Health Indicators

Conceptual and operational considerations

Pan American Health Organization

World Health Organization
REGIONAL OFFICE FOR THE Americas

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HEALTH INDICATORS: CONCEPTUAL AND OPERATIONAL CONSIDERATIONS

INTRODUCTION

The purpose of this publication is to assist Member States in the Region of the Americas to select, manage, interpret and use health indicators. Its overall aim is to facilitate progress towards the monitoring and analysis of health situations and trends. Measuring and monitoring health indicators are important to provide a foundation for measuring inequalities and guide evidence-based decision making in public health.

This document examines conceptual and practical considerations for selecting and calculating health indicators. It is intended for two main audiences: a) national level persons with responsibility for generating, analyzing, and validating timely and reliable data on health systems and services and this includes persons in vital statistics agencies and public health professionals; and b) users of health information for decision-making to strengthen health service delivery. However, the authors recognize that the Member Countries in the Region are at varying levels of progress with regard to human resources and institutional capacities to produce reliable, comparable, and consistent health information.

BACKGROUND

The Pan American Health Organization (PAHO) Regional Core Health Data Initiative (RCHDI) was launched in 1995 to contribute to knowledge about the state of health and wellbeing of populations and promote the use of reliable data for decision-making. The objective of the RCHDI is to monitor the health goals and mandates of PAHO's Member States, in addition to annually compiling a minimum set of data and indicators to characterize the health situation and trends in the Region. In 1997, the 40th Directing Council of PAHO adopted resolution CD.40.R10, institutionalizing the RCHDI. One hundred and eighteen indicators were selected and grouped into subject areas. Since 1997, the majority of Member Countries and territories have implemented the RCHDI to monitor their health situation and trends at the national and sub-national levels *(1, 2)*. The PAHO Strategic Plan 2014-2019, continues to promote the use of strategic health information as a tool for decision-making in health to include policy-setting, reorganization of health services, and mobilization of resources, among other things.

In recent years, there has been marked improvement in the capacity of the Member Countries to generate and analyze health information. In many cases, this effort has been enhanced by their subscribing to the RCHDI. This improvement can be seen, for example, in the capacity of many countries to properly monitor

and evaluate their achievement and/or progress towards of Millennium Development Goal (MDG) targets. Building on the MDG initiative and to complete the targets that they did not achieve, countries are now required to monitor 17 Sustainable Development Goals (SDG) with 169 targets under the 2030 Agenda for Sustainable Development that was adopted by world leaders in 2015. This universal Agenda reaffirms health as a fundamental right. The goals and targets represent a global aspiration for the planet, for people, and for their prosperity; they articulate the desire that no one should be left behind. To this end, SDG-3 states: "To ensure healthy lives and promote well-being for all at all ages." In order to monitor these targets, accessible, high-quality, timely, reliable, and disaggregated data are needed to measure advances, ensure that no one is left behind and are essential to decision-making *(3)*.

The document contains five sections. Section 1 discusses health indicators, definitions, uses, and attributes; Section 2, development and measurement of health indicators; Section 3, data sources for developing health indicators; Section 4, steps in evaluating the quality of data and health indicators; and Section 5, indicators estimated by indirect methods: basic concepts, uses, and limitations. Each section begins with a summary of its specific objectives, and includes a list of relevant links to websites and complementary documents. It is hoped that this publication will constitute a valuable resource to strengthen health information systems and promote the integration of data into the decision-making process.

RELATED LINKS

- Strategic Plan of the Pan American Health Organization 2014-2019.
  http://www2.paho.org/hq/index.php?option=com_docman&task=doc_view&gid=38002&Itemid=270&lang=en

- Preparing the Region of the Americas to Achieve the Sustainable Development Goal on Health.
  http://iris.paho.org/xmlui/bitstream/handle/123456789/10016/9789275118634_eng.pdf

- Sixty-ninth World Health Assembly WHA69.11. Health in the 2030 Agenda for Sustainable Development.
  http://apps.who.int/gb/ebwha/pdf_files/WHA69/A69_R11-en.pdf

- Inter-agency Health Information Network (RIPSA). Core indicators for health in Brazil: Concepts and applications–2nd ed. RIPSA. Brasilia: Pan American Health Organization; 2008.
  http://www.paho.org/bra/index.php?option=com_docman&view=download&category_slug=informacao-e-ana-lise-saude-096&alias=168-indicadores-basicos-para-salud-brasil-conceptos-e-aplicaciones-8&Itemid=965
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2. Pan American Health Organization (PAHO). 10-year evaluation of the Regional Core Health Data Initiative, 2004.
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HEALTH INDICATORS: DEFINITION, USES, AND ATTRIBUTES

Contents

Basic health concepts, measurement, health indicators, and their use, with examples.

Objective

To introduce the subject and outline basic skills, in order to improve the understanding of health indicators.

AFTER READING THIS SECTION, THE READER WILL BE ABLE TO DEFINE:

- What it means to be healthy

- What an indicator is, and what health indicators are

- What level of measurement is normally used for indicators of a population's health

- What the main uses of health indicators are

- What value health indicators for decision-making in health

1.1 ESSENTIAL DEFINITIONS

1.1.1 THE CONCEPT OF HEALTH

To discuss health indicators, one must consider the very meaning of health. Because of its multidimensional nature, the concept must be examined in light of various cultural and theoretical referents. The concept is therefore a function of the historic period and place in which its definition is formulated. This document, however, does not delve further into that issue; it merely cites the fact that several authors *(1–3)* have made major efforts to examine the concept through various historically-proposed models, such as the holistic model and the physical well-being (or wellness) model.

