Socioeconomic status and non-communicable disease behavioural risk factors in low-income and lower-middle-income countries: a systematic review

Luke Allen, Julianne Williams, Nick Townsend, Bente Mikkelsen, Nia Roberts, Charlie Foster, Kremlin Wickramasinghe

Summary

Background Non-communicable diseases are the leading global cause of death and disproportionately affect those living in low-income and lower-middle-income countries (LLMICs). The association between socioeconomic status and non-communicable disease behavioural risk factors is well established in high-income countries, but it is not clear how behavioural risk factors are distributed within LLMICs. We aimed to systematically review evidence on the association between socioeconomic status and harmful use of alcohol, tobacco use, unhealthy diets, and physical inactivity within LLMICs.

Methods We searched 13 electronic databases, including Embase and MEDLINE, grey literature, and reference lists for primary research published between Jan 1, 1990, and June 30, 2015. We included studies from LLMICs presenting data on multiple measures of socioeconomic status and tobacco use, alcohol use, diet, and physical activity. No age or language restrictions were applied. We excluded studies that did not allow comparison between more or less advantaged groups. We used a piloted version of the Cochrane Effective Practice and Organisation of Care Group data collection checklist to extract relevant data at the household and individual level from the included full text studies including study type, methods, outcomes, and results. Due to high heterogeneity, we used a narrative approach for data synthesis. We used descriptive statistics to assess whether the prevalence of each risk factor varied significantly between members of different socioeconomic groups. The study protocol is registered with PROSPERO, number CRD42015026604.

Findings After reviewing 4242 records, 75 studies met our inclusion criteria, representing 2135 314 individuals older than 10 years from 39 LLIMCs. Low socioeconomic groups were found to have a significantly higher prevalence of tobacco and alcohol use than did high socioeconomic groups. These groups also consumed less fruit, vegetables, fish, and fibre than those of high socioeconomic status. High socioeconomic groups were found to be less physically active and consume more fats, salt, and processed food than individuals of low socioeconomic status. While the included studies presented clear patterns for tobacco and food use and physical activity, heterogeneity between dietary outcome measures and a paucity of evidence around harmful alcohol use limit the certainty of these findings.

Interpretation Despite significant heterogeneity in exposure and outcome measures, clear evidence shows that the burden of behavioural risk factors is affected by socioeconomic position within LLMICs. Governments seeking to meet Sustainable Development Goal (SDG) 3.4—reducing premature non-communicable disease mortality by a third by 2030—should leverage their development budgets to address the poverty-health nexus in these settings. Our findings also have significance for health workers serving these populations and policy makers tasked with preventing and controlling the rise of non-communicable diseases.

Funding WHO.

Copyright © 2017 World Health Organization; licensee Elsevier. This is an Open Access article published under the CC BY 3.0 IGO license which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. In any use of this article, there should be no suggestion that WHO endorses any specific organisation, products or services. The use of the WHO logo is not permitted. This notice should be preserved along with the article’s original URL.

Introduction Non-communicable diseases account for 70% of global deaths, and the disproportionate concentration of premature deaths from these diseases in lower-income countries has been described as “the social justice issue of our generation”. The Sustainable Development Goals (SDGs) include the target of reducing premature deaths from non-communicable diseases by a third over the next 15 years. The disconnect between non-communicable disease prevention, development, and poverty reduction strategies was mentioned by WHO in the first Global Action plan in 2008, with calls for improved coordination culminating in two “Non-communicable diseases and Development Cooperation” dialogues in 2015. Development agencies—mainly working with the poorest members of low-income and lower-middle-income countries—must address the social justice issue of our generation.
Articles

Research in context

Evidence before this study
We searched PubMed and Google scholar on July 28, 2015, with no language restrictions. Our search terms were a list of World Bank-defined low-income and lower-middle income countries (LLMICs); MeSH and free-text terms for tobacco use, alcohol use, diet, and physical inactivity; and socioeconomic status. Studies published before 1990 were excluded. There was a moderate risk of bias among the included studies.

From this search, we identified a 2005 non-systematic review of surveys from 11 low-income and middle-income country (LMIC) WHO subregions and a meta-analysis of studies examining tobacco use and income. These studies report higher prevalence of tobacco use (odds ratio 1.48, 95% CI 1.38–1.59) and lower alcohol use in the poorest strata of LMICs compared with more affluent groups. The most comprehensive analysis to date comes from an analysis of LMIC World Health Survey data from 2002–04. Self-reports from 232,056 participants from 48 countries—of which 25 were upper-middle-income and 23 were low-income or lower-middle-income (LMICs)—suggested that those with more education and assets were more likely to be physically inactive and consume insufficient fruit and vegetables and less likely to smoke daily. The socioeconomic patterning of heavy episodic drinking was mixed and inequalities were more pronounced in the least developed countries. The findings from this study are now 10 years old, and largely drawn from upper-middle or high-income countries.

Added value of this study
To our knowledge, this study is the first systematic review to examine the distribution of the main non-communicable behavioural risk factors across different socioeconomic groups within LMICs and the first study to report on physical activity and socioeconomic status in developing countries. This work supports ongoing efforts to link non-communicable disease prevention with the global development agenda and provides evidence for development agencies on how to engage with non-communicable diseases. Our study shows that lower socioeconomic groups are more likely to drink alcohol, use tobacco, and consume insufficient fruit and vegetables than more advantaged groups. Higher socioeconomic groups were found to be more inactive and might consume more fats, salt, and processed food. Our findings substantially augment the scant evidence from previous LMIC-based reviews on individual risk factors. With the use of broader measures of socioeconomic status, we found significant differences between castes, classes, sexes, and occupational groups with the widest differences observed across different educational strata.

