American Journal of Epidemiology

Vol. 186, No. 6
DOI: 10.1093/aje/kwx045
Advance Access publication:
August 21, 2017

Practice of Epidemiology

Comparison of Health Examination Survey Methods in Brazil, Chile, Colombia, Mexico, England, Scotland, and the United States

Jennifer S. Mindell*, Alison Moody, Andres I. Vecino-Ortiz, Tania Alfaro, Patricia Frenz, Shaun Scholes, Silvia A. Gonzalez, Paula Margozzini, Cesar de Oliveira, Luz Maria Sanchez Romero, Andres Alvarado, Sebastián Cabrera, Olga L. Sarmiento, Camilo A. Triana, and Simón Barquera

* Correspondence to Dr. Jennifer S. Mindell, 1-19 Torrington Place, Department of Epidemiology and Public Health, University College London, London, WC1E 6BT, United Kingdom (e-mail: j.mindell@ucl.ac.uk).

Initially submitted April 1, 2016; accepted for publication October 14, 2016.

Comparability of population surveys across countries is key to appraising trends in population health. Achieving this requires deep understanding of the methods used in these surveys to examine the extent to which the measurements are comparable. In this study, we obtained detailed protocols of 8 nationally representative surveys from 2007–2013 from Brazil, Chile, Colombia, Mexico, the United Kingdom (England and Scotland), and the United States—countries that that differ in economic and inequity indicators. Data were collected on sampling frame, sample selection procedures, recruitment, data collection methods, content of interview and examination modules, and measurement protocols. We also assessed their adherence to the World Health Organization's "STEPwise Approach to Surveillance" framework for population health surveys. The surveys, which included half a million participants, were highly comparable on sampling methodology, survey questions, and anthropometric measurements. Heterogeneity was found for physical activity questionnaires and biological samples collection. The common age range included by the surveys was adults aged 18–64 years. The methods used in these surveys were similar enough to enable comparative analyses of the data across the 7 countries. This comparability is crucial in assessing and comparing national and subgroup population health, and to assisting the transfer of research and policy knowledge across countries.

epidemiologic measurements; Great Britain; health status indicators; health surveys; Mexico; population surveillance; South America; United States

Abbreviations: ENS, Encuesta Nacional de Salud; ENSANUT, Encuesta Nacional de Salud y Nutrición; ENSIN, Encuesta Nacional de Situación Nutricional; HSE, Health Survey for England; NCD, noncommunicable disease; NHANES, National Health and Nutrition Examination Survey; PNS, Pesquisa Nacional de Saúde; SHeS, Scottish Health Survey; STEPS, STEPwise Approach to Surveillance; WHO, World Health Organization.

Chronic noncommunicable diseases (NCDs) are a growing problem worldwide (1), affecting low- and middle-income countries as well as more affluent countries. There is increasing political commitment globally to improvement of the treatment and prevention of NCDs (2, 3). However, data based on health-service use or users ignore those not accessing health care, for diverse reasons, and data from health interview surveys ignore those with undiagnosed disease—millions of individuals in developing countries. Administrative data fails to represent those with undiagnosed disease and limits the ability to design, implement, and monitor timely policies and interventions to prevent, detect, or manage such diseases. For example, almost half the cases of diabetes identified by the health examination survey (through blood tests) in Mexico in 2006 were undiagnosed (4).

Interview-based data can also mislead. For example, self-reported weight is often underestimated and height overestimated (5) to a variable extent (6–11). Self-perception of obesity

category also varies (12, 13). These inaccuracies limit the capacity to design, implement, and monitor timely policies and interventions to prevent, detect, and manage NCDs and their risk factors.

Health examination surveys collect self-reported data through interview or questionnaire and also take physical and biological measurements, such as anthropometry, blood pressure, and blood sugar levels. These enable more accurate estimation of population prevalence and severity of diseases such as hypertension or diabetes, including undiagnosed disease (14–17). Evidence from Mexico, the United Kingdom, and the United States show that data from examination surveys are used by policy-makers to identify health problems and aid decision-making (18–21); this is a legal requirement in Chile. Given the importance of socioeconomic, geographical, and ethnic inequalities in mortality and morbidity (22–24), health examination surveys also permit more accurate understanding of inequalities in disease prevalence, detection, and management, including health-care use (5, 25). These surveys are significantly more expensive to run than interview surveys, although the cost of running one health examination survey was estimated to be 0.03% of health and social care costs and 0.01% of societal costs for the main diseases monitored by the survey (S. Morris, University College London, London, personal communication, 2016).

Comparisons across countries or regions of the world are increasingly used to benchmark services and learn from the experiences of others. For example, Brazil considers evaluations by 3 of the most established health technology assessment agencies in the world—National Institute for Health and Care Excellence in the United Kingdom (NICE), Canadian Agency for Drugs and Technologies in Health (CADTH), and Australia's health ministry—as part of their own assessment (26).

Such comparisons can also be used to assess the extent to which differences in disease prevalence between areas is amenable to changes in socioeconomic conditions and/or health or other policy interventions (27). Early comparisons were hampered by using dissimilar data sources (28). More useful data are obtained from studies designed at the outset to collect data in a uniform way. Examples include the Health, Alcohol and Psychosocial Factors in Eastern Europe (HAPIEE) study (29), and the World Health Organization (WHO) Monitoring of Trends and Determinants in Cardiovascular Disease (MONICA) Project (30). However, neither collected nationally representative data.

Increasing numbers of countries are introducing nationally representative, general-population health examination surveys. Many are learning from other countries' experiences (31). Funding coordinating centers allows common protocols to be developed and shared, as with the WHO's Study of Ageing Populations (32), the WHO's STEPwise Approach to Surveillance (STEPS) program (33), or the European Union–funded European Health Examination Survey pilot (34).

Surveys set up independently may still be sufficiently comparable to allow policy-relevant cross-national data analyses. Comparisons of sampling, recruitment, and participation across the more established national examination surveys in European countries demonstrated comparability in many aspects but differences in eligibility, definitions of response rates in country-specific reports, and, particularly, a dichotomy of location for data collection: Field staff in England and Scotland visit potential participants in their own homes, but participants in continental Europe are invited to attend a central examination center (35).

