Comparison of health examination survey methods in Brazil, Chile, Colombia, Mexico, England, Scotland and the USA

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Abstract

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 paper, we obtained detailed protocols of eight nationally representative surveys in seven countries from Latin America, the United Kingdom and the United States of America 2007-2013 that differ in economic and inequity indicators. Data on sampling frame, sample selection procedures, recruitment, data collection methods, content of interview and examination modules, and measurement protocols were collected. We also assessed their adherence to the WHO 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 each survey was adults aged 18 to 64 years old. The methods used in these surveys were similar enough to enable comparative analyses of the data across the seven countries. This

is crucial in assessing and comparing national and subgroup population health, and to assisting the transfer of research and policy knowledge across countries.

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STEPS (WHO Stepwise approach to Surveillance)

WHO (World Health Organization)

HES (Health Examination Survey)

NCD (Non-communicable disease)

Introduction

Chronic non-communicable 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 improve treatment and prevention of NCDs.(2,3) However, data based on health service use or users ignore those not accessing healthcare, for diverse reasons; 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.(6,7,8,9,10,11) 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.(14,15,16,17) Evidence from Mexico, the UK and the USA show that data from examination surveys are used by policy-makers to identify health problems and aid decision-making(18,19,20,21); this is a legal requirement in Chile. Given the importance of socioeconomic, geographical and ethnic inequalities in mortality and morbidity,(22,23,24) health examination surveys also permit more accurate understanding of inequalities in disease prevalence, detection, and management, including healthcare use.(5,25) These surveys are significantly more expensive to run than interview surveys, although the cost of running one health examination survey was 0.03% of health and social care costs and 0.01% of societal costs for the main diseases monitored by the survey (S Morris, personal communication).

Comparisons across countries or regions of the world are increasingly used to benchmark services and learn from others' experiences. For example, Brazil considers evaluations by three of the most established health technology assessment agencies in the world: National Institute for Health and Care Excellence in the UK (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' experience.(31) Funding co-ordinating centers allows common protocols to be developed and shared, such as the WHO's Study of AGEing Populations,(32) the WHO's *STEPwise approach to risk factor 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: fieldstaff 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 five general population health examination surveys in four Latin American countries (Brazil, Chile, Colombia, and Mexico) and three long-established surveys – the National Health And Nutrition Examination Survey (NHANES) in the USA and the Health Survey for England (HSE) and Scottish Health Survey (SHeS) in the UK – and compares them with the WHO STEPS approach. Four Latin

American countries have conducted at least two 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 USA, both due to its 'gold standard' reputation for health examination surveys and because of being Latin America's nearest neighbor.(36) The second national examination survey included as a comparator is the Health Survey for England.(37) This started in 1991 and is larger than NHANES, though 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 two UK surveys, the Latin American surveys collect data only at participants' home. 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 understand better 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 UK.

<Insert Abbreviated Table 1 around here>

Methods

Surveys

Most of the seven countries had more than one health examination survey in a series that changed little in methods over the last decade. We compared the most recent completed survey in each country, except in Colombia where two 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)

Encuesta Nacional de Salud (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)

Health Survey for England (HSE) 2013, England(37,44)

Scottish Health Survey (SHeS) 2008-2011, Scotland(45,46)

National Health And Nutrition Examination Survey (NHANES) 2011-12, USA(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.(33) 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 http://aje.oxfordjournals.org/) 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 seven countries. Table 2 shows the target population and inclusion and exclusion criteria in the eight surveys. All the surveys had a target population of the free-living (non-institutionalized) general population. In the USA, military personnel were excluded. All the surveys included the WHO STEPS target age-group of 25-64y; only ENS from 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 but no survey excluded them from the sampling frame.

<*Insert Table 2 around here*>

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 2). In the Brazilian and Chilean surveys, only one individual was selected per household; in the Colombian ENS, two were selected if there were more than four eligible individuals in the household. In Mexico, one individual from each of four age groups plus one or two recent users of health services were selected, while in the USA, 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 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 geographical or by level of urbanization. In England, Scotland, and both Colombian surveys, stratification also included socio-economic indicators. Clustering of the sample (to reduce fieldwork costs) was used in each country except Scotland, which was clustered geographically within each year 2008-2011 but was not clustered over the fixed four-year period. No clusters were overlapping.
Details of each stage are provided in Web Table 2, 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 (where the probability of selection into the survey sample for each cluster is proportional to its 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), urban/rurality (Chile), or population subgroup (Chile, Mexico, USA). 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 non-response, conforming with the WHO STEPS recommendation. Each survey excluded addresses that were not occupied private homes; and residents in institutions; and persons not in the target population.

Web table 3 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 fieldworker visited. In the USA, 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' home.