Implications of all the available evidence
Combined with previous work, the association between non-communicable disease risk factors and socioeconomic status seems to be dependent on setting, population, and exposure definitions. Tobacco use seems to be almost universally more prevalent in low socioeconomic groups than in high socioeconomic groups, whereas alcohol and diet require further investigation. Our findings have importance for the development community that have a part to play in ensuring that their projects do not promote environments that promote non-communicable diseases in low-income settings. This study shows that there is a clear socioeconomic gradient of non-communicable disease risk behaviours within most LMICs. Education was strongly correlated with healthier behaviour in most settings and might be an important tool in controlling the epidemic. Other interventions should be focused on social groups that are most at risk.

income countries (LLMICs)—might be more likely to realign their activities to address non-communicable disease prevention if there was clear evidence that non-communicable diseases and their risk factors affect these populations. The distribution of diseases and risk factors between nations is well established, but little evidence for the socioeconomic distribution of risk factors within LLMICs has been published. The urgent need for disaggregated data was underlined at the 2011 UN High Level Meeting on non-communicable diseases.

Only a few studies on the intranational distribution of behavioural risk factors have been published: a 2005 non-systematic review of surveys from 11 low-income and-middle-income country (LMIC) WHO subregions and a meta-analysis of studies examining tobacco use and income. These studies report a higher prevalence of tobacco use (odds ratio [OR] 1.48, 95% CI 1.38–1.59) and lower alcohol use in the poorest strata of LMICs than in more affluent strata. The most comprehensive analysis to date comes from an analysis of LMIC World Health Survey data from 2002–04. Self-reports from 232,056 participants from 48 countries (23 of which were LMICs) suggested that those with more education and assets were more likely to be physically inactive and consume insufficient fruit and vegetables, and less likely to smoke daily, than those with a lower level of education. The socioeconomic patterning of heavy episodic drinking was mixed and inequalities were more pronounced in the least developed countries. The findings from this study are now 10 years old and largely drawn from non-LLMICs. These reviews were limited by indirect estimates of behaviour and narrow definitions of socioeconomic status.

Non-communicable diseases are the leading cause of death and individuals living in LMICs are 1.5 times more likely to die prematurely from these conditions than those living in high-income countries. With
increasing international attention being paid to the epidemic, international and intranational health inequalities, and the potential role for development agencies in combatting non-communicable diseases, it is important that we have up to date information about the socioeconomic patterning of the most important non-communicable disease risk factors in lower-income settings.

We aimed to systematically review current evidence on the association between socioeconomic status and harmful use of alcohol, tobacco use, unhealthy diets, and physical inactivity within LLMICs.

Methods

Search strategy and selection criteria

We did a systematic review following a registered protocol and PRISMA guidelines\textsuperscript{15} (appendix). We searched Embase, MEDLINE, Web of Science, Global Health, and TRoPHI for all studies that included primary data published between Jan 1, 1990, and July 30, 2015. We also searched grey literature in Digital Dissertations (Global full-text plus), WHOLIS (WHO Library), and the WHO regional databases AIM (AFRO), LILACS (AMRO/PAHO), IMEMR (EMRO), IMSEAR (SEARO), and WPRIM (WPRO). We reviewed the first 30 results from Google Scholar and searched MEDLINE In-process and other non-indexed citations, the websites of the World Bank, DFID, USAID, and WHO, and scrutinised the reference lists of included papers and contacted key authors to uncover additional or forthcoming work.

We used English search terms (appendix) but did not restrict results by language or age of participants. Records were included if they presented primary data from one or more of the 84 LLMICs, as definned by the 2013 World Bank analytic classifications\textsuperscript{16} or on one or more non-communicable behavioural risk factor (defined by WHO as tobacco use, unhealthy diet, harmful alcohol use, and physical inactivity)\textsuperscript{17} and if the data were stratified by at least one socioeconomic indicator.

To accommodate differing views, capture all relevant studies, and broaden the systematic review, we included household or individual-level data measures of income, wealth, assets, socioeconomic status, education, caste, and occupation (where categories were ordinal). We excluded studies that did not allow comparison between more or less advantaged groups. Authors were contacted for additional data where socioeconomic wealth, assets, socioeconomic status, education, caste, household or individual-level data measures of income, studies, and broaden the systematic review, we included.

We assessed data quality using a modified Newcastle-Ottawa scale,\textsuperscript{20} as recommended by the Cochrane Collaboration (appendix).\textsuperscript{21} Appropriate versions of the scoring rubric were used for randomised controlled trials, case-control studies, and cross-sectional studies. Scores were based on design-specific sources of bias, methods for selecting participants, exposure measures, outcome variables, and methods to control confounding. The source of funding was recorded for each study.

The main outcome was differences in prevalence or relative risk of non-communicable disease behavioural risk factors between different socioeconomic groups. We also planned to examine how age, sex, urban or rural location, and study quality affected findings. We assessed variability within studies in our quality scoring. This included considering the uniformity of training for those conducting the study and the instruments used to gather data. Significant heterogeneity between studies, particularly in the exposure and outcome measures precluded quantitative synthesis and meta-analysis. We used a narrative approach, grouping studies by outcome measure and WHO region. We analysed differences between outcomes, geographic regions, age groups, and sex. We also present sensitivity analyses for each risk factor having removed all medium and low-quality studies. The protocol of this study is registered with PROSPERO, number CRD42015026604. We used Excel to generate simple descriptive statistics.