This paper provides descriptions of the methods used by 5 health examination surveys of the general population in 4 Latin American countries (Brazil, Chile, Colombia, and Mexico) and 3 long-established surveys—the National Health and Nutrition Examination Survey (NHANES) in the United States and the Health Survey for England (HSE) and Scottish Health Survey (SHeS) in the United Kingdom—and compares them with the WHO STEPS approach. The 4 Latin American countries have conducted at least 2 nationally representative health examination surveys (Chile, Colombia, and Mexico) or are conducting a second one (Brazil). By describing the methods they have used, this paper brings them to the attention of an English-speaking audience. Comparisons have been made with NHANES in the United States, both due to its "gold standard" reputation for health examination surveys and because it is Latin America's nearest neighbor (36). The second national examination survey included as a comparator is the HSE (37). The HSE started in 1991 and is larger than NHANES, although with fewer measurements made. The Scottish Health Survey, started in 1995, has used similar methods for data collection as its counterpart in England. Like these 2 UK surveys, the Latin American surveys collect data only at participants' homes. We examine sample selection, recruitment of participants, data collection methods, and examination protocols and compare these with the WHO's standardized protocols for STEPS. This will enable policy-makers and practitioners to better understand the sources of data on the prevalence and severity of diagnosed and undiagnosed disease in these countries and the extent to which such data are comparable. This is the first paper from the Encuestas de Salud de las Americas y el Reino Unido (ESARU) network of health examination survey researchers from the Americas and the United Kingdom.

METHODS

Most of the 7 countries had more than one health examination survey in a series that had changed little in methods over the last decade. We compared the most recently completed survey in each country, except in Colombia where 2 different health examination surveys had collected different measurements. We obtained information on the following health examination surveys, from published reports and through discussion with survey staff:

- Pesquisa Nacional de Saúde (PNS), 2013, Brazil (38)
- Encuesta Nacional de Salud (ENS), 2009–10, Chile (39, 40)
- ENS, 2007, Colombia (41)
- Encuesta Nacional de la Situación Nutricional en Colombia (ENSIN), 2010, Colombia (42)
- Encuesta National de Salud y Nutrición (ENSANUT), 2012, Mexico (43)
- HSE, 2013, England (37, 44)
- SHeS, 2008–2011, Scotland (45, 46)
- NHANES, 2011–2012, United States (36)

Information was collected on sampling frame, sample selection procedures, recruitment, data collection methods, and content of interview and examination modules, using the WHO STEPS protocol as the framework (34). The detailed protocols for biophysical measurements (height, weight, waist and hip circumference, blood pressure, and biological samples) were obtained and compared. Web Appendix 1 (available at https://academic.oup.com/aje) provides information on where the questionnaires and protocols for these surveys can be obtained.

RESULTS

Sample design, target population, participant recruitment, and response rates

Table 1 provides health-relevant information about the 7 countries. Table 2 shows the target population and inclusion and exclusion criteria in the 8 surveys. All the surveys had a target population of the free-living (noninstitutionalized) general population. In the United States, military personnel were excluded. All the surveys included the WHO STEPS target age group of 25–64 years; only ENS in Colombia had an upper age limit, but the minimum age for eligibility varied among the surveys. In each survey, those who could not speak the majority/official language of that country were ineligible, and no survey excluded them from the sampling frame.

All surveys used multistage probability sampling. The number of sampling stages and number of individuals selected per household varied between surveys (Table 2 and Web Table 1). In the Brazilian and Chilean surveys, 1 individual was selected per household; in the Colombian ENS, 2 were selected if there were more than 4 eligible individuals in the household. In Mexico, 1 individual from each of 4 age groups plus 1 or 2 recent users of health services were selected, and in the United States, individuals were randomly selected to fill quotas by sex, age, ethnicity, and income. In the Colombian ENSIN and the English and Scottish surveys, all adults (maximum of 10) in the selected household were invited to participate. All surveys used a Kish grid to select specific participants at random where more eligible individuals were present.

Each survey stratified the primary sampling units at the first sampling stage, mainly geographically or by level of urbanization. In England, Scotland, and in both Colombian surveys, stratification also included socioeconomic indicators. Clustering of the sample (to reduce fieldwork costs) was used in each country except Scotland, which was clustered geographically within each year in 2008–2011 but was not clustered over the fixed 4-year period. No clusters were overlapping.

Details of each stage are provided in Web Table 1, including the nature and number of the sampling units and the stratification variables. Each survey selected at least 100 primary sampling units, above the 50–100 minimum recommended by the STEPS protocols.

Probability-proportional-to-size sampling for the primary sampling units (in which the probability of selection into the survey sample for each cluster is proportional to its

Table 1. Health-Relevant Characteristics of 7 Countries in the Americas and the United Kingdom

Country	Area, km^2	Population Aged ≥18 Years (Year)	Gini Coefficient (2012)[a]	Income Level[b]	GNI per Capita[a,c]	Population Living on Less Than $1.25/Day PPP, %[c]	Population Living on Less Than $4/Day PPP, %[c]	Population Living in Urban Areas, 2014, %	Life Expectancy at Birth, years[b]		Dying Aged 30–70 Years From Main 4 NCDs[b]	NCDs as % of All Deaths	Health-Care Coverage, %[d]
									Men	Women			
Brazil	8,538,000	135,000,000 (2013)	0.49	Upper middle	11,760	3.8	23.8	84.6	71.3	78.6	19	74	100[e]
Chile	756,000	13,600,000 (2015)	0.51	High	14,900	0.8	9.9	89.2	77.1	82.7	12	84	97[f]
Colombia	1,142,000	32,700,000 (2015)	0.54	Upper middle	7,780	5.6	32.8	75.3	72.3	78.9	12	71	94[g]
Mexico	1,944,000	79,500,000 (2014)	0.48	Upper middle	9,980	1.0	23.7	78.1	71.7	77.4	16	77	87[f]
England	130,427	42,700,000 (2014)	0.36[h]	High	42,690[h]			79.6[h]	78.9	82.7	12[h]	89[h]	100[f]
Scotland	78,772	4,300,000 (2014)		High					77.1	81.1			100[f]
United States	9,147,000	245,000,000 (2015)	0.41	High	55,200			82.4	76.4	81.2	14	88	85[f]

Abbreviations: GNI, gross national income; NCD, noncommunicable disease; PPP, purchasing power parity.
[a] Data from the World Bank (67).
[b] Data from the World Health Organization (1).
[c] Current US dollars, Atlas method, 2014.
[d] Total coverage includes public, social security, private, and other systems.
[e] Data from the Brazilian Portal da Saúde (68).
[f] Data from the Organisation for Economic Co-operation and Development (69).
[g] Data from the Colombia Health Observatory (Asi Vamos En Salud) (70).
[h] Figure is for the United Kingdom.