Achieved survey size ranged from >5400 individuals interviewed in Chile to >160,000 in each Colombian survey. Web table 3 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 co-operated but response rates for biophysical measurements decreased markedly, 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 that country.

Socio-economic data: Household income was collected in all surveys except in Colombia, and education level 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, ex- 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 USA 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 4 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 5 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 and 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 two readings unless they were >3cm different.

Blood pressure was measured in all countries but not all surveys (not measured in ENSIN in Colombia). Measurements were taken by a nurse in the participants' home except in the USA, where a doctor carried out the measurement in a mobile examination center. Electronic sphygmomanometers were used in Brazil, Chile, Colombia, England and Scotland; mercury sphygmomanometer in the USA; and both 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 5). Colombia had the most stringent exclusion criteria. One measurement was taken in Colombia (ENS); two in Mexico, and three (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 sub-sample of participants were 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 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 HDL-cholesterol. Blood samples were taken fasting in Colombia ENS, Chile, Mexico and the USA, whilst they were non-fasting 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 USA. Sodium was measured in all but the USA, plus 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 USA. Lung function was measured through spirometry (England, Scotland and the USA). Saliva samples were taken in England and Scotland, for cotinine (a marker of tobacco exposure). Oral and vaginal swabs were taken in the USA (for Human Papilloma virus).

<Insert Table 3 around here>

Linkage to other data

Participants in England, Scotland, and the USA 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 risk factor surveillance program to conduct a systematic assessment of the design methods of eight population surveys in seven countries. Overall, survey questionnaires and anthropometric measurements were highly comparable, with minor differences across surveys. Less overlap was found when comparing measurements that use biological samples.

Sample selection: key similarities and differences

All the assessed surveys were nationally representative of the non-institutionalized general population of speakers of that country's main language. Each survey had a multistage, probability sampling design. Oversampling was undertaken in three 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, exceeding the WHO STEPS minimum (25-64). 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 USA where the measurements were conducted in mobile examination centers. This contrasts with a comparison of methods of nationally-representative health examination surveys in Europe, where participants were invited to central examination centers in five of the seven countries studied.(**Error! Bookmark not defined.**)

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.(**Error! Bookmark not defined.**) Some of the factors affecting response rates to health examination surveys have been discussed elsewhere.(**Error! Bookmark not defined.**) There is reasonable evidence that pursuing higher response rates tends to recruit more people like those who have already taken part; adjustment for non-response 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 reduced costs (P Margozzini, personal communication).

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, not right, arm, so systolic blood pressure in Chile may be underestimated by an average of 1.8mmHg, and diastolic blood pressure overestimated minimally.(48) Taking three measurements (not done in Colombia or Mexico) is important: mean systolic pressure and

hypertension prevalence are lower (by 0.5mmHg and 1%, respectively) after incorporating a third measurement.(49)

In the USA and Mexico, BP was measured using a mercury sphygmomanometer; in the other countries, an electronic device was used. Although three different machines were used, four countries used the same model, the Omron HEM-907, and all devices were from the same manufacturer. Validation of the Omron HEM-907 following an international protocol found mean(SD) systolic blood pressure 0.1(5.1)mmHg higher and diastolic 1.9(4.2)mmHg lower than mercury sphygmomanometer readings in older people.(50) A one-third sub-sample 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 (SBarquera, personal communication). Another study found no difference in systolic, and lower diastolic, pressures with non-clinical staff using electronic devices compared with healthcare staff using mercury devices.(51) We recommend that any future study comparing blood pressure and hypertension data across countries could 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 USA but non-fasting and at any time of day in Brazil, England, and Scotland; affecting comparability of blood lipids and glucose but not of glycated hemoglobin that reflects long-term glycemia. Additional biophysical measurements varied across surveys.

For detecting undiagnosed diabetes, fasting capillary glucose 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 metabolizing the glucose while in transit to the laboratory (not a problem in the USA, 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 hyperglycemia. 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, GPAQ was used in Chile and the USA; IPAQ was used in Colombia and Scotland. GPAQ and IPAQ 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 GPAQ and IPAQ would allow comparison of data in Chile, Colombia, Scotland and USA.(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) Korea has run an annual survey similar to NHANES since 1998, where participants attend a mobile examination center.(58) There are also national health examination surveys in Canada (since 2007-09),(59) Australia,(60) and New Zealand.(61) The last of these started as a health interview survey. Since 2002/03, 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.(61) Other countries, such as the Philippines, have national nutrition surveys which 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 on what works best; set common benchmarks on 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 that the STEPS recommended minimum upper age limit increases, where NCDs and their risk factors are the focus. Collecting more socio-economic 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 ESARU consortium intends to compare prevalence of risk factors and NCDs across countries and time, to enhance understanding and inform policy-making.