Role of the funding source

An employee of the funder (BM) contributed to the study design and review of draft manuscripts. The funder did not have any involvement in data collection, data analysis, or data interpretation. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.
Results

Our literature search returned 4242 records and 106 additional records were retrieved from other sources (figure 1). Over 1000 studies were from higher-income or upper-middle-income countries. We assessed 247 full-text articles, of which 75 met our inclusion criteria. These articles covered 39 countries and presented data for 2135 314 individuals aged older than 10 years. The median sample size (individuals for whom data of interest were reported) was 1984 (range 66–471 143).

Five articles presented data for all risk factors, 41 articles reported on a single risk factor, and the remaining 29 articles reported data for two or three risk factors.

Ten different socioeconomic indicators were used (income, wealth or assets, state-defined poverty, literacy, education, occupational class, occupational status [employed or unemployed], job seniority, caste, researcher-defined socioeconomic status).

One article presented Global Adult Tobacco Survey data from two LLMICs, another reported World Health Survey data for smoking rates in 28 LLMICs, and the remaining 73 articles reported data from one country each. 44 studies were done in southeast Asian populations, with 35 pertaining to India. Data were presented for 20 African LLMICs countries, whereas the Americas and Europe had the lowest representation with two apiece. There were no data for 45 of the 84 LLMICs (figure 2).

Over half of the included studies had been published since 2010 and seven were published before 2000. 70 studies were cross-sectional, two were prospective longitudinal cohort studies, two were case control studies, and one study was a randomised controlled trial. Five studies were not peer reviewed; all were WHO STEPS surveys. Overall, 13 studies were of low quality, 33 were moderate, and 29 were of high quality, leading to a low risk of bias across studies. The most common study weaknesses were loss to follow-up and failure to control for confounding factors. Studies in African populations were more likely to be non-peer reviewed, to be of a lower quality, and have smaller sample sizes. Studies reporting data on Indian populations and tobacco use tended to be larger and of a higher quality than those for other populations and risk factors. Most studies were funded by governments, public health agencies, development agencies, and non-governmental or non-profit organisations. A summary of all high quality studies is presented in the table. Details of all included studies are available in the appendix.

29 studies from 15 countries reported measures of physical activity. Three WHO STEPS surveys

Figure 1: Study selection

Figure 2: Sources of data from low-income and lower-middle-income countries
from India, Eritrea, and Côte d’Ivoire had not been peer-reviewed, but the remaining 26 were published in peer-reviewed journals. Three studies were low quality, 18 were moderate (including the WHO surveys), and eight were of high quality. Nine studies,37,38,48,52–55,57,61 reported outcomes based on WHO recommendations and results from the International and Global Physical Activity Questionnaires,62–64 five studies used definitions derived from other sources,22,41,44,58,60 and 15 did not refer to any pre-existing definition.25,27,31,36,42,43,45–47,49–51,56,59,65 Measures of sedentary behaviour (not technically a non-communicable disease behavioural risk factor) were reported in 19 studies; high or sufficient levels of activity were reported in ten studies. All data were derived from survey instruments rather than the use of accelerometers or other devices.

There was a paucity of studies reporting adjusted results that were statistically significant; however, most studies found that individuals with a high socioeconomic status were less active than groups with a lower