Table 2. The Target Population in 8 National Health Examination Surveys in the Americas and the United Kingdom, 2007–2013

Protocol	Survey Year	Age Range of Surveyed, years	No. of Stages	Sampling of Individuals	Excluded From Sample	Other Exclusion Criteria
WHO STEPS standard	N/A	25–64	N/A	No. of individuals selected	N/A	N/A
Brazil, PNS	2013	≥18	3	One resident aged ≥18 years randomly selected among eligible residents	Age <18 years	Uninhabited private household, noncontact, and refusal
Chile, ENS	2009–2010	≥15	4	One resident aged ≥15 years randomly selected among eligible residents of selected households; double probability for aged ≥65 years	Age <15 years	Pregnant women; people with violent behavior; people who do not speak Spanish
Colombia, ENSIN	2010	0–64	4	All individuals of interest in the household	Age >65 years	Only for anthropometric measurements: women who had given birth in the 3 months preceding the survey
Colombia, ENS	2007	0–69	4	Aged <18 years: all individuals of interest in the household. Aged 18–69 years: 1 randomly selected if <4 individuals aged 18–69 years at the household; 2 randomly selected if ≥4 residents aged 18–69 years	Age >69 years	Absence at time of the interview due to work or study
Mexico, ENSANUT	2012	All	4	If possible, 1 individual from each of: children <5 years; children 5–9 years; adolescents; adults; and 1 or 2 health services users	Uninhabited private household	Absence at time of the interview
England, HSE[a]	2013	All	3	All adults (maximum of 10) at selected address	Business or institutions[b], vacant buildings, demolished buildings, building still being built	Lack of mental capacity to give informed consent; people who do not speak English
Scotland, SHeS[a]	2008–2011	All	3	All adults (maximum of 10) at selected address	Business or institutions[b], vacant buildings, demolished buildings, building still being built	Lack of mental capacity to give informed consent; unable to speak English
United States, NHANES[a]	2011–2012	All	4	A subsample of individuals selected based on sex, age, race and Hispanic origin, and income	Deadwood (not a residential address); institutionalized individual military personnel and citizens living outside the United States	Failure to provide written consent treated as a refusal to participate

Abbreviations: ENS, Encuesta Nacional de Salud; ENSANUT, Encuesta Nacional de Salud y Nutrición; ENSIN, Encuesta Nacional de Situación Nutricional; HSE, Health Survey for England; N/A, not applicable; NHANES, National Health And Nutrition Examination Survey; PNS, Pesquisa Nacional de Saúde; SHeS, Scottish Health Survey; STEPS, STEPwise Approach to Surveillance; WHO, World Health Organization.

[a] These surveys have been run repeatedly, and the methods have changed little. Results in this table are for the most recent year, as an example.

[b] Residents living in institutions (e.g., prisons, residential or nursing care, student halls of residence) were excluded, for practical reasons.

relative size) was used by each survey. Deliberate oversampling was employed in some surveys to ensure adequate sample size for subgroup analysis—for example, by region (England), urbanity/rurality (Chile), or population subgroup (Chile, Mexico, and the United States). In these cases, sample selection weights were calculated for data analysis to facilitate reconstruction of population estimates from sample estimates.

No survey used replacement for dealing with nonresponse, conforming with the WHO STEPS recommendation. Each survey excluded addresses that were not occupied private homes, residents in institutions, and persons not in the target population.

Web Table 2 compares recruitment methods and data collection methods in the surveys. All surveys included face-to-face recruitment on the doorstep; some also sent an information letter before the field worker visited. In the United States, health examinations took place in mobile examination centers, with doctors, nurses, and phlebotomists. In the other studies, health examinations were carried out by nurses in the participants' homes.

Achieved survey size ranged from approximately 5,400 individuals interviewed in Chile to >160,000 in each Colombian survey. Web Table 2 details the response rates to each major survey stage, where available: interview, height and weight measurement, blood pressure measurement, and taking blood samples. Generally, around 80% of households cooperated, but response rates for biophysical measurements were markedly lower, especially for blood samples, with a high heterogeneity of the blood sample response rate from 33% in Scotland to 91% in Chile.

Research ethics approval

For each survey, the relevant institutional or national ethics review board approved the survey, and free and informed consent of the participants (or, for children, their legal guardians) was obtained.

Questionnaire information collected

Demographic data. Age and sex were universally captured. Ethnic group or indigenous background was collected in each country other than Chile, using the relevant categories for the country.

Socioeconomic data. Household income was collected in all surveys except in Colombia. Educational level was collected in all surveys.

Health status. Each survey included a measure of self-rated general health. All but Colombia's ENSIN survey asked about doctor-diagnosed chronic illnesses, including diabetes, hypertension, heart attack, angina, and stroke. Some, but differing, information on medication use was collected in each survey except ENSIN in Colombia.

Lifestyle factors were considered by all studies, including directly comparable smoking status (current, former, or never smokers) for all except ENSIN. Information about alcohol intake was measured by all surveys but ENSIN, although with a variety of questions, including drinking frequency, heaviest drinking day in the last week or month, and total weekly or monthly consumption. Chile and the United States used the Global Physical Activity Questionnaire, as recommended by STEPS, while Colombia ENSIN, Mexico, and England used the International Physical Activity Questionnaire. Diet (most commonly fruit and vegetable intake) was recorded across all surveys, but the information was not directly comparable as some surveys used short modules (e.g., food frequency questionnaires) and others used 24-hour recall.

Web Table 3 lists in more detail the items proposed by STEPS for core and extended modules of questions and what each country's most recent health examination survey collected in relation to these.

Health examination measurements

The major examination measurements were more comparable across the surveys than interview measures (Web Table 4 compares the surveys' protocols with those specified by STEPS; this is summarized in Table 3).

Height and weight were measured and body mass index calculated in all surveys. In all countries, shoes were removed, and the head was positioned in the Frankfort plane for height. In Chile, a straight wall (without skirting board) and set square were used to make the height measurement, but all other countries used a stadiometer. Heavy clothing was taken off for weight.

