic impact of chronic diseases: how do households respond to shocks? Evidence from Russia. *Soc Sci Med* 2008; **66:** 2296–307.

43 Koch E, Romero T, Romero CX, et al. Early life and adult socioeconomic influences on mortality risk: preliminary report of a 'pauper rich' paradox in a Chilean adult cohort. *Ann Epidemiol* 2010; **20:** 487–92.

44 Liu X, Lv Y, Wang B, Zhao G, Yan Y, Xu D. Prediction of functional outcome of ischemic stroke patients in northwest China. *Clin Neurol Neurosurg* 2007; **109:** 571–77.

45 Zhou G, Liu X, Xu G, Liu X, Zhang R, Zhu W. The effect of socioeconomic status on three-year mortality after first-ever ischemic stroke in Nanjing, China. *BMC Public Health* 2006; **6:** 227.

46 Li K, Yu S. Economic status, smoking, occupational exposure to rubber, and lung cancer: a case-cohort study. *J Environ Sci Health C Environ Carcinog Ecotoxicol Rev* 2002; **20:** 21–28.

47 Xu Z, Brown LM, Pan GW, et al., Cancer risks among iron and steel workers in Anshan, China, Part II: case-control studies of lung and stomach cancer. *Am J Ind Med* 1996; **30:** 7–15.

48 Yeole BB, Sankaranarayanan R, Sunny L, Swaminathan R, Parkin DM. Survival from head and neck cancer in Mumbai (Bombay), India. *Cancer* 2000; **89:** 437–44.

49 Sunny L, Swaminathan R, Sankaranarayanan R, Parkin DM. Population-based survival from colorectal cancer in Mumbai, (Bombay) India. *Eur J Cancer* 2001; **37:** 1402–08.

50 Yu Y, Taylor PR, Li JY, et al., Retrospective cohort study of risk-factors for esophageal cancer in Linxian, People's Republic of China. *Cancer Causes Control* 1993; **4:** 195–202.

51 Cui Y, Shu XO, Gao Y, et al. The long-term impact of medical and socio-demographic factors on the quality of life of breast cancer survivors among Chinese women. *Breast Cancer Res Treat* 2004; **87:** 135–47.

52 Chen Z, Meltzer D. Beefing up with the Chans: evidence for the effects of relative income and income inequality on health from the China Health and Nutrition Survey. *Soc Sci Med* 2008; **66:** 2206–17.

53 Hou X, Jia W, Bao Y, et al. Risk factors for overweight and obesity, and changes in body mass index of Chinese adults in Shanghai. *BMC Public Health* 2008; **8:** 389.

54 Sauvaget C, Ramadas K, Thomas G, Vinoda J, Thara S, Sankaranarayanan R. Body mass index, weight change and mortality risk in a prospective study in India. *Int J Epidemiol* 2008; **37:** 990–1004.

55 Yin R, Li H, Wu J, et al., Effects of alcohol consumption and other lifestyle behaviors on blood pressure for the middle-aged and elderly in the Guangxi Hei Yi Zhuang and Han populations. *Alcohol* 2007; **41:** 541–50.

56 Khan JA, Trujillo AJ, Ahmed S, et al., Distribution of chronic disease mortality and deterioration in household socioeconomic status in rural Bangladesh: an analysis over a 24-year period. *Int J Epidemiol* 2015; **44:** 1917–26.

57 Liu X, Zhu C. Will knowing diabetes affect labor income? Evidence from a natural experiment. *Econ Lett* 2014; **124:** 74–78.

58 Adeniyi OV, Yogeswaran P, Longo-Mbenza B, Ter Goon D, Ajayi AI. Cross-sectional study of patients with type 2 diabetes in OR Tambo district, South Africa. *BMJ Open* 2016; **6:** e010875.

59 Bonu S, Rani M, Peters DH, Jha P, Nguyen SN. Does use of tobacco or alcohol contribute to impoverishment from hospitalization costs in India. *Health Policy Plan* 2005; **20:** 41–49.

60 Brinda EM, Andres AR, Enemark U. Correlates of out-of-pocket and catastrophic health expenditures in Tanzania: results from a national household survey. *BMC Int Health Hum Rights* 2014; **14:** 5.

61 Efroymson D, Ahmedb S, Townsend J, et al., Hungry for tobacco: an analysis of the economic impact of tobacco consumption on the poor in Bangladesh. Tob Control 2001; **10:** 212–17.

62 Hamid SE, Ahsan SM, Begum A. Disease-specific impoverishment impact of out-of-pocket payments for health care: evidence from rural bangladesh. *Appl Health Econ Health Policy* 2014; **12:** 421–33.

63 Kimman M, Jan S, Yip CH, et al. Catastrophic health expenditure and 12-month mortality associated with cancer in southeast Asia: results from a longitudinal study in eight countries. *BMC Med* 2015; **13:** 190.

64 Martinson IM, Su Xiao Y, Liang YH. The impact of childhood cancer on 50 Chinese families. *J Pediatr Oncol Nurs* 1993; **10:** 13–18.

65 Ramachandran A, Ramachandran S, Snehalatha C, et al. Increasing expenditure on health care incurred by diabetic subjects in a developing country: a study from India. *Diabetes Care* 2007; **30:** 252–56.

66 Shobhana R, Rao PR, Lavanya A, Vijay V, Ramachandran A. Cost burden to diabetic patients with foot complications—a study from southern India. *J Assoc Physicians India* 2000; **48:** 1147–50.

67 Tharkar S, Satyavani K, Viswanathan V. Cost of medical care among type 2 diabetic patients with a co-morbid condition—hypertension in India. *Diabetes Res Clin Pract* 2009; **83:** 263–67.