<table>
<thead>
<tr>
<th>Physical activity</th>
<th>Site</th>
<th>Study design</th>
<th>Number of participants</th>
<th>Population</th>
<th>Age (years)</th>
<th>Exposure</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinra, 2010</td>
<td>India</td>
<td>Cross-sectional</td>
<td>1983</td>
<td>1600 villages in 18 states</td>
<td>20–69</td>
<td>Socioeconomic status</td>
<td>Low physical activity; &lt;1.69 MET</td>
</tr>
<tr>
<td>Gupta, 2003</td>
<td>India</td>
<td>Cross-sectional</td>
<td>573</td>
<td>General population in Jaipur</td>
<td>NA</td>
<td>Education</td>
<td>Low physical activity; &lt;30 min leisure time physical activity 3 times a week</td>
</tr>
<tr>
<td>Qanh, 2008</td>
<td>Vietnam</td>
<td>Cross-sectional</td>
<td>1776</td>
<td>STEPS survey in Ho Chi Minh</td>
<td>25–64</td>
<td>Assets/education/income</td>
<td>Low physical activity; &lt;600 MET min per week</td>
</tr>
<tr>
<td>Gupta, 2012</td>
<td>India</td>
<td>Cross-sectional</td>
<td>6198</td>
<td>Middle-class areas of 11 cities</td>
<td>18–75</td>
<td>Education/occupation/ socioeconomic status</td>
<td>Low physical activity; no regular work or leisure time physical activity</td>
</tr>
<tr>
<td>Dhungana, 2014</td>
<td>Nepal</td>
<td>Cross-sectional</td>
<td>406</td>
<td>Rural community in Sindhuli</td>
<td>20–50</td>
<td>Education/socioeconomic status</td>
<td>Low physical activity; &lt;150 minutes moderate physical activity/week</td>
</tr>
<tr>
<td>Zeba, 2014</td>
<td>Burkina Faso</td>
<td>Cross-sectional</td>
<td>330</td>
<td>Ouagadougou residents</td>
<td>25–60</td>
<td>Assets/education</td>
<td>Physical activity and sedentary time; means &gt;3 h and &lt;3 h MET, respectively</td>
</tr>
<tr>
<td>Reddy, 2007</td>
<td>India</td>
<td>Cross-sectional</td>
<td>19 969</td>
<td>Industrial workers from 10 cities</td>
<td>20–69</td>
<td>Education</td>
<td>Leisure time physical activity</td>
</tr>
<tr>
<td>Singh, 1997</td>
<td>India</td>
<td>Cross-sectional</td>
<td>1767</td>
<td>Two villages in rural north India</td>
<td>25–64</td>
<td>Socioeconomic status</td>
<td>Sedentary*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alcohol</th>
<th>Site</th>
<th>Study design</th>
<th>Number of participants</th>
<th>Population</th>
<th>Age (years)</th>
<th>Exposure</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonu, 2005</td>
<td>India</td>
<td>Cross-sectional</td>
<td>22 685</td>
<td>Inpatients from 1995 National Survey</td>
<td>&gt;10</td>
<td>Alcohol use</td>
<td>Poverty; borrowing or financial distress during hospital admission</td>
</tr>
<tr>
<td>Gupta, 2012</td>
<td>India</td>
<td>Cross-sectional</td>
<td>6198</td>
<td>Middle-class areas of 11 cities</td>
<td>18–75</td>
<td>Education/occupation/ socioeconomic status</td>
<td>Alcohol abuse</td>
</tr>
<tr>
<td>Samuel, 2012</td>
<td>India</td>
<td>Cross-sectional</td>
<td>2218</td>
<td>Rural and urban southern India</td>
<td>26–32</td>
<td>Assets/education</td>
<td>Alcohol use</td>
</tr>
<tr>
<td>Hashibe, 2003</td>
<td>India</td>
<td>Case-control</td>
<td>47 773</td>
<td>Adults in Kerala</td>
<td>&gt;35</td>
<td>Income/education/ occupation</td>
<td>Alcohol use</td>
</tr>
<tr>
<td>Neufeld, 2005</td>
<td>India</td>
<td>Cross-sectional</td>
<td>471 143</td>
<td>1995 National Sample Survey</td>
<td>&gt;10</td>
<td>Poverty/ caste/ education</td>
<td>Alcohol use; regular use of any alcoholic beverage</td>
</tr>
<tr>
<td>Kinra, 2010</td>
<td>India</td>
<td>Cross-sectional</td>
<td>1983</td>
<td>1600 villages in 18 states</td>
<td>20–69</td>
<td>Socioeconomic status</td>
<td>Alcohol use; consumed &gt;10 days per month over last 6 months</td>
</tr>
<tr>
<td>Dhungana, 2014</td>
<td>Nepal</td>
<td>Cross-sectional</td>
<td>406</td>
<td>Rural community in Sindhuli</td>
<td>20–50</td>
<td>Education/socioeconomic status/ caste</td>
<td>Alcohol use; used alcohol up to 30 days before interview</td>
</tr>
<tr>
<td>Subramanian, 2005</td>
<td>India</td>
<td>Cross-sectional</td>
<td>301 984</td>
<td>1998 National Family Health Survey</td>
<td>&gt;18</td>
<td>Assets/ caste/ education</td>
<td>Household member drinks alcohol</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diet</th>
<th>Site</th>
<th>Study design</th>
<th>Number of participants</th>
<th>Population</th>
<th>Age (years)</th>
<th>Exposure</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hashibe, 2003</td>
<td>India</td>
<td>Case-control</td>
<td>47 773</td>
<td>Adults in Kerala</td>
<td>&gt;35</td>
<td>Income/education/ occupation</td>
<td>Daily vegetables, high intake of fruit</td>
</tr>
<tr>
<td>Gupta, 2012</td>
<td>India</td>
<td>Cross-sectional</td>
<td>6198</td>
<td>Middle-class areas of 11 cities</td>
<td>18–75</td>
<td>Education/occupation/ socioeconomic status</td>
<td>Less than two servings fruit and vegetables per day, more than 20 g fat per day</td>
</tr>
<tr>
<td>Ganesan, 2012</td>
<td>India</td>
<td>Cross-sectional</td>
<td>1261</td>
<td>Urban diabetics from Chennai</td>
<td>&gt;40</td>
<td>Socioeconomic status</td>
<td>Low or high fibre diet; scored using a questionnaire</td>
</tr>
<tr>
<td>Kinra, 2010</td>
<td>India</td>
<td>Cross-sectional</td>
<td>1983</td>
<td>1600 villages in 18 states</td>
<td>20–69</td>
<td>Socioeconomic status</td>
<td>Low fruit and vegetable intake; &lt;400 g/day</td>
</tr>
<tr>
<td>Dhungana, 2014</td>
<td>Nepal</td>
<td>Cross-sectional</td>
<td>406</td>
<td>Rural community in Sindhuli</td>
<td>20–50</td>
<td>Education/socioeconomic status/ caste</td>
<td>Low fruit and vegetable intake; &lt;400 g/day</td>
</tr>
<tr>
<td>Agrawal, 2014</td>
<td>India</td>
<td>Cross-sectional</td>
<td>156 317</td>
<td>National Family Health Survey</td>
<td>20–49</td>
<td>Caste/ socioeconomic status</td>
<td>Non-vegetarian; eats meat, fish, milk, eggs, curd, dairy</td>
</tr>
<tr>
<td>Agrawal, 2014</td>
<td>India</td>
<td>Cross-sectional</td>
<td>156 317</td>
<td>National Family Health Survey</td>
<td>20–49</td>
<td>Caste/ wealth</td>
<td>Daily fish consumption</td>
</tr>
</tbody>
</table>