> *The concept of health used in this document was developed in 1947 by the World Health Organization (WHO)[1]. It states that health is "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." (4).*

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[1] In the following year, 1948, the World Health Assembly chose 7 April (the date on which the World Health Organization was created) to celebrate World Health Day, in order to foster awareness of the different factors that affect health.

The WHO concept is, in part, aligned with the holistic model, and reinforces the positive connotations of "health." Some critics have complained that this concept is utopian and unattainable *(2)*. They argue that the notion of well-being reflects an idealization of the concept and is therefore not useful as a goal for health services because it is not sufficient to develop operational indicators of health. Others have cited its reliance on cultural contexts and its failure to consider a range of dimensions. Nevertheless, there are those who have found the WHO definition of health as an acceptable option, and considers it a step forward from the definition provided by biomedical models. Several scholars have devoted efforts to make health measurable in this conceptual framework *(5)*. Notably, the WHO concept emphasizes that health is not the exclusive responsibility of the health sector, but rather, is a responsibility shared by other sectors. This view is supported by the integrated system of the Sustainable Development Goals (SDGs) and targets which may facilitate policy integration across sectors.

1.1.2 DEFINING THE INDICATORS

The verb "measure" refers to the procedure of applying a reference scale to a variable or set of variables *(6)*, while the noun "measurement" refers to the extent, dimension, quantity, etc., of an attribute.

According to Morgenstern *(7)*, measuring health variables involves using different levels of measurements, which can be generated in two ways:

1. By direct individual observation (for example, by measuring individuals' blood pressure or access to health services when needed); and,

2. By observation of population groups or location-based observations. Rates and proportions are generated (such as the prevalence of hypertension or the percentage of female adolescents between the ages of 15 and 19 years who are mothers); averages (such as the average per capita salt intake in a municipality); and medians (median survival of cancer patients, for example), among others.

The measurements generated by observations of groups or locations are used to produce population-specific measurements, which can then be classified on different levels:

1. **Aggregate measurements of health:** These are measurements (averages, medians, proportions) that provide a summary view of the observations of individuals in each observed group (for example, prevalence of hypertension in women and men within a given age group). In other words, they measure health in the population.

2. **Ecological or environmental measurements:** These refer to the physical characteristics of the place where a population group lives or works. Some of these characteristics can be difficult to measure (for example, exposure to air pollution, hours per day of exposure to sunlight, or exposure to dengue vectors). These factors are external to the individual.

3. **Global measurements:** These refer to attributes of the group or place without analogues at the individual level (population density, human development index, per capita gross domestic product, etc.). These are considered as contextual indicators.

This publication uses the phrase "health indicator" as a synonym for "indicator of the population's health," rather than "indicator of individual health." It therefore uses information on groups or places generated by aggregate measurements of health. These are commonly based on an event of interest, a reference population, and inclusion/exclusion criteria.

Measuring dimensions of health in a population requires estimations, and therefore there is a certain degree of imprecision.

> *Every health indicator is an estimate (a measurement with some degree of imprecision)*
> *of a given health dimension in a target population.*

1.1.3 DATA, INDICATOR, AND HEALTH INDICATOR

There is a hierarchy of concepts in the field of public health. The word **data** refers to the most basic unit (input) which, when managed, generates an **indicator**; the indicator, once analyzed, generates **information**, which, once interpreted, generates knowledge. The **knowledge** requires dissemination by appropriate and efficient communication processes, in order to influence health-related decision-making and produce an **action**. This spiral that begins with the production of evidence and culminates in public health action is the basis for what has been called "evidence-based public health" *(8-10)*.

> *An indicator is a measurement that reflects a given situation.*

Common to the various definitions of indicators in the literature *(10-12)* is the notion that indicators are summary measures that can, in a simple way, reveal (or measure) a situation that is not obvious when considered by itself. A health indicator, then, is a way of measuring specified health characteristics in a given population.

For the purpose of this document, health indicators are defined as summary measures that capture relevant information on different attributes and dimensions of health status and performance of a health system. Health indicators attempt to describe and monitor a population's health status. The attributes relate to health characteristics or qualities, while the concept of health itself encompasses physical, emotional, spiritual, environmental, mental, and social well-being .

In this context, it is important to distinguish between a piece of data (singular), or datum (plural), and an indicator. A datum can be considered to consist of any numerical element that has contributed to the construction of the indicator.

> *Datum and indicator are not synonymous concepts, although in some contexts the conceptual distinction may not be entirely clear.*

For example, the incidence rate of congenital syphilis in a specific population and year is an indicator. The data are the number of cases of congenital syphilis diagnosed in children under one year old (the numerator) and the total number of live births in that specific population and year (the denominator). However, the datum referring to each new case of congenital syphilis is also an indicator by itself. The indicator indicates vertical transmission of the disease, reflects the quality of prenatal care, and points to an event that health services can prevent.

Finally, indicators are dynamic, reflecting specific time-linked, cultural situations and contexts. For example, many countries in the Region of the Americas are currently experiencing rapid aging of the population, as well as an increase in chronic noncommunicable diseases (NCD). As such, some countries are still struggling to collect the relevant data on key indicators for effective control of NCD.

1.1.4 POSITIVE AND NEGATIVE HEALTH INDICATORS

The classification of indicators as positive or negative reflects whether they are associated directly or inversely with health.