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Table 1. Health-relevant characteristics of seven countries in the Americas and the UK [a]

Process	Area (km^2)	Popn. aged 18+	Gini coefficient (2012)	Income level	GNI per capita [b]	Popn. living on <$1.25 a day PPP (%)	Popn. living on <$4 a day PPP (%)	Popn. living in urban areas, 2014 (%)	Life expectancy at birth (y)		Dying aged 30-70y from main four NCDs	NCDs as % of all deaths	Healthcare coverage [c]
									Male	Female			
Brazil	8 538 000	135m	0.49	Upper middle	11 760	3.8%	23.8%	84.60%	71.3	78.6	19%	74%	100%
Chile	756 000	13.6m	0.51	High	14 900	0.8%	9.9%	89.20%	77.1	82.7	12%	84%	97%
Colombia	1 142 000	32.7m	0.54	Upper middle	7 780	5.6%	32.8%	75.30%	72.3	78.9)	12%	71%	94%
Mexico	1 944 000	79.5m	0.48	Upper middle	9 980	1.0%	23.7%	78.10%	71.7	77.4	16%	77%	87%
England	130 427	42.7m	0.36 [d]	High	42 690 [d]	-	-	79.6% [d]	78.9	82.7	12% [d]	89% [d]	100%
Scotland	78 772	4.3m		High		-	-		77.1	81.1			100%
USA	9 147 000	245m	0.41	High	55 200	-	-	82.40%	76.4	81.2	14%	88%	85%

GNI: gross national income); NCD: non-communicable disease; popn: population; PPP: purchasing power parity.

[a] *Please see the web materials for years of population estimates.*

[b] Current US$, Atlas method, 2014

[c] Total coverage includes public, social security, private, and other systems.
[d] Figure relates to the UK
References: World Bank. Country and economy factsheets. *data.worldbank.org/country/.* Accessed September 22 2016.
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Table 2. The target population in eight national health examination surveys in the Americas and the UK

Process	Survey year	Age range	No. of stages	Sampling of individuals	Excluded from sample	Other exclusion criteria
WHO STEPS standard	**N/A**	25-64y	n/a	No of individuals selected	n/a	n/a
Brazil PNS	**2013**	18+	3	One resident aged 18+ randomly selected among eligible residents	Age <18y	Uninhabited private household, non-contact and refusal
Chile ENS	**2009/2010**	15+	4	One resident aged 15+ randomly selected among eligible residents of selected households; Double probability for aged 65+.	Age <15y	Pregnant women; People with violent behavior; do not speak Spanish
Colombia ENSIN	**2010**	0-64y	4	All individuals of interest in the household	Age >65y	Only for anthropometric measurements: Women who had given birth in the 3 months preceding the survey
Colombia ENS	**2007**	0-69y	4	Aged <18: all individuals of interest in the household. Aged 18-69: 1 randomly selected if <4 individuals aged 18-69 at the household; 2 randomly selected if 4+ residents aged 18-69	Age >69y	Absence at time of the interview due to work or study
Mexico ENSANUT	**2012**	All ages	4	If possible, 1 individual from each of: children <5y; children 5-9y; adolescents; adults; and 1 or 2 health services users	If uninhabited private household	Absence at time of the interview
England HSE [a]	**2013**	All ages	3	All adults (max 10) in selected address	Business or institutions[b], vacant buildings, demolished buildings, building still being built.	Lack of mental capacity to give informed consent; do not speak English
Scotland SHeS [a]	**2008-2011**	All ages	3	All adults (max 10) in selected address	Business or institutions[b], vacant buildings, demolished buildings, building still being built.	Lack of mental capacity to give informed consent; do not speak English
USA NHANES [a]	**2011/12**	All ages	4	A subsample of individuals is selected based on sex, age, race and Hispanic origin, and income	Deadwood Dus; Institutionalised individual military personnel and citizens living outside the USA.	Failure to provide written consent treated as a refusal to participate

ENS: Encuesta Nacional de Salud; ENSANUT: Encuesta Nacional de Salud y Nutrición; ENSIN: Encuesta Nacional de Situación Nutricional; HSE: Health Survey for England; NHANES: National Health And Nutrition Examination Survey; PNS: Pesquisa Nacional de Saúde; SHeS: Scottish Health Survey.

[a] These surveys have been run on many occasions. 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.

Table 3. Summary of comparison of national surveys in the Americas and the UK with WHO STEPS examination protocols

Country	Core WHO STEPS measurements taken according to 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
USA	yes	yes	yes	yes	yes	yes

ENS: Encuesta Nacional de Salud; ENSIN: Encuesta Nacional de Situación Nutricional.

[a] yes indicates the WHO STEPS protocol was followed