Waist circumference was measured in all surveys except Colombia ENS, with the same protocol in each country (horizontal measurement midway between lowest rib and iliac crest). Chile included an additional measurement over the iliac crest to assess inter-observer variability for waist measurement quality control.

Hip measurement (at the widest part) was also taken in Brazil, Mexico, England, and Scotland. The Brazil, England, and Scotland protocols mandated 2 readings unless they were >3 cm different. If so, a third measurement was taken; the mean of the closer 2 measurements was used.

Blood pressure was measured in all countries but not all surveys; it was not measured in ENSIN in Colombia. Measurements were taken by a nurse in the participants' home except in the United States, where a doctor carried out the measurement in a mobile examination center. Electronic sphygmomanometers were used in Brazil, Chile, Colombia, England, and Scotland, a mercury sphygmomanometer was used in the United States, and both were used in Mexico, where a validation exercise was conducted to compare the measurements. Brazil, Mexico, England, and Scotland used the same device; Chile and Colombia used different devices from the same manufacturer. Most countries used a range of cuff sizes, but Colombia used only a standard adult cuff. In all countries, participants were seated for 5 minutes before the measurement was taken. Other restrictions varied (Web Table 4). Colombia had the most stringent exclusion criteria. One measurement was taken in Colombia (ENS); 2 in Mexico, and 3 (STEPS protocol) in the other countries. These measurements were restricted to 08.00–11.00 in Chile (mean = 09.00), but not in other surveys.

In Brazil, Mexico, and Colombia ENS, only a random subsample of participants was eligible for biological sampling. Venous blood samples were taken in each survey (by nurses or phlebotomists) except in Colombia, where microbiologists collected capillary samples for ENS; no blood samples

Table 3. Summary of Comparison of National Surveys in the Americas and the United Kingdom With WHO STEPS Examination Protocols, 2007–2013

Survey Country	Conformance to Core WHO STEPS Measurements According to Local Protocol[a]					
	Height	Weight	Waist	Blood Pressure	Fasting Blood Glucose	Total Cholesterol
Brazil	Yes	Yes	Yes	Yes	Glycated hemoglobin	Yes
Chile	Differs	Yes	Yes	Used left arm	Yes	Yes
Colombia (ENSIN)	Yes	Yes	Yes	Not done	No blood sample	No blood sample
Colombia (ENS)	Yes	Yes	Not Done	Yes	Capillary blood	Yes
Mexico	Yes	Yes	Yes	<3 measurements	Yes	Yes
England	Yes	Yes	Yes	Yes	Glycated hemoglobin	Yes
Scotland	Yes	Yes	Yes	Yes	Glycated hemoglobin	Yes
United States	Yes	Yes	Yes	Yes	Yes	Yes

Abbreviations: ENS, Encuesta Nacional de Salud; ENSIN, Encuesta Nacional de Situación Nutricional; STEPS, STEPwise Approach to Surveillance; WHO, World Health Organization.

[a] Yes indicates the WHO STEPS protocol was followed.

for cholesterol or glycemia were collected in ENSIN. All countries analyzed the samples for markers of diabetes (glycated hemoglobin and/or fasting glucose) and total and high-density lipoprotein cholesterol. Blood samples were taken fasting in Colombia ENS, Chile, Mexico, and the United States; they were nonfasting and at any time of the day in Brazil, England, and Scotland. Other analyses varied by survey and/or survey year.

Urine samples were taken in Brazil, Chile, England, Scotland, and the United States. Sodium was measured in all countries but the United States, as was creatinine to standardize the sample volume. Less commonly analyzed were albumin, potassium, various minerals, or markers of sexually transmitted diseases.

Other biophysical measurements were taken less commonly. Additional anthropometric measures were taken in Chile, England, Scotland, and the United States. Lung function was measured through spirometry (England, Scotland, and the United States). Saliva samples were taken in England and Scotland to test for cotinine (a marker of tobacco exposure). Oral and vaginal swabs were taken in the United States (for human papilloma virus).

Linkage to other data

Participants in England, Scotland, and the United States were asked for permission to link their survey data to mortality data. In England and Scotland, permission was also sought for linkage to national cancer registry and hospital admissions data. In Chile and Brazil, linkage of survey data to mortality data is requested from national authorities, not participants.

DISCUSSION

We used the WHO STEPwise Approach to Surveillance program to conduct a systematic assessment of the design methods of 8 population surveys in 7 countries. Overall, survey questionnaires and anthropometric measurements were highly comparable, with minor differences across surveys. Less overlap was found when comparing measurements that used biological samples.

Sample selection: key similarities and differences

All the assessed surveys were nationally representative of the noninstitutionalized general population of speakers of that country's main language. Each survey had a multistage probability sampling design. Oversampling was undertaken in 3 surveys to enable subgroup analysis, but each provided sample selection weights to ensure national analyses would be representative. The number of individuals selected in each household varied across surveys, but the details and rationale were well described for each. The common age range for all surveys was 18–64 years of age, exceeding the WHO STEPS minimum (25–64 years of age). Face-to-face recruitment was used in all surveys, and biophysical measurements were carried out by health professionals in the participants' own home, except in the United States, where the measurements were conducted in mobile examination centers. This contrasts with a comparison of methods of nationally representative health examination surveys in Europe, in which participants were invited to central examination centers in 5 of the 6 countries studied (35).

Response rates varied considerably, particularly for blood samples, but were consistently higher in Latin America than in most European health examination surveys, where survey response rates have been falling (35). Some of the factors affecting response rates to health examination surveys have been discussed elsewhere (35). There is reasonable evidence that pursuing higher response rates tends to recruit more people like those who have already taken part. Adjustment for nonresponse reduces bias more than additional expensive attempts to increase recruitment beyond what can be achieved with a usual degree of effort (47).

Measurement protocols: key similarities and differences

Country-specific protocols for survey questionnaires and anthropometric measurements showed good agreement with

the STEPS protocol. Comparable equipment and protocols were used for waist circumference in all surveys; only Chile differed from STEPS for height and weight. In Chile, measurement variability was 60% less using a wall and set square than a stadiometer, and it reduced costs (P. Margozzini, Pontificia Universidad Católica de Chile, Santiago, personal communication, 2016).