> *Indicators are considered positive when they have a direct relationship (association, correlation) with healthiness. The higher the indicator value, the better the state of health of the people in the population being studied.*

Life expectancy at birth is an indicator of long-term survival. As such, it can be considered a positive health indicator. Other examples of positive indicators are the proportion of cured tuberculosis cases, of vaccine coverage, or of met family planning needs.

> *Indicators are considered negative when they have an inverse relationship (association, correlation) with healthiness. The higher the indicator value, the worse is the state of health of the people in the population being studied.*

Examples of negative indicators are infant mortality rate, maternal mortality ratio, rate of incidence of AIDS, and proportion of tuberculosis patients abandoning treatment.

1.2 USES OF HEALTH INDICATORS

The development of indicators is not an end in itself merely to observe and document the spatial or temporal distribution of the thing being measured. Rather, the reason indicators are used in public health is to drive decision-making for health. The ultimate objective is to improve the health of the population and reduce unjust and preventable inequalities *(13)*.

Some authors have put forth proposals concerning the uses of health indicators *(3, 10, 14)*. Some main uses or applications are:

- **Description.** Health indicators can be used, for example, to describe health care needs in a population, and the disease burden in specific population groups. The description of a population's health needs can guide decisions about the extent and nature of unmet needs, the inputs needed to address the problem, and the groups that should receive the greatest attention, among other functions.

- **Forecast or prognosis**. Health indicators can be used to anticipate results with regard to the state of health (forecast) of a population or a group of patients (prognosis). These indicators are used to measure individual risk and prognosis, as well as forecast disease burdens in populations. Additionally, they can forecast the risk of disease outbreaks, thereby helping to prevent epidemics or halt the territorial spread of particular health problems.

- **Explanation.** Health indicators can facilitate an understanding of why some individuals in a population are healthy and others are not. In this context, one can analyze indicators in relation to social determinants of health, such as gender roles and norms; ethnicity, income, and social support, in addition to interrelatedness of these determinants.

- **System management and quality improvement.** The production and regular monitoring of health indicators can also provide feedback to improve decision-making in various systems and sectors. For example, the notable improvements in the quality of data and indicators generated in PAHO Member Countries are due in large part to improved national health information systems to collect, analyze, and monitor a set of basic health indicators. In Brazil, for example, the Inter-agency Health Information Network (RIPSA) promotes production and analysis of health indicators, with feedback to the country's data sources and national information systems.

- **Evaluation**. Health indicators can show the results of health interventions. The monitoring of such indicators can detect the impact of health policies, programs, services, and actions. Various authors have analyzed the adequacy (results aligned with expectations) and plausibility (results unexplained by external factors) of the evidence of health impact. In this regard, the trends and distribution of health indicators are useful, and sometimes sufficient, as evidence of the results of public health policies, programs, services, and actions *(15)*.

- **Advocacy.** Indicators can serve as tools to support or oppose particular ideas and ideologies in different historical and cultural contexts. An example is the eloquence with which politicians invoke certain health indicators to defend or oppose particular policies or governments. The use

of health indicators for advocacy is one of the most important strategies for progress because it can guide political decisions to improve levels of health in the population

- **Accountability.** Health indicators can provide needed information—on risks, disease and mortality patterns, and health-related trends over time—for a wide range of audiences and users such as governments, health professionals, international organizations, civil society, and the general community. Providing these groups with the information to monitor a population's health situation and trends is vital for social control, evaluation, and institutional monitoring.

- **Research.** Simple observation of the temporal and spatial distribution of health indicators in population groups can facilitate analysis and lead to a hypothesis to explain observed trends and discrepancies.

- **Measure gender gaps.** Gender-sensitive indicators measure gaps between men and women resulting from differences or inequalities in gender roles, norms, and relations. They also provide evidence as to whether differences between men and women, as revealed by a health indicator (mortality, morbidity, risk factors, attitude toward seeking health services), are the result of gender-based inequalities. Constructing these indicators can require the disaggregation and/or addition of new variables. For example, to supplement the percentage of female adolescents who are mothers, one might add as a variable the percentage of these mothers reporting that the father of their child is at least 30 years old.

1.3 DISAGGREGATION OF DATA BASED ON PERSON, PLACE, AND TIME

It should be noted that regional and national data can conceal differences among countries and among groups within countries regarding their problems and health needs. Data must therefore be disaggregated, in order to identify groups with priority health needs and determine where inequities exist. In addition, monitoring changes in the distribution patterns of an event, over time, helps in formulating hypotheses regarding health phenomena, such as the impact of health actions and policies, changes in patterns of disease susceptibility in a population, and the introduction of new virus serogroups or serotypes exhibiting new behaviors, etc.

> *An attribute of most indicators is that they can be disaggregated by geographical levels (regional, national, local) and in different population subgroups (by age, sex, socioeconomic status, ethnic origin etc.). Its sensitivity to changes over time, as these relate to changes in other areas of the society (such as socioeconomic, environmental, or public policy changes), is also a necessary attribute (2).*

Gender-related issues, for example, are essential factors in understanding the human immunodeficiency virus (HIV-AIDS) epidemic. Although both men and the women can be exposed to HIV, male-female transmission of the virus is more common than female-male transmission *(16)*. Many other social, educational, economic, and cultural factors are also important, and can differentially affect the specific needs of men and women and the responses of the health sector. Data, disaggregated by sex and age, measured by prevalence and incidence are important to understand the HIV epidemic. These basic types of data are needed to address the gender inequalities that fuel the epidemic.