(Table continues on next page)
Characteristics of included high-quality studies

<table>
<thead>
<tr>
<th>Site</th>
<th>Study design</th>
<th>Number of participants</th>
<th>Population</th>
<th>Age (years)</th>
<th>Exposure</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Continued from previous page)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Tobacco**

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of participants</th>
<th>Population</th>
<th>Age (years)</th>
<th>Exposure</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhoi, 2005 India</td>
<td>Cross-sectional</td>
<td>22 685</td>
<td>Inpatients from 1995 Nat. Survey</td>
<td>&gt;10</td>
<td>Tobacco use</td>
</tr>
<tr>
<td>Hashibe, 2003 India</td>
<td>Case-control</td>
<td>47 773</td>
<td>Adults in Kerala</td>
<td>&gt;35</td>
<td>Income/education/occupation</td>
</tr>
<tr>
<td>Corsi, 2014 India</td>
<td>Cross-sectional</td>
<td>4534</td>
<td>20 villages in Andhra Pradesh</td>
<td>&gt;20</td>
<td>Income/education</td>
</tr>
<tr>
<td>Kina, 2010 India</td>
<td>Cross-sectional</td>
<td>1983</td>
<td>1600 villages in 18 states</td>
<td>20-69</td>
<td>Socioeconomic status</td>
</tr>
<tr>
<td>Neufeld, 2005 India</td>
<td>Cross-sectional</td>
<td>471 143</td>
<td>1995 National Sample Survey</td>
<td>&gt;10</td>
<td>Poverty/ caste/education</td>
</tr>
<tr>
<td>Gupta, 2003 India</td>
<td>Cross-sectional</td>
<td>573</td>
<td>General population in Jaipur</td>
<td>NA</td>
<td>Education</td>
</tr>
<tr>
<td>Singh, 2000 India</td>
<td>Cross-sectional</td>
<td>1767</td>
<td>Two villages in rural north India</td>
<td>25-64</td>
<td>Socioeconomic status</td>
</tr>
<tr>
<td>Gupta, 2012 India</td>
<td>Cross-sectional</td>
<td>6198</td>
<td>Middle-class areas of 11 cities</td>
<td>18-75</td>
<td>Education/occupation/ socioeconomic status</td>
</tr>
<tr>
<td>Reddy, 2007 India</td>
<td>Cross-sectional</td>
<td>19 969</td>
<td>Industrial workers from 10 cities</td>
<td>20-69</td>
<td>Education</td>
</tr>
<tr>
<td>Singh, 2007 India</td>
<td>Cross-sectional</td>
<td>2222</td>
<td>Residents of Morabadab</td>
<td>25-64</td>
<td>Socioeconomic status</td>
</tr>
<tr>
<td>Samuel, 2012 India</td>
<td>Cross-sectional</td>
<td>2218</td>
<td>Rural and urban southern India</td>
<td>26-32</td>
<td>Assets/education</td>
</tr>
<tr>
<td>Gupta, 2015 India</td>
<td>Cross-sectional</td>
<td>6198</td>
<td>Middle-class areas of 11 cities</td>
<td>&gt;20</td>
<td>Education</td>
</tr>
<tr>
<td>Narayan, 1996 India</td>
<td>Cross-sectional</td>
<td>13 558</td>
<td>Residents of Delhi</td>
<td>25-64</td>
<td>Education/occupation</td>
</tr>
<tr>
<td>Rani, 2003 India</td>
<td>Cross-sectional</td>
<td>334 553</td>
<td>1998 National Family Health Survey</td>
<td>&gt;15</td>
<td>Wealth/education/ caste</td>
</tr>
<tr>
<td>Heck, 2012 Bangladesh</td>
<td>Cross-sectional</td>
<td>19 934</td>
<td>Married Bangladeshi adults</td>
<td>18-75</td>
<td>Education</td>
</tr>
<tr>
<td>Dhunga, 2014 Nepal</td>
<td>Cross-sectional</td>
<td>406</td>
<td>Rural community in Sindhuli</td>
<td>20-50</td>
<td>Education/ socioeconomic status/ caste</td>
</tr>
<tr>
<td>Bovet, 2002 Tanzania</td>
<td>Cross-sectional</td>
<td>9254</td>
<td>Residents of Dar es Salaam</td>
<td>25-64</td>
<td>Wealth/education</td>
</tr>
<tr>
<td>Tomstad, 2012 Cambodia</td>
<td>Cross-sectional</td>
<td>5592</td>
<td>2006 National Tobacco Survey</td>
<td>&gt;18</td>
<td>Education/ income/ occupation</td>
</tr>
<tr>
<td>Ali, 2006 Pakistan</td>
<td>Cross-sectional</td>
<td>411</td>
<td>Men from rural Sindh province</td>
<td>&gt;18</td>
<td>Education/ Income</td>
</tr>
<tr>
<td>Hosseinpoor, 2012 28 LLMICs</td>
<td>Cross-sectional</td>
<td>213 807</td>
<td>2003 World Health Survey</td>
<td>&gt;18</td>
<td>Socioeconomic status</td>
</tr>
<tr>
<td>Jena, 2012 India</td>
<td>Cross-sectional</td>
<td>69 296</td>
<td>2009 Global Tobacco Survey data</td>
<td>&gt;15</td>
<td>Occupation/education</td>
</tr>
<tr>
<td>Kishore, 2013 India, Thailand, and Bangladesh</td>
<td>Cross-sectional</td>
<td>92 491</td>
<td>2009 Global Adult Tobacco Survey</td>
<td>&gt;15</td>
<td>Education</td>
</tr>
</tbody>
</table>