Measurement of blood pressure differed in fine detail, but the protocols, exclusions, and ranges of cuff size used in most surveys were similar enough to enable cross-country data comparison with reasonable confidence. In Chile, blood pressure was measured in the left rather than the right arm, so systolic blood pressure in Chile may be underestimated by an average of 1.8 mm Hg, and diastolic blood pressure overestimated minimally (48). Taking 3 measurements (not done in Colombia or Mexico) is important: Mean systolic pressure and hypertension prevalence are lower (by 0.5 mm Hg and 1%, respectively) after incorporating a third measurement (49).

In the United States and Mexico, blood pressure was measured using a mercury sphygmomanometer; in the other countries, an electronic device was used. Although 3 different machines were used, 4 countries used the same model, the Omron HEM-907 (Omron Healthcare, Inc., Bannockburn, Illinois), and all devices were from the same manufacturer. Validation of the Omron HEM-907 following an international protocol found mean systolic blood pressure 0.1 (standard deviation, 5.1) mm Hg higher and diastolic 1.9 (standard deviation, 4.2) mm Hg lower than mercury sphygmomanometer readings in older people (50). A one-third subsample in Mexico had measurements taken by both the electronic device and a mercury sphygmomanometer. They found the electronic devices recorded slightly higher systolic and slightly lower diastolic blood pressures, but hypertension prevalence was not affected (S. Barquera, Instituto Nacional de Salud Pública, Mexico City, personal communication, 2016). Another study found no difference in systolic, and lower diastolic, pressures with nonclinical staff using electronic devices compared with health-care staff using mercury devices (51). We recommend that any future study comparing blood pressure and hypertension data across countries use that internal comparability data to determine what adjustments, if any, are required to ensure comparability of data measured with mercury or electronic sphygmomanometers.

More heterogeneity was seen when comparing the collection of biological samples. Venous blood samples were taken from all surveys except Colombia. Capillary samples were collected in Colombia ENS. Blood samples were taken fasting in the surveys in Chile, Mexico, Colombia, and the United States but nonfasting and at any time of day in Brazil, England, and Scotland; this affects comparability of blood lipids and glucose but not of glycated hemoglobin, which reflects long-term glycemia. Additional biophysical measurements varied across surveys.

For detecting undiagnosed diabetes, fasting capillary glucose samples would be directly comparable with each other but not with the fasting venous blood glucose samples. However, venous blood samples can underestimate glucose levels unless the correct anticoagulant is supplemented with an inhibitor to prevent red blood cells from metabolizing the glucose while in transit to the laboratory. This was not a problem in the United States, where blood samples were processed immediately. This is also not a problem with glycated hemoglobin (HbA_{1c}) measurement, which has the additional advantages of not requiring a fasting sample because of measuring longer-term glycemic control. However, it is much more expensive to measure. Hence, fasting plasma glucose has been standard in large population surveys in low- and middle-income countries because of budget constraints. Now that measurement of glycated hemoglobin has been standardized internationally, there is an agreed definition of diabetes using glycated hemoglobin (52). Thus the prevalence of undiagnosed diabetes can be compared across the different studies with reasonable confidence, using the relevant definitions, although the extent of poor control of diagnosed diabetes cannot.

The focus of our study was primarily the examination elements of the surveys. However, comparability of self-reported cardiovascular risk factors is also important. Regarding physical activity instruments, the Global Physical Activity Questionnaire was used in Chile and the United States; the International Physical Activity Questionnaire was used in Colombia and Scotland. The Global Physical Activity Questionnaire and International Physical Activity Questionnaire have been compared in multiple countries and found to have moderately strong concurrent validity (53), although activity is overestimated when compared with accelerometry (54). Use of different instruments would generally enable identification of inactive individuals, although categorization of other participants into more or less active may be inconsistent (55). The travel module of both the Global Physical Activity Questionnaire and International Physical Activity Questionnaire would allow comparison of data in Chile, Colombia, Scotland, and United States (56).

Recommendations for future population surveys

Despite the expense, a number of countries now have national examination surveys of health. Pan-European collaborations have demonstrated that the desire to conduct nationally representative health examination surveys exists in most countries, and that despite the constraints of limited resources, the number of countries who are developing, piloting, and conducting full-size examination surveys is increasing (e.g., Portugal, Luxembourg, Serbia) (57). Since 1998, Korea has run an annual survey similar to NHANES, in which participants attend a mobile examination center (58). There are also national health examination surveys in Canada (since 2007–2009) (59), Australia (60), and New Zealand (61). The last of these started as a health interview survey. Since 2002–2003, elements of an examination survey have been added gradually, following the WHO STEPS approach of measuring height and weight, then adding blood pressure, and most recently taking biological samples (54). Other countries, such as the Philippines, have national nutrition surveys that include biochemical and anthropometry measurements but not blood pressure and other physical measurements. The lack of an up-to-date global register makes it difficult to identify all such studies; the WHO database of STEPS surveys addresses this issue for low- and middle-income countries (62).

Comparable population surveys are essential to keep measurements consistent over time and to evaluate the health status of the population and specific population subgroups. Further,

they allow cross-country comparison of data, with the potential advantage of enabling knowledge transfer on effective programs and policy decisions across countries (63). By building comparable data sources, researchers and policy-makers can learn from other countries' experiences about what works best, set common benchmarks for preventing chronic conditions and risk factors, determine rates of undiagnosed chronic conditions, and perform comparative risk-assessment studies (64). Given the aging population worldwide, including in low- and middle-income countries, and the increase in incidence of NCDs with age, we recommend an increase to the STEPS-recommended minimum upper age limit, where NCDs and their risk factors are the focus. Collecting more socioeconomic information will also enable assessment of within-country inequalities, important for realization of post-2015 sustainable development goals (65).

STEPS is an outstanding tool to standardize population-level health examination surveys across countries. Yet our results indicate that it is imperative to improve the guidance on chronic disease surveillance and standardization of collecting data on risk factors (both for well-recognized problems, such as tobacco use and alcohol consumption, and emerging problems, such as sugar-sweetened beverages) and to improve indicators for effective coverage. This will also help to study changes in the food systems (nutrition transition) associated with chronic diseases. These goals can be accomplished by building capacities through international networks (66), by enhancing a commitment to standardization of surveys and by facilitating funding for collective field work technology investment and sharing. Where we have demonstrated sufficient comparability in data, the Encuestas de Salud de las Americas y el Reino Unido consortium intends to compare prevalence of risk factors and NCDs across countries and time, to enhance understanding and inform policy-making.