Another example is the use of health indicators to evaluate social inequalities in health. Although the present document does not address that subject in depth, it is worth noting that measures of central tendency (such as averages, medians, and proportions) can conceal major internal inequalities in a given geographical area or population subgroup, or at particular points in time. It is therefore extremely important to observe an indicator's internal dispersion, whether by deviations from patterns, quartiles, or maximum/minimum values (among other measures of dispersion), in order to identify any internal heterogeneity that may be present. For example, examining Brazil's infant mortality rate in 2013 (15.0 per 1,000 live births) has limited informational value if the indicator ranges from 10.4 (in the South region) to 19.4 (Northeast), and if within the Northeast region it ranges between 14.9 (in the state of Pernambuco) to 24.7 (in Maranhão), or if it varies widely within Maranhão.

The bibliography in this section covers numerous measures of inequality in health indicators, designed to reveal their internal distribution rather than merely their values *(7, 8)*. The preferred indicators are those that show distribution at the highest level of detail possible, whether spatially (in subregional, subnational, or municipal units), with regard to individual characteristics (sex, age, socioeconomic level, schooling, occupation, ethnic origin, geographic location), or in terms of time (days, weeks, months, years).

According to WHO (*6*), the stratification factors most commonly used to monitor health inequalities are represented by the acronym PROGRESS: **P***lace* (region, province, state), **R***ace* or ethnicity, **O***ccupation*, **G***ender*, **R***eligion*, **E***ducation*, **S***ocioeconomic status*, and **S***ocial capital* or resources. It should be noted that the number of indicators needed at the global and regional levels is less than at the national level, which in turn is less than at the state level, and so on (Figure 1).

Figure 1. Different decisions and issues call for different types and levels of indicators.

LEVEL	DISAGREGATION
Global and Regional	Sub-region, country, sex. Global and regional goals
National	Estate, sex, age group, ethnic group. Regional and national goals
District	Indicators for notification and planning at the district and national levels
Community	Indicators of the health situation at the community level
Health services	Indicators for management of health services

1.4 DESIRABLE ATTRIBUTES OF A HEALTH INDICATOR

The criteria for selecting health indicators vary according to the purpose, available sources, and anticipated users, among other factors. This section describes some attributes that are desirable in any indicator. It also looks at the importance of having indicators that can be stratified based on the characteristics of the person, place, and time being examined. As mentioned previously, susceptibility to disaggregation is an attribute for a health indicator.

Following are some of the attributes that are useful in evaluating indicators that measure the health of populations *(10; 18-21)*.

- **Measurability and feasibility:** This refers to the availability of data to measure the indicator. If an indicator cannot be measured by available data, or if calculating it is too complex, it is not easy to monitor progress toward and fulfillment of objectives *(17)*. However, the practical value of a potential indicator must also be considered. For example, many health indicators that are generated from data from national information systems either have no relevance to—and therefore no impact on—decision-making, are of questionable validity, lack timeliness, or have some other limitation.

- **Validity:** This is the ability of an indicator to measure what it is intended to measure. It is linked to the accuracy of the data sources used and method of measurement. For example, mortality information systems are usually fairly valid tools for calculating numbers of deaths in countries with adequate vital statistics records[2] *(22)*, but may be less valid for estimating the causes of deaths due to errors of diagnosis and coding *(19)*. Furthermore, information systems with low coverage can generate calculations of indicators that have little validity because of selection bias (reported cases may differ systematically from unreported cases). For example, morbidity data can be subject to detection bias (which is one type of selection bias) if the severity of the case influences the probability of it being reported, so that only the most serious cases are likely to be reported.

- **Timeliness:** Indicators should be compiled and reported at the proper time, which is to say by the time they are needed for health-related decision-making. The lag time between the collection

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[2] Vital statistics reflect events related to the life and death of individuals and their families, as well as their civil status, including births, marriages, divorces, separations, and deaths *(22)*.

and reporting of data should be minimal to ensure that the indicator is reporting current rather than historic information.

- **Replicability:** Measurements should be the same when made by different people using the same method. An indicator is considered replicable if there is no bias on the part of the observer, the instruments used to measure it, or the data sources used, among other factors.

- **Sustainability:** This refers to the qualities needed for the indicator to be usable over a span of time. It depends on the local conditions to sustain the data sources, as well as on maintaining the technical capacity needed to estimate the indicator. Above all, political will is a very important requirement. The more relevant and useful the indicator is for health management and the simpler it is to estimate, the more likely it is to be sustainable. In general, indicators involving more complex methods of calculation (such as indicators of disease burdens, quality of life, and disability-free life expectancy), though important for management, may have limited sustainability because of the lack of national capacities to retain and maintain technical resources in the local health services. However, if an indicator is important, efforts should be made to strengthen the technical capacity needed to generate it.

- **Relevance and importance:** Indicators must provide information that is appropriate and useful for guiding policies and programs as well as for decision-making. For example, estimating the prevalence rates of carriers of genetic or biological markers predictive of diseases with no known effective public health intervention or method of prevention is available (such as, Alzheimer's disease) may be of academic interest, but irrelevant for health management purposes.

- **Comprehensible:** The indicator must be understood by those responsible for taking action, and, specifically, by those responsible for decision-making. If two similar indicators measure the same health condition, the one that is easier to understand should be chosen. Therefore, the easier the comprehension, the greater the probability that the indicator will be considered in decision-making for health.