**Notes:** MET = Metabolic Equivalent of Task. LLMIC = low-income and lower-middle-income countries. *Walks less than 14.5 km, less than 20 flights of stairs, or does no moderate activity 5 days per week. †Hardcore smoker is defined as someone who currently smokes daily, with no quit attempt in last 12 months or whose last quit was for less than 24 h; no intention to quit in next 12 months or not interested in quitting first smoke within 30 min of waking, and who has knowledge of harms. High-quality survey findings and findings for physical activity, alcohol, diet, and tobacco are in the appendix.

**Table: Characteristics of included high-quality studies**

Most participants were aged 15–65 years old. Studies that excluded people aged over 60 years, or those younger than 30 years, still found that higher socioeconomic groups were the least active. The eight high-quality physical activity studies corroborate these findings. Single studies from the capital cities of Vietnam and Burkina Faso found that wealthy and educated individuals were the least active. The six papers from India and Bangladesh showed that higher socioeconomic status was associated with lower levels of physical activity in rural settings, and this association was reversed in urban settings. None of these studies controlled for occupation; however, Reddy and colleagues examined physical activity in 20 000 industrial workers and found...
that those with primary or no education were eight times less active than the most educated workers in their leisure-time (p=0.001). This study did not account for other important sources of physical activity including commuting, employment, or housework.

24 studies from ten countries reported measures of alcohol use.\(^{25,27,28,31,32,34–36,38–41,43,45,47,52,66–73}\) Three studies were graded as low quality (including the only randomised controlled trial), 13 were moderate, and eight were of high quality, including the only case-control study. Four studies reported prevalence of harmful alcohol use, defined in terms of the frequency and volume of alcohol consumed.\(^{35,40,41,69}\) The remaining 18 reported measures of any alcohol use as the outcome variable. There was reasonable agreement between the various socioeconomic proxies; none of the studies that used multiple exposure measures found conflicting assessments.

One study found that alcohol users were more likely to experience impoverishment than non-users but this association was not statistically significant.\(^{40}\) Overall, low-income uneducated groups in rural areas were the most likely to engage in harmful drinking behaviour. The widest differences were observed between different educational groups; smaller gaps were observed when comparing income strata.

Analysing the findings by region, alcohol use—while not necessarily at harmful levels—was most prevalent in low-income and less-educated groups across India,\(^{34,38,40,45,52,66}\) and in the solitary study from the Americas.\(^{77}\) Prevalence of alcohol use tended to be higher in more affluent and well educated Africans;\(^{25,27,28,31,35}\) however, most of these studies were published in the 1990s\(^{25,27,28}\) and sample sizes were in the hundreds for all but one study—a randomised controlled trial graded as low quality.\(^{73}\) No studies from Europe, the eastern Mediterranean, or western Pacific regions were published. All five studies that reported results by sex found men to drink more than women;\(^{31,27,41,67,70}\) however, inequalities were often more pronounced between women. The smaller numbers of women in these studies rendered many of these findings not significant.

Six of the eight high-quality studies assessed alcohol use rather than harmful use of alcohol.\(^{27,31,34,38,40,45}\) The largest differences were observed between members of different castes and educational groups. Gupta and colleagues\(^{40}\) assessed (undefined) alcohol abuse in middle-class urban Indians, finding minor differences between educational and self-assessed socioeconomic tertiles. Individuals in middle occupational classes had double the rate of alcohol abuse compared with the lowest occupational class (10·8% vs 5·1%); however, no measures of significance were presented.\(^{40}\)

26 papers from 11 countries reported on eight different aspects of diet.\(^{24,27,29,30,34,36,40,41,45,52,66,67,70–73}\) There was one case-control study\(^{40}\) and the remainder were cross-sectional. Four studies were low quality, 14 were moderate, and eight were of high quality. Six studies, from Pakistan,\(^{43}\) India,\(^{38,40,43}\) and Nigeria\(^ {42}\) found higher consumption of unhealthy fats in individuals of high socioeconomic status. Two studies examining salt intake found a higher prevalence in high-income households in Chennai\(^{17}\) and non-significant differences in a low quality multisite Indian survey.\(^{41}\) Two higher quality African studies found that the individuals of high socioeconomic status were more likely to consume diets high in processed foods.\(^{36,38}\)

Studies from Indonesia, Syria, Nepal, Benin, Eritrea, and Nigeria all found lower fruit and vegetable intake in less affluent and less educated groups.\(^{16,30,32,40,72,75}\) These studies tended to present results that were either significant but unadjusted or adjusted but not significant; only two studies presented significant adjusted findings.\(^{38,39}\) Six larger and higher quality studies from India predominantly found lower fruit and vegetable intake in groups of lower socioeconomic status.\(^{14,16,41,45,52,65}\)