ACKNOWLEDGMENTS

Author affiliations: Research Department of Epidemiology and Public Health, Institute of Epidemiology and Health Care, Faculty of Public Health Sciences, University College London, London, United Kingdom (Jennifer S. Mindell, Alison Moody, Shaun Scholes, Cesar de Oliveira, Luz Maria Sanchez Romero); Department of International Health, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Maryland (Andres I. Vecino-Ortiz); Escuela de Salud Pública, Facultad de Medicina, Universidad de Chile, Santiago, Chile (Tania Alfaro, Patricia Frenz); Facultad de Medicina, Universidad de los Andes, Bogotá, Colombia (Silvia A. Gonzalez; Andres Alvarado; Olga L. Sarmiento; Camilo A. Triana; Andres I. Vecino-Ortiz); Departamento de Salud Pública, Facultad de Medicina, Pontificia Universidad Católica de Chile, Santiago, Chile (Paula Margozzini); Facultad de Medicina, Universidad de Chile, Santiago, Chile (Sebastián Cabrera); Clínica Dávila, Santiago, Chile (Sebastián Cabrera); and Centro de Investigación en Nutrición y Salud, Instituto Nacional de Salud Pública de Mexico, Cuernavaca, Mexico (Luz Maria Sanchez Romero, Simón Barquera).

This study was partially funded by a Santander Research Catalyst Grant from UCL to enable J.S.M. and S.S. to attend a 2-day workshop in Santiago to work on the study, but this study was not otherwise funded. J.S.M., A.M., and S.S. are funded in part by the NHS Digital to work on the Health Survey for England. C.d.O. is funded by the National Institute on Aging and a consortium of UK government departments to work on the English Longitudinal Study of Ageing (ELSA). L.M.S.R. was funded by a PhD studentship from the National Council on Science and Technology of Mexico (CONACYT) PhD scholarship (reference 217523). O.L.S., S.G., and A.I.V. were funded by the Research Office at the Universidad de los Andes. C.T. was funded by the grant for young researchers from Colciencias.

We thank the Chilean Ministry of Health for organizing and funding a seminar to explore similarities and differences between many of the surveys presented in this paper, We also thank the participants in, the field staff for, and the funders and commissioners of the 8 surveys, including the Ministries and other government agencies of the countries that commissioned these surveys.

The results and opinions expressed in this paper are the sole responsibility of the authors. Neither any of these funders nor the Ministries and other government agencies of the countries that commissioned these surveys, were involved with this study or with this manuscript, including the decision to undertake this study, data collection and interpretation, writing the paper, or the decision to submit it for publication. The authors affirm they have not entered into an agreement with any of the funders that may have limited their ability to complete the research as planned. The authors further affirm that they have had full control of all primary data.

J.S.M. and S.S. report grants from University College London, funded by Santander, during the conduct of the study. J.S.M., S.S., and A.M. report grants from the Health and Social Care Information Centre, outside the submitted work. The other authors report no conflicts.

REFERENCES

1. World Health Organization. Noncommunicable diseases country profiles 2014. http://ww.who.int/nmh/publications/ncd-profiles-2014/en/. Published July, 2014. Accessed September 19, 2016.
2. NCD Alliance. *NCD Alliance Strategic Plan 2016–2020*. https://ncdalliance.org/sites/default/files/resource_files/NCDA_StrategicPlan16-20_EN.pdf. Published January, 2016. Accessed September 19, 2016.
3. United Nations General Assembly. Resolution adopted by the General Assembly. A/66/L.1. Political declaration of the High-Level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. http://www.un.org/ga/search/view_doc.asp?symbol=A/66/L.1. Published September 16, 2011. Accessed September 19, 2016.
4. Barquera S, Campos-Nonato I, Aguilar-Salinas C, et al. Diabetes in Mexico: cost and management of diabetes and its