> *In summary, Indicators play a critical role in turning data into relevant information for decision makers in public health. Health indicators are relevant to define the health-related goals to be pursued by national health authorities.*

RELATED LINKS

- National Health Service (NHS). Institute for Innovation and Improvement. The good indicator guide: understand how to use and choose indicators.
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DEVELOPMENT AND MEASUREMENT OF HEALTH INDICATORS

Contents

Health indicators, categorized according to their mathematical measurement (indicators based on absolute and relative measures), their epidemiological interpretation (prevalence and incidence); and the type of indicator (indicators of behavioral risk factors, morbidity, and mortality, as well as those used for evaluation of health services).

Objective

To gain familiarity with the most common ways of calculating health indicators, their interpretation, and their uses and limitations.

After reading this section, the reader will be able to define:
- Indicators based on absolute and relative measures
- Indicators of prevalence and incidence
- Positive and negative indicators
- Indicators of structure, process, outcome, and impact
- Indicators of supply and utilization

2.1 CONCEPTUAL CONSIDERATIONS: INDICATORS CATEGORIZED ACCORDING TO THEIR MATHEMATICAL MEASUREMENT

Measurement is the procedure of applying a standard scale to a variable or set of values. This is necessary in order to facilitate comparisons at different points in time and among different populations. An indicator may be as simple as an absolute number of events or a complex calculation, such as; life expectancy at birth; fertility rate; description of quality of life; description of functional capacity; description of depressive symptoms; ascertainment of Apgar score, etc. There is a distinction between health indicators based on absolute mathematical measures and those based on relative measures. In most cases, indicators based on relative measures have a numerator and a denominator, usually in reference to the same time and place.

The most frequent measurements are counts (absolute measures), ratios, proportions, rates, and odds (relative measures) *(1-4).*

2.1.1 COUNT

> *A count gives the number of occurrence of the event(s) being studied, within a specified time and at a specified place.*

It describes the magnitude of the problem, and is referred to as the absolute frequency. It indicates the impact of a disease in precise numerical terms. It is the basic information needed to calculate indicators, to analyze health conditions, and to plan and manage health services. For example, if 250 persons in a community are diagnosed with tuberculosis, this information is essential as an input for decision-making regarding, for example, the number of therapeutic drugs needed by the health services. Absolute frequency is also very important for monitoring health events and variations in the event under observation, especially where there are few cases. An analysis of the absolute frequency should include an analysis of relative frequencies (for example, where diseases such as measles and rabies are in the eradication phase, or in cases where indigenous and imported cases are being reported).

Monitoring the absolute number of health events can also function as an impetus for formulating hypotheses about changing patterns of the disease and its associated mortality. The number of endemic cases of measles in a given country/territory previously free of such cases is an important indicator of the reintroduction of the disease, and should trigger a series of public health actions. As an example, the number of cases of microcephaly in Recife (Pernambuco, Brazil, 2015) when compared with the same indicator in an equivalent previous period was the indicator that aroused suspicion that the Zika virus epidemic could involve congenital transmission and could have major consequences for newborns. The number of cases of chikungunya in a given population should guide health managers in organizing the care network to include physiotherapeutic care for treating cases of arthritis associated with the disease. As well, the number of pregnant girls under age 15 years is important to identify and monitor cases of sexual abuse of minors.

2.1.2 RATIO, PROPORTION, RATE, AND ODDS

For temporal or spatial comparisons, however, especially when there is a significant change in the size of the reference population[3] (or base population), absolute measures will be of limited value. It would not be very informative, for example, to compare the absolute numbers of deaths due to traffic accident in

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[3] Reference population or base population: the population in which the events of interest were observed, or even the population of people who might (potentially) be connected with the event in question.

São Paulo, Brazil (with approximately 11.4 million inhabitants in 2010), with the number in Quito, Ecuador (which has approximately 1.8 million inhabitants), because the reference populations (which include the traffic accident victims) are very different in size. The absolute number of traffic accidents could yield very different numbers even when road conditions, legislation, driver education, poor judgement, and alcohol consumption, among other risk factors might be similar. In such cases, relative measures must be formulated to take into account the effects of different reference populations sizes.

In mathematics a **ratio** shows a relationship between two numbers. It is calculated by dividing one quantity by another, which may or may not be of the same type. However, there are several types of ratios each with special characteristics, as explained below:

- **Proportion:** This is when the numerator is a subset of the denominator. A proportion tends to be expressed as a percentage (%). It is the observed relative frequency of an event and provides an estimate of probability. It should be noted that, according to the frequentist approach,[4] the probability of an event's occurrence is given by the relative frequency of the event over the long term (in infinite attempts or repetitions of the experiment). As an example, if a finite number of people in a reference population are observed, and 10% of them are seen to suffer from hypertension, there is a 10% probability that a person chosen at random from that population is hypertensive. Similarly, if children from birth up to ten years old in a reference population are observed and 3% of them have developed some type of allergy, a randomly selected live newborn from that population has a 3% probability of developing some type of allergy by the age of ten. These are examples of probability estimates.

- **Rate:** The numerator is the absolute number of occurrences of the event being studied in a specified time. The denominator is the reference population (or population being studied) at the same time.

- **Odds:** The numerator is the proportion of the event of interest, and the denominator is the proportion of the non-event. The numerator and denominator are thus complementary proportions (p/1-p).

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[4] According to the frequentist approach, the probability (P) that an event (A) will occur is the relative frequency of the event (A) over the long term, in repeated experiments under similar conditions. $P(A) = m/n$ ($n \rightarrow \infty$), where m = the number of times the event A is observed, and n = the number of repetitions of the experiment. (Colton T., Statistics in medicine. Boston: Little, Brown & Co.; 1974, p. 32)

In summary, it is customary to use the word *ratio* for indicators based on relative measures that do not align conceptually with proportions, odds, and rates. For example, the word *ratio* is used when the numerator and the denominator represent events of different types, for instance; in the case of hospital beds (number of hospital beds divided by size of population) or the maternal mortality ratio (number of maternal deaths divided by total number of live births).