68 Gwatidzo SD, Stewart Williams J. Diabetes mellitus medication use and catastrophic healthcare expenditure among adults aged 50+ years in China and India: results from the WHO study on global AGEing and adult health (SAGE). *BMC Geriatr* 2017; **17:** 14.

69 Okoronkwo IL, Ekpemiro JN, Okwor EU, Okpala PU, Adeyemo FO. Economic burden and catastrophic cost among people living with type2 diabetes mellitus attending a tertiary health institution in south-east zone, Nigeria. *BMC Res Notes* 2015; **8:** 527.

70 Grimshaw JM, Thomas RE, MacLennan G, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health Technol Assess* 2004; **8:** iii–iv, 1–72.

71 Peters DH, El-Saharty S, Siadat B, Janovsky K, Vujicic M. Improving health service delivery in developing countries: from evidence to action. Washington, DC: World Bank, 2009.

72 Chhabra S, Sonak M, Prem V, Sharma S, et al. Gynaecological malignancies in a rural institute in India. *J Obstet Gynaecol* 2002; **22:** 426–29.

73 Hoang VM, Byass P, Dao LH, Nguyen TK, Wall S. Risk factors for chronic disease among rural Vietnamese adults and the association of these factors with sociodemographic variables: findings from the WHO STEPS survey in rural Vietnam, 2005. *Prev Chronic Dis* 2007; **4:** A22.

74 Longo-Mbenza B, Ngoma DV, Nahimana D, et al. Screen detection and the WHO stepwise approach to the prevalence and risk factors of arterial hypertension in Kinshasa. *Eur J Cardiovasc Prev Rehabil* 2008; **15:** 503–08.

75 Minh HV, Byass P, Chuc NT, Wall S. Gender differences in prevalence and socioeconomic determinants of hypertension: findings from the WHO STEPs survey in a rural community of Vietnam. *J Hum Hypertens* 2006; **20:** 109–15.

76 Mohan V, Mathur P, Deepa R, et al. Urban rural differences in prevalence of self-reported diabetes in India—the WHO-ICMR Indian NCD risk factor surveillance. *Diabetes Res Clin Pract* 2008; **80:** 159–68.

77 Chen R, Hu Z, Chen RL, et al. Socioeconomic deprivation and survival after stroke in China: a systematic literature review and a new population-based cohort study. *BMJ Open* 2015; **5:** e005688.

78 Elwell-Sutton TM, Jiang CQ, Zhang WS, et al. Inequality and inequity in access to health care and treatment for chronic conditions in China: the Guangzhou Biobank Cohort Study. *Health Policy Plan* 2013; **28:** 467–79.

79 Forde I, Chandola T, Garcia S, Marmot MG, Attanasio O. The impact of cash transfers to poor women in Colombia on BMI and obesity: prospective cohort study. *Int J Obes (Lond)* 2012; **36:** 1209–14.

80 Ginsburg C, Griffiths PL, Richter LM, Norris SA. Residential mobility, socioeconomic context and body mass index in a cohort of urban South African adolescents. *Health Place* 2013; **19:** 99–107.

81 Yang ZH, Chen WL, Huang HZ, Pan CB, Li JS. Quality of life of patients with tongue cancer 1 year after surgery. *J Oral Maxillofac Surg* 2010; **68:** 2164–68.

82 Huang CC, Yabiku ST, Kronenfeld JJ. The effects of household technology on body mass index among Chinese adults. *Pop Res Pol Rev* 2015; **34:** 877–99.

83 Moradi G, Karimi K, Esmailnasab N, Roshani D. Survival of patients with stomach cancer and its determinants in Kurdistan. *Asian Pac J Cancer Prev* 2016; **17:** 3243–48.

84 Rasouli MA, Moradi G, Roshani D, Nikkhoo B, Ghaderi E, Ghaytasi B. Prognostic factors and survival of colorectal cancer in Kurdistan province, Iran: a population-based study (2009–2014). *Medicine (Baltimore)* 2017; **96:** e5941.

85 Yan H, Liu B, Meng, et al. The influence of individual socioeconomic status on the clinical outcomes in ischemic stroke patients with different neighborhood status in Shanghai, China. *Int J Med Sci* 2017; **14:** 86–96.

86 Yu Y, Sloan FA. Trends in elderly health by cohort: evidence from China. *China Econ Rev* 2017; **44:** 282–95.

87 Yeole BB, Sunny L, Swaminathan R, Sankaranarayanan R, Parkin DM. Population-based survival from colorectal cancer in Mumbai, (Bombay). *India. Eur J Cancer* 2001; **37:** 1402–08.

88 Chaturvedi N, Jarrett J, Shipley MJ, Fuller JH. Socioeconomic gradient in morbidity and mortality in people with diabetes: cohort study findings from the Whitehall Study and the WHO Multinational Study of Vascular Disease in Diabetes. *BMJ* 1998; **316:** 100–05.

89 Stronks K, van de Mheen HD, Mackenbach JP. A higher prevalence of health problems in low income groups: does it reflect relative deprivation? *J Epidemiol Community Health* 1998; **52:** 548–57.

90 Mathur C, Stigler MH, Perry CL, Arora M, Reddy KS. Differences in prevalence of tobacco use among Indian urban youth: the role of socioeconomic status. *Nicotine Tob Res* 2008; **10:** 109–16.

91 Monteiro CA, Conde WL, Popkin BM. Income-specific trends in obesity in Brazil: 1975–2003. *Am J Public Health* 2007; **97:** 1808–12.

92 Popkin BM, Paeratakul S, Ge K, Zhai F. Body weight patterns among the Chinese: results from the 1989 and 1991 China Health and Nutrition Surveys. *Am J Public Health* 1995; **85:** 690–94.