complications and challenges for health policy. *Global Health*. 2013;9:3.
5. Moody A. Adult anthropometric measures, overweight and obesity. In: Craig R, Mindell J, eds. *Health Survey for England 2012*. Leeds, United Kingdom: Health and Social Care Information Centre, 2013:289–327.
6. Großschädl F, Haditsch B, Stronegger WJ. Validity of self-reported weight and height in Austrian adults: sociodemographic determinants and consequences for the classification of BMI categories. *Public Health Nutr*. 2012; 15(1):20–27.
7. Villanueva EV. The validity of self-reported weight in US adults: a population based cross-sectional study. *BMC Public Health*. 2001;1:11.
8. Conde WL, Oliveira DR, Borges CA, et al. Consistência entre medidas antropométricas em inquéritos nacionais [Consistency between anthropometric measures in national surveys]. *Rev Saude Publica*. 2013;47(1):69–76.
9. Díaz-García J, González-Zapata LI, Estrada-Restrepo A. Comparación entre variables antropométricas auto reportadas y mediciones reales [Comparison between self-reported anthropometric variables and real measurement data]. *Arch Latinoam Nutr*. 2012;62(2):112–118.
10. Shiely F, Hayes K, Perry IJ, et al. Height and weight bias: the influence of time. *PLoS One*. 2013;8(1):e54386.
11. Hattori A, Sturm R. The obesity epidemic and changes in self-report biases in BMI. *Obesity (Silver Spring)*. 2013;21(4): 856–860.
12. Valdiva G, Margozzini P. Encuestas Nacionales de Salud: un ejemplo de instrumentos esenciales para contribuir al diseño de políticas de salud [National Health Surveys: an example of essential instruments that contribute to the design of health policies]. *Persona Soc*. 2012;26(1):147–174.
13. Kaufer-Horwitz M, Martinez J, Goti-Rodriguez LM, et al. Association between measured BMI and self-perceived body size in Mexican adults. *Ann Hum Biol*. 2006;33(5–6): 536–545.
14. Tolonen H, Koponen P, Mindell J, et al. Under-estimation of obesity, hypertension and high cholesterol by self-reported data. Comparison of self-reported information and objective measures from health examination surveys. *Eur J Public Health*. 2014;24(6):941–948.
15. Falaschetti E, Mindell J, Knott C, et al. Hypertension management in England: a serial cross-sectional study from 1994 to 2011. *Lancet*. 2014;383(9932):1912–1919.
16. Vecino-Ortiz AI, Trujillo AJ, Ruiz F. Undetected diabetes in Colombia. *Int J Public Pol*. 2012;8(4–6):362–373.
17. Cabrera S, Alvo M, Mindell JS, et al. La Encuesta Nacional de Salud de Chile entrega información valiosa para planificación de políticas de salud. Análisis de Nefropatía Diabética como indicador de ahorro potencial [The National Health Survey of Chile gives useful information to health policy planning: Analysis of Diabetic Nephropathy as an index of potential saving]. *Rev Med Chil*. 2015;143(5):679–681.
18. Charvel S, Cobo F, Hernández-Ávila M. A process to establish nutritional guidelines to address obesity: lessons from Mexico. *J Public Health Policy*. 2015;36(4):426–439.
19. Oyebode O, Mindell J. Use of data from the Health Survey for England in obesity policy making and monitoring. *Obes Rev*. 2013;14(6):463–476.
20. Oyebode O, Mindell JS. A review of the use of health examination data from the Health Survey for England in government policy development and implementation. *Arch Public Health*. 2014;72(1):24–32.
21. Woteki CE, National Health and Nutrition Examination Survey. Integrated NHANES: uses in national policy. *J Nutr*. 2003;133(2):582S–584S.
22. Barquera S, Pedroza-Tobias A, Medina C, et al. Global overview of the epidemiology of atherosclerotic cardiovascular disease. *Arch Med Res*. 2015;46(5): 328–338.
23. Mújica OJ, Vázquez E, Duarte EC, et al. Socioeconomic inequalities and mortality trends in BRICS, 1990–2010. *Bull World Health Organ*. 2014;92(6):405–412.
24. Commission on Social Determinants of Health, Marmot M (Chair). Closing the gap in a generation. Health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health. Geneva, Switzerland: World Health Organization; 2008. http://www.who.int/social_determinants/thecommission/finalreport/en/. Accessed September 19, 2016.
25. Ministerio de Salud, División de Planificación Sanitaria, Departamento de Epidemiología. Encuesta Nacional de Salud. Chile 2009–2010. Tomo 1. Resumen ejecutivo y equipo de trabajo [National Health Survey. Chile 2009–10. Volume 1. Executive summary and work team]. Santiago, Chile: Ministerio de Salud, Gobierno de Chile; 2011. http://web.minsal.cl/portal/url/item/bcb03d7bc28b64dfe040010165012d23.pdf. Accessed September 19, 2015.
26. Keeton W. BRICS seek value for money as health-care costs rise. *Bull World Health Organ*. 2014;92(6):392–393.
27. Antikainen RL, Moltchanov VA, Chukwuma C, et al. Trends in the prevalence, awareness, treatment and control of hypertension: the WHO MONICA Project. *Eur J Cardiovasc Prev Rehabil*. 2006;13(1):13–29.
28. Gray L, Merlo J, Mindell J, et al. International differences in self-reported health measures in 33 major metropolitan areas in Europe. *Eur J Public Health*. 2012;22(1):40–47.
29. Peasey A, Bobak M, Kubinova R, et al. Determinants of cardiovascular disease and other non-communicable diseases in Central and Eastern Europe: rationale and design of the HAPIEE study. *BMC Public Health*. 2006; 6(1):255.
30. Tunstall-Pedoe H, World Health Organization. MONICA Project. MONICA, monograph, and multimedia sourcebook: world's largest study of heart disease, stroke, risk factors, and population trends 1979–2002. Geneva, Switzerland: World Health Organization; 2003.
31. Kuulasmaa K, Tolonen H, Koponen P, et al. An overview of the European Health Examination Survey Pilot Joint Action. *Arch Public Health*. 2012;70(1):20–24.
32. World Health Organization. *WHO Study on Global AGEing and Adult Health (SAGE) Survey Manual*. http://www.who.int/healthinfo/survey/SAGESurveyManualFinal.pdf?ua=1. Published 2006. Accessed September 19, 2016.
33. World Health Organization. *STEPS Manual*. http://www.who.int/chp/steps/Part2.pdf?ua=1. Updated November 14, 2008. Accessed September 19, 2016.
34. Tolonen H, Koponen P, Mindell J, et al. European Health Examination Survey—towards a sustainable monitoring system. *Eur J Public Health*. 2014;24(2):338–344.
35. Mindell JS, Giampaoli S, Goesswald A, et al. Sample selection, recruitment and participation rates in health examination surveys in Europe—experience from seven national surveys. *BMC Med Res Methodol*. 2015;15(1):78.
36. Johnson CL, Dohrmann SM, Burt VL, et al. National Health and Nutrition Examination Survey: sample design, 2011–2014. *Vital Health Stat*. 2014;2(162):1–25.