As an example, in a specific year a community had a total population of 20,000; it had 300 hospital beds, of which 250 were in public hospitals and 50 in private facilities. The ratio of the number of hospital beds to the community's population in that year is calculated as follows: 300/20,000 = 0.015 beds per inhabitant. (Multiplying by 100 converts it to a percentage). Thus we have 1.5% or 1.5 beds per 100 population.

The number of public hospital beds as a proportion of total hospital beds in the community in that year is 250/300 = 0.833. In other words, 83.3% of the hospital beds in the community are public.

The odds of a hospital bed being public rather than private in that year is calculated as 250/300 (the event as a proportion of possible events) divided by 50/300 (the non-event as a proportion of possible events) = 0.833/0.167 = or 0.833/(1- 0.833) = 5 public hospital beds per private hospital bed. Table 1 presents the information used in the example above.

Table 1. Examples of indicators that use different relative measures[a]

INDICATOR	NUMERATOR	DENOMINATOR	VALUE OF THE INDICATOR
Ratio of hospital beds to inhabitants	300 beds	20,000 inhab	1.5 beds per 100 population
Proportion (%) of public hospital beds	250 beds	300 beds	83.3% public beds
Odds of public versus private beds	250 / 300	50 / 300	5 public hospital beds per 1 private bed

[a] Population of the municipality = 20,000 inhabitants (in the year in question); hospital beds: 250 public and 50 private (total: 300 beds).

2.1.3 DEFINITION OF THE MULTIPLICATIVE BASE USED TO DESCRIBE A POPULATION

As mentioned earlier, indicators based on relative measures consist of a numerator and a denominator. The general formula with a multiplicative base is:

$$\frac{X}{y} * 10^{\,n}$$

The notation 10^n specifies the multiplicative base, and n normally assumes values of 2 ($10^2 = 100$), 3 ($10^3 = 1,000$), 4 ($10^4 = 10,000$), or 5 ($10^5 = 100,000$). The selection of an n value reflects two objectives. First, it should facilitate an understanding of the indicator's magnitude. For example, mortality due to major groups of causes are multiplied by $10^4 = 10,000$. It is easier to grasp the magnitude of mortality from, for example, diseases of the respiratory tract as 6 deaths per 10,000 inhabitants rather than as 0.0006 deaths per inhabitant. Mortality due to major groups of causes is expressed as a proportion of $10^2 = 100$ deaths, while the infant mortality rate is expressed as the proportion of $10^3 = 1,000$ live births. Table 2 shows data by absolute numbers and multiplicative bases.

Table 2. Absolute number of deaths, proportional mortality[a] and mortality[b] due to large groups of underlying causes of death, Region of the Americas, 2010

CHAPTER OF ICD-10	ABSOLUTE NUMBER (n)	PROPORTIONAL MORTALITY[a] (PER 100 DEATHS)	MORTALITY RATE[b] (PER 10,000 INHAB.)
Cardiovascular diseases (I00-I99)	1,640,172	29.3	17.37
Neoplasms (C00-D48)	1,131,635	20.2	11.99
Diseases of the respiratory tract (J00-J99)	571,686	10.2	6.06
External causes (V01-Y98)	538,463	9.6	5.70
Endocrine, nutritional, and metabolic disorders (E00-E90)	336,623	6.0	3.57
Digestive system diseases (K00-K93)	273,047	4.9	2.89
Nervous system diseases (G00-G99)	213,173	3.8	2.26
Ill-defined deaths (R00-R99)	192,126	3.4	2.04
Infectious and parasitic diseases (A00-B99)	188,330	3.4	2.00
Mental and behavioral disorders (F00-F99)	163,266	2.9	1.73
Diseases of the genitourinary system (N00-N99)	149,695	2.7	1.59
Diseases originating in the perinatal period (P00-P99)	72,358	1.3	0.77
Congenital malformations (Q00-Q99)	41,787	0.7	0.44
Diseases of the musculoskeletal system (M00-M99)	30,623	0.5	0.32
Diseases of the blood and blood-forming organs (D50-D89)	27,451	0.5	0.29
Skin and subcutaneous diseases (L00-L99)	13,110	0.2	0.14
Pregnancy, childbirth, and puerperium (O00-O99)	5,559	0.1	0.06
Diseases of the ear and mastoid process (H60-H95)	266	0.0	0.00
Diseases of the eye and adnexa (H00-H99)	137	0.0	0.00
Total	**5,589,507**	**100.0**	**59.21**

ICD-10, International Classification of Diseases, 10th edition.

[a] Proportional mortality from causes refers to the proportion of deaths due to each selected cause, in relation to total number of deaths reported for all causes.

[b] Mortality rate per cause is the proportion of deaths due to each selected cause, in relation to the population of the place in the year of interest (assumed population 944 million for the Region of the Americas in 2010).

Source: PAHO/WHO Regional Mortality Information System (updated May 2014).

2.2 INDICATORS CATEGORIZED ACCORDING TO THEIR MATHEMATICAL AND EPIDEMIOLOGICAL INTERPRETATION

The interpretation of health indicators can vary considerably, depending on the epidemiological situation and the type of event represented by the numerator. Thus, one speaks of indicators based on the proportion of incident events and on the proportion of prevalent events. The resulting rates are the two most commonly used to describe diseases in public health.

2.2.1 INDICATORS BASED ON INCIDENT EVENTS

> *An incident event is defined as a new event or case of a disease (or a death or other health condition) that occurred in a specified time period.*

Several relative indicators can be generated from incident events. The relative measures that can be calculated for incident events in public health are cumulative incidence or proportion of incidence, together with the incidence rate or incidence density. Below is the definition and interpretation of an incidence rate:

INCIDENCE RATE

Concept: The incidence rate is defined as the number of new cases of a disease or other health condition, divided by the population at risk for the disease (exposed population) in a specific place during a specified period of time.

Mathematical interpretation: The incident rate is the probability that an individual belonging to the at-risk population is affected by the disease of interest during a specified period of time.

Epidemiological interpretation: This rate calculates the probability of a change of state (for example, from health to illness, from living to dead, without a given event and with an adverse event, etc.) during a given time interval. In epidemiological terms, this is called "risk." The risk, then, is the probability of a change of state (involving disease, death, adverse effect) in a population being studied during a given time interval (*3*). In the case of the example cited under 2.1.2 about the probability of developing allergy from birth to ten years old, it can be said that the measure of incidence (proportion) in ten years is the risk that a newborn child in that population will develop an allergy before turning ten.

Calculation method: The incidence rate is computed as follows:

$$INCIDENCE = \frac{Number\ of\ new\ cases\ occurring\ in\ place\ X\ in\ a\ given\ period\ of\ time}{Number\ of\ new\ cases\ occurring\ in\ place\ X\ in\ a\ given\ period\ of\ time} * 10^n$$

2.2.2 INDICATORS BASED ON PREVALENT EVENTS

> *A prevalent event (or case) is defined as an event or existing case of a disease (or other condition) at a specified time.*

As with incident events, health indicators based on relative measures can be created on the basis of prevalent events (absolute measures). In epidemiology, the most important relative measure calculated on the basis of prevalent events is the proportion or prevalence rate. There are other measures of prevalent events (such as period prevalence), but they are unusual, and are not covered in this document.

PREVALENCE RATE

Concept: The prevalence rate is defined as the number of existing cases of a disease or other health event divided by the number of persons in population at that specified time. Each individual is observed on a single occasion, at which time the individual's status with respect to the event in question is ascertained.

Mathematical interpretation: The prevalence rate is the probability that an individual belonging to the base population is affected by the event (disease) of interest at a given time.

Epidemiological interpretation: The prevalence rate determines who in the population has a given disease and who does not at a specific point in time. However, it does not indicate the risk of getting the disease. In the case of the example cited under 2.1.2, in which 10% of a given population suffers from hypertension, the measure is the prevalence rate of hypertension. It is possible, then, to calculate that if one selects a random individual in that population, the probability (estimated by the prevalence coefficient) that that person is hypertensive is 10%.

Calculation method: The prevalence rate is calculated as follows:

$$PREVALENCE\ COEFFICIENT = \frac{Number\ of\ existing\ cases\ in\ place\ X\ at\ a\ given\ time}{Number\ of\ existing\ cases\ in\ place\ X\ at\ a\ given\ time} * 10^n$$

2.2.3 RELATIONSHIP BETWEEN INCIDENCE RATE AND PREVALENCE RATE

The prevalence rate of a disease (or other condition) is directly proportional to its incidence rate times the average duration of the disease, according to the following formula *(3)*:

$$Prevalence = Incidence * t \text{ (average duration of the disease)}$$

High prevalence of a disease in a population could suggest high incidence or the fact that the disease or condition was of prolonged duration as, for example, diseases that become chronic and are incurable though the case-fatality rate was not high. On the other hand, low prevalence of a disease could indicate either low incidence or short duration of the disease or condition (either because death occurs rapidly or because the condition was cured quickly). In considering this relationship, it should be noted that whatever the incidence, if the event is so acute that its average duration tends toward zero, the prevalence of that event will also tend toward zero. Examples of this include human rabies and death due to all causes.

2.2.4 USES OF PREVALENCE AND INCIDENCE INDICATORS

Incidence is essential for analyzing the occurrence of new events in populations and their related factors. Prevalence is essential for planning and organizing existing resources and services as well as for obtaining additional support, when necessary.

Prevalence and incidence are generally used for chronic communicable diseases such as leprosy and tuberculosis, as well as for non-communicable chronic diseases such as diabetes. Incidence is used for acute diseases of short duration and are curable or ends in death (such as human rabies, measles, chikungunya fever, dengue, etc.). Incidence rate is preferred when the purpose is to calculate risk (the individual probability of the new event occurring in a given time interval) and, thereby, identify individual risk factors *(4)*.

2.3 TYPES OF HEALTH INDICATORS

A comprehensive list of indicator types, classified according to the event to be measured, could be listed in this section. To demonstrate the usefulness and limitations of indicators, this section concerns itself with a limited number of indicators in four domains: the health situation (morbidity); health situation (mortality); behavioral risk factors; and health services.

At the conclusion of this section, there is a list of links with examples and technical specifications for a number of health indicators, such as the WHO Global Reference List of 100 Core Health Indicators and the Inter-agency Health Information Network (RIPSA) document.

2.3.1 MORBIDITY INDICATORS

> *Morbidity indicators are designed to measure the occurrence of diseases, injuries, and disabilities in populations.*

These indicators can be expressed by measuring incidence or by measuring prevalence. Assessing morbidity rates requires direct observation (surveys and other research); reporting of events in surveillance systems; and reporting of diseases in hospitals and outpatient information systems, specific registries, etc.