One high-quality survey of low fibre intake found a low socioeconomic status preponderance\(^{26}\) and three large Indian studies found less affluent groups to consume the least fish and most meat.\(^{66,77}\) There was good agreement between different poverty markers; all but two studies that used more than one measure found that similar groups were identified as consuming the least healthy diet.\(^{41,45}\) Women were found to consume less fruit and vegetables than men in two Indian studies.\(^{41,45}\) Four other studies reporting dietary findings by sex found non-significant differences.\(^{34,35,45,48}\) In 320 elderly residents of Baroda city, India, men consumed twice as much fat as women.\(^{30}\)

When we examined the effect of age on these dietary findings, we found that studies examining older populations came to the same conclusions as other studies examining the same dietary component.\(^{29,34,40,79,80}\) One cross-sectional study examining cholesterol intake in Pakistani schoolchildren found the highest consumption in boys and girls from the highest socioeconomic group.\(^ {44}\) After removing all medium and low-quality studies, five high-quality studies suggest that high socioeconomic groups consume more fat, fish, fibre, and fruit and vegetables than lower socioeconomic groups in southeast Asia.\(^{34,41,45,52,77}\) The remaining small cross-sectional study in Burkina Faso\(^ {46}\) found that those with the most education and assets were twice as likely to consume an unhealthy diet (high in fat and sugar, low in fibre, plant protein, and complex carbohydrates) as those with the lowest education and assets.

50 studies reported data for tobacco use in 39 countries (appendix), almost twice the number of studies examining other risk factors.\(^{23,25,28,31,32,34–36,38–40,42–47,49–52,68,77,79,80}\) Eight studies were low quality, 18 were moderate, and 23 were of high quality—a much higher proportion than for other risk factors. 33 studies reported smoking
Low income, caste, and socioeconomic status were associated with a tobacco use prevalence roughly twice that of high-status groups. Overall, low socioeconomic groups in most of the LLMICs in which evidence was available were more likely to use tobacco and alcohol, and to consume less fruit, vegetables, fish, and fibre, and more meat than high socioeconomic groups. High socioeconomic status tended to have higher levels of physical inactivity and consume more fats, salt, and processed foods than low socioeconomic groups (figure 3).

The finding that low socioeconomic groups were more likely to use tobacco than high socioeconomic groups was the same in every geographical region. Studies that examined older populations came to the same conclusions. The remaining 49 studies found tobacco use, in all forms, to be more prevalent in low socioeconomic groups than in high socioeconomic groups (figure 3) and consumed more fats, salt, and processed food. 

Discussion
This systematic review identifies broad trends in global behavioural risk factors for non-communicable diseases, finding that low socioeconomic groups in many countries are more likely to drink alcohol, use tobacco, and consume insufficient fruit and vegetables than are high socioeconomic groups. High socioeconomic groups tend to be more inactive and consume more fats, salt, and processed food. 

This systematic review is the first to examine the socioeconomic distribution of all four major behavioural risk factors within LLMICs. Our findings substantially augment the scant evidence from previous LLMIC-based reviews on individual risk factors; Ciapponi and colleagues showed a significant income gradient for tobacco use but their focus on income only excluded many of the studies included in our systematic review. With the use of a broad range of socioeconomic indicators, we found significant differences between castes, classes, sexes, and occupational groups with the widest differences observed across educational strata. Our tobacco findings mirror the well-established inequalities from high-income countries, where low-income groups are the most likely to smoke, start
smoking earlier, consume more tobacco, quit less successfully, experience more adverse health effects, and die at a younger age than affluent groups.\textsuperscript{102–105} The last study to examine socioeconomic status and tobacco in LMICs was performed by Blakely and colleagues in 2005.\textsuperscript{11} They found that low-income groups from 11 LMIC WHO subregions had a marginally higher prevalence of tobacco use and lower use of alcohol than did higher-income groups.\textsuperscript{8} Most studies included in our systematic review used direct surveys, whereas Blakely and colleagues relied on estimates of consumption derived from household economic data.\textsuperscript{11} Evidence summarised in the Global Alcohol Report also suggests that abstinence is more common in low-income groups and that alcohol-related harm is more prevalent in low socioeconomic groups than in high-income groups; however, these data are mainly drawn from high-income countries.\textsuperscript{106,107} Our findings suggest that alcohol use and harmful alcohol use tend to be most prevalent in low socioeconomic groups. We note that data for harmful alcohol use were lacking from 79 of 84 LMICs and the few existing African studies are of low quality. There is an urgent need to quantify the burden of risky alcohol use in LMICs.

Our dietary findings complement studies from high-income countries that have consistently found a positive association between socioeconomic status and consumption of fruit, vegetables, fibre, and fish.\textsuperscript{108–114} Whereas low socioeconomic status groups in high-income settings tend to consume higher levels of salt and processed food,\textsuperscript{111,112} we found the opposite in LMICs, but there was a conspicuous absence of studies on salt intake given the impact of this dietary risk factor.\textsuperscript{8} Our findings corroborate those of Mayén and colleagues\textsuperscript{112} who found higher consumption of all foods except fibre in high socioeconomic status groups in their systematic review of dietary patterns in LMICs; however, three quarters of their included studies were from upper-middle-income countries.