37. Mindell J, Biddulph JP, Hirani V, et al. Cohort profile: the health survey for England. *Int J Epidemiol*. 2012;41(6):1585–1593.
38. Landman Szwarcwald, C. Pesquisa Nacional de Saúde [National Health Survey]. http://www.pns.icict.fiocruz.br/index.php?pag=principal. Accessed September 19, 2016.
39. Ministerio de Salud, División de Planificación Sanitaria, Departamento de Epidemiología. *Encuesta Nacional de Salud ENS Chile 2009–2010. III. Metodologia* [National Health Survey ENS Chile 2009–2010. Methodology]. Santiago, Chile: MINSAL; 2010. http://epi.minsal.cl/wp-content/uploads/2016/08/ENS_2009-2010_CAP3_-Metodologi%CC%81a.pdf. Accessed September 20, 2016. Spanish.
40. Departamento de Epidemiología. *Encuesta Nacional de Salud (ENS). Cuestionarios* [National Health Survey. Questionnaires]. Santiago, Chile: Ministerio de Salud, Gobierno de Chile; 2012. http://epi.minsal.cl/cuestionarios-ens/. Accessed September 20, 2016.
41. Rodríguez J, Ruiz F, Peñaloza E, et al. *Encuesta Nacional de Salud 2007. Resultados Nacionales* [National Health Survey 2007. National results]. Bogotá, Colombia: República de Ministerio de la Protección Social; 2009. https://www.minsalud.gov.co/Documentos%20y%20Publicaciones/ENCUESTA%20NACIONAL.pdf. Published January, 2009. Accessed September 20, 2016.
42. Instituto Colombiano de Bienestar Familiar ICBF. *Encuesta Nacional de la Situación Nutricional en Colombia 2010* [National Survey of the Nutritional Situation in Colombia 2010]. Bogotá, Colombia: Instituto Colombiano de Bienestar Familiar ICBF; 2010. http://www.javeriana.edu.co/documents/245769/3025871/Resumen_Ejecutivo_ENSIN_2010.pdf/160e9856-006d-4a60-9da3-d71606703609. Accessed September 20, 2016.
43. Instituto Nacional de Salud Pública. ENSANUT. Encuesta Nacional de Salud y Nutrición 2012 [ENSANUT. National Survey of Health and Nutrition 2012]. http://ensanut.insp.mx/informes.php. Accessed September 20, 2016.
44. Craig R, Mindell J, eds. *Health Survey for England 2013*. Leeds, United Kingdom: The NHS Information Centre; 2014.
45. Gray L, Batty GD, Craig P, et al. Cohort profile: the Scottish Health Surveys cohort: linkage of study participants to routinely collected records for mortality, hospital discharge, cancer and offspring birth characteristics in three nationwide studies. *Int J Epidemiol*. 2010;39(2):345–350.
46. Rutherford L, Sharp C, Bromley C, eds. Scottish Health Survey 2011: Volume 3—Technical Report. Edinburgh, United Kingdom: The Scottish Government; 2012. http://www.gov.scot/Publications/2012/09/8038. Published September 12, 2012. Accessed September 20, 2016.
47. Hall J, Brown V, Nicolaas G, et al. Extended field efforts to reduce the risk of non-response bias: have the effects changed over time? Can weighting achieve the same effects? *Bull Methodol Sociol*. 2013;117(1):5–25.
48. Lane D, Beevers M, Barnes N, et al. Inter-arm differences in blood pressure: when are they clinically significant? *J Hypertens*. 2002;20(6):1089–1095.
49. Montero J, Mansilla C, Margozzini P. Efecto de la incorporación de registros adicionales a la presión arterial en la Encuesta Nacional de Salud, Chile 2010 [Effects of incorporating additional blood pressure measurements during The National Health Survey in Chile]. *Rev Med Chil*. 2016;144(3):285–290.
50. Omboni S, Riva I, Giglio A, et al. Validation of the Omron M5-I, R5-I and HEM-907 automated blood pressure monitors in elderly individuals according to the International Protocol of the European Society of Hypertension. *Blood Press Monit*. 2007;12(4):233–242.
51. Reidpath DD, Ling ML, Yasin S, et al. Community-based blood pressure measurement by non-health workers using electronic devices: a validation study. *Glob Health Action*. 2012;5:14876.
52. The International Expert Committee. International Expert Committee report on the role of the A_{1c} assay in the diagnosis of diabetes. *Diabetes Care*. 2009;32(7):1327–1334.
53. Bull FC, Maslin TS, Armstrong T. Global physical activity questionnaire (GPAQ): nine country reliability and validity study. *J Phys Act Health*. 2009;6(6):790–804.
54. Leppe J, Margozzini P, Villarroel L, et al. Validity of the global physical activity questionnaire in the National Health Survey—Chile 2009–10. *J Sci Med Sport*. 2012;15(S1):S297.
55. Scholes S, Bridges S, Ng Fat L, et al. Comparison of the Physical Activity and Sedentary Behaviour Assessment Questionnaire and the Short-form International Physical Activity Questionnaire: an analysis of Health Survey for England data. *PLoS One*. 2016;11(3):e0151647.
56. Hallal PC, Gomez LF, Parra DC, et al. Lessons learned after 10 years of IPAQ use in Brazil and Colombia. *J Phys Act Health*. 2010;7(suppl 2):S259–S264.
57. Kuulasmaa K, Tolonen H, Koponen P, et al. An overview of the European Health Examination Survey Pilot Joint Action. *Arch Public Health*. 2012;70(1):20.
58. Kweon S, Kim Y, Jang MJ, et al. Data resource profile: the Korea National Health and Nutrition Examination Survey (KNHANES). *Int J Epidemiol*. 2014;43(1):69–77.
59. Health Canada. Canadian Health Measures Survey. https://www.canada.ca/en/health-canada/services/environmental-workplace-health/environmental-contaminants/human-biomonitoring-environmental-chemicals/canadian-health-measures-survey.html. Accessed September 20, 2016.
60. Australian Bureau of Statistics. Australian Health Measures Survey. http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/2DBC984324181B26CA257B82001791AA?opendocument. Accessed September 20, 2016.
61. Ministry of Health. Content Guide 2014/15: The New Zealand Health Survey. http://www.health.govt.nz/publication/questionnaires-and-content-guide-2014-15-new-zealand-health-survey. Published December 10, 2015. Accessed September 20, 2016.
62. World Health Organization. STEPS Country Reports. http://www.who.int/chp/steps/reports/en/. Accessed September 20, 2016.
63. Murray CJ. Towards good practice for health statistics: lessons from the Millennium Development Goal health indicators. *Lancet*. 2007:369(9564):862–873.
64. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380(9859):2224–2260.
65. Hosseinpoor AR, Bergen N, Magar V. Monitoring inequality: an emerging priority for health post-2015. *Bull World Health Organ*. 2015;93(9):591–591A.
66. Kumanyika S. INFORMAS (International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support): summary and future directions. *Obes Rev*. 2013;14(suppl 1):157–164.
67. World Bank. Country and economy factsheets. http://data.worldbank.org/country/. Accessed September 22, 2016.
68. Ministério da Saúde do Brasil. Portal da Saúde. Brasília, Brasil. http://portalsaude.saude.gov.br/index.php/cidadao/entenda-o-sus. Accessed July 26, 2016.

69. Organisation for Economic Co-operation and Development. Coverage for healthcare (chapter), Society at a glance 2014. Paris, France: OECD Publishing; 2014. http://www.oecd-ilibrary.org/social-issues-migration-health/society-at-a-glance-2014/coverage-for-health-care_soc_glance-2014-26-en. Accessed September 20, 2016.

70. Colombia Health Observatory (Así Vamos En Salud). *Atención Primaria de Salud: avances y retos en Colombia)*. [Annual Report 2014: Progress and Challenges of Primary Health Care]. Bogotá: Colombia Health Observatory; 2014. http://www.fsfb.org.co/sites/default/files/Tendencias%20de%20la%20salud%20-%20informe%20anual%202014.pdf. Accessed October 3, 2016.