Various factors can affect the accuracy of the measurement of morbid events, namely:

a. **Data quality**: Poor data quality makes it difficult to interpret and compare data from different areas of a country or among different countries. Data quality is compromised by the diversity of data sources on morbidity such as surveillance systems, routine public and private hospital in-patients and outpatients records; surveys prepared by national institutions, and research conducted by academic groups.

b. **The validity of measurement instruments**: The accuracy of medical diagnostic tests (probability of diagnostic errors, such as false positives and false negatives) and the validity of the data collection instruments used in the surveys, as well as the coverage and quality of the information systems being used, can compromise the validity of measurement instruments. The use of more precise and accurate diagnostic tests can have a significant effect on the identification of cases

(incident or prevalent cases), and can highlight apparent, but non-real, changes in trends of those indicators.

c. **Disease severity**: The severity of a disease affects the probability of it being diagnosed and reported. A disease can manifest itself with different degrees of severity, resulting in hospitalization (captured information) or no hospitalization (uncaptured information). A disease can also occur more than once in a given lifetime which can result in attributing several episodes to a single person.

d. **Cultural norms**: Cultural perceptions affect health-seeking behaviors and the manner in which different diseases are detected and managed by family members.

e. **Confidentiality**: The desire for confidentiality on the part of patients and the omission of events in reports (e.g., cases of HIV infection and illegal abortion) affect the accuracy of data.

f. **Health information systems**: The existence or absence of health information systems capable of generating reliable data from hospitals, outpatients, reportable diseases registries, cancer registries, and other data sources can also affect the accuracy of data.

Some examples of morbidity indicators, method of calculation, data sources and the purpose of the indicator are described below:

HUMAN IMMUNODEFICIENCY VIRUS (HIV) DIAGNOSIS RATE

- **Calculation method:** The rate is the number of new diagnosis of HIV in a population during a specified period of time divided by the number of persons at-risk for developing HIV during that period of time. HIV diagnosis rate can be calculated per 100,000 and disaggregated by age, sex, ethnicity, and other variables. The definition of a confirmed case of AIDS is based on the specific criteria adopted by the countries.
- **Common sources:** The data for the numerator normally come from national health surveillance systems and other disease reporting systems.
- **Examples of interpretation:** This indicator estimates the risk of developing AIDS for members of a defined population during a specified time period. Analysis of this estimate at different points in time and in different population subgroups provide useful information to monitor the indicator's magnitude. This indicator can also provide preliminary evidence of the effectiveness of disease prevention policies, programs, and actions. As an example, it can also provide input for research on possible associations between the incidence of the disease on one hand, and risk behaviors and/or the extent of antiretroviral therapy coverage, on the other.

HYPERTENSION PREVALENCE RATE

- **Calculation method:** The number of existing cases of hypertension (per 100,000), divided by the number of persons in the population in a specified time. The rate can be disaggregated by sex, age groups, ethnicity and other variables of interest.

- **Common sources:** The data for the numerator normally come from population surveys using representative (national or local) samples. Consequently, the indicator is an estimate of a sample and should be accompanied by the degree of certainty of the estimate and the amount of unexplained variability (confidence interval).

- **Examples of interpretation:** This indicator estimates the prevalence of hypertension in the population. Analysis of this estimate over time and in different population subgroups makes it possible to monitor its magnitude and to forecast the demand for health services related to the disease, as well as to plan preventive and promotional interventions.

PROPORTION OF HOSPITAL ADMISSIONS FOR EXTERNAL CAUSES

- **Calculation method:** The number of hospital admissions, by groups of external causes (per 100,000) divided by the total number of hospital admissions for external causes in a specified time period. The proportion can be disaggregated by sex, age groups, ethnicity and other variables of interest.

- **Common sources:** The data for this indicator's numerator and denominator normally come from the information systems of (national or local) hospitals. In interpreting the indicator, care must be taken to ensure that both public and private hospitals, are represented.

- **Examples of interpretation:** This indicator estimates the proportion of all hospital admissions that are due to external causes. Analysis of this estimate over time and in different population subgroups makes it possible to monitor the indicator's magnitude and distribution as well as to measure the impact of preventive interventions.

2.3.2 MORTALITY INDICATORS

> *Mortality data are a fundamental source of demographic, geographic and cause-of-death information. This data is used to quantify health problems as well as to define or monitor health priorities and goals.*

Mortality in a specified place at a specific time can be measured in a number of ways such as in absolute numerical terms, as proportions, and as rates. Unlike morbidity, death is a unique and clearly identifiable event that reflects the occurrence and severity of a disease. It is advisable to disaggregate mortality data by characteristics, such as, cause, age, sex, place of residence and occurrence; and ethnic origin, among other factors.

Mortality is the oldest and most common source of data on a population's health status. Mortality data collection is compulsory in all countries of the Americas, and the use of death certificates is mandatory. WHO has issued international recommendations concerning the variables that should be included in death certificates as well as the guidelines for the sequencing and medical coding of the diseases entered on the certificate. Most of the countries in the Region use the International Classification of Diseases, 10th revision (ICD-10) to code the causes of death, allowing for comparisons between and among different countries at different times.

Various factors can affect the accuracy with which death and its characteristics are measured—particularly, the underlying cause of death[5] *(5)*. These factors include:

a. The existence of national legislation requiring the issuance of a death certificate as a legal prerequisite for authorizing burial.
b. The accuracy of medical diagnostic tests (probability of diagnostic errors such as