Our finding that rural high socioeconomic status groups tend to be the most physically inactive departs from the experience of high-income countries.\textsuperscript{115–118} A possible explanation is that rural low socioeconomic status groups tend to work in physically demanding occupations in LMICs.\textsuperscript{110} In cities, this association was reversed and evidence from China suggests that low socioeconomic status migrants take up less physically demanding jobs when they move to cities.\textsuperscript{122} If cities truly attenuate the socioeconomic gradient in occupational activity, then leisure-time physical activity might be proportionally more important as an explanatory variable. Reddy and colleagues found that higher socioeconomic status Indian groups engaged in more leisure-time physical activity than low socioeconomic status groups in urban areas.\textsuperscript{12} A large systematic review from mainly high-income countries has shown that leisure activity is associated with larger health gains than occupational activity.\textsuperscript{123} Our findings highlight the need for more research in LMICs to explore the health effects of various domains of physical activity on different socioeconomic groups in rural and urban settings.

This systematic review was done in line with PRISMA and Cochrane guidance, following a registered protocol and assessing risk of bias using well established criteria. The bidirectional association between socioeconomic status and health is widely averred but infrequently assessed within LMICs.\textsuperscript{11,114–119} To our knowledge, this is the first systematic review to explore intranational socioeconomic patterning of behavioural risk factors in these countries and the first study to report that increasing wealth and education are associated with physical inactivity and increasing consumption of fats, salt, and processed food in a number of LMICs. Our work demonstrates important associations and emphasises the importance of context; trends vary by region, sex, urbanicity, and exposure. Most included studies were moderate to high quality and almost invariably used a cross-sectional, survey-based approach.

Our method was designed to capture all studies on socioeconomic status and non-communicable disease behavioural risk factors. As a result, our findings are extremely heterogeneous and require careful interpretation. We treated the highest and lowest groupings of each exposure (eg, education, income, or social class) as if they were interchangeable even though each study tended to use a unique definition, cutoff, and study population. This allowed us to identify broad trends for future research to examine in detail; however, it meant that our findings should not be seen as definitive. The large amount of data also prevented us from presenting deep analysis of each risk factor in this systematic review; however, our comprehensive data extraction and presentation of all original data and subgroup descriptors in the appendix allows further study to build upon this initial global assessment. The heterogeneity in outcome measures for each risk factor limits the ability of any systematic review to synthesise findings clearly, and the surfeit of smoking and alcohol definitions is especially noteworthy given the relative homogeneity of the products. A further source of bias was a dependence on survey instruments rather than objective measurements to establish tobacco use, alcohol use, diet, and physical activity between the studies. Survey responses are not very reliable and socioeconomic differences in recall bias might affect observed gradients in behaviour.

Use of the 2013 World Bank classification of income excluded countries that have only recently been reclassified as upper-middle-income; however, our focus on countries that are currently low-income enhances the usefulness of this systematic review as development agencies are moving away from upper-middle-income settings.\textsuperscript{124} Because of resource constraints, we were unable to perform a duplicate screen and data extraction.
for every record. Our high levels of agreement at each stage, including perfect agreement in triple-checked data extraction samples, provide reassurance that this systematic review includes all relevant data.

In view of the broad scope of this systematic review, the fact that over half of the countries classed as low-income or lower-middle-income were not represented in our search results is striking. Almost half of the included studies relate to India, and the evidence from the Americas, the eastern Mediterranean, and Europe is relatively scant. The fact that so many LLMICs were not represented is a major finding, but also a weakness in itself; the excellent evidence from India is not generalisable to all low socioeconomic groups in LLMICs and research is needed to explore whether the patterns we identify hold true in countries where surveillance is non-existent.

Of the 47 publicly available LLMIC-based WHO STEPS surveys,13 only five present behavioural risk factors stratified by any marker of socioeconomic status.35–39 All STEPS reports should make these routinely collected data publicly available.

Our findings provide an overview of the current evidence, underlining intranational trends and data gaps. Policy makers and national development agencies working in the countries where 82% of premature deaths occur should review the evidence relevant to their setting and consider whether their current non-communicable disease prevention strategies are appropriate. Where low socioeconomic status correlates with non-communicable disease risk factors, governments can use development funds to simultaneously improve literacy, living standards, and income alongside health. The definitions used to identify behavioural risk factors are inconsistent, and data are not available for most LLMICs. Rectification of these issues, with surveillance reporting risk factors stratified by socioeconomic status, is an obvious research priority. Nevertheless, this should not delay action in the countries where data exist.

Contributors BM, KW, and NT conceived the research project, coordinated the contributors, and revised drafts of the manuscript. LA selected the studies, designed and executed the analyses, interpreted the findings, wrote the first draft, revised subsequent drafts, and prepared the manuscript. JW, NT, and KW contributed to analysis design, study selection, data extraction, and data analysis. CF revised drafts of the report and contributed to the data analysis. NR developed the search strategy, searched the databases, and contributed to the revision of subsequent drafts.

Declaration of interests
We declare no competing interests. The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions, or policies of the institutions with which they are affiliated.

Acknowledgments
This study was funded and commissioned by WHO. NT (grant number 006/P&C/CORE/2013/OXFSTATS), KW (grant number 006/P&C/CORE/2013/OXFSTATS), and CF (006/PSS/CORE/2016/OXFORD) received funding from the British Heart Foundation. JW is a DPhil student receiving funding from the Nuffield Department of Population Health, University of Oxford. NR is employed by the Bodleian Health Care Libraries.

References


80 Nwamah JU, Otojiro GTO. Fruit and vegetable consumption pattern and health challenges of elderly (≥ 60 years) staff in the University of Nigeria, Nsukka and Enugu campuses: a case study. Pak J Nutr 2014; 13: 626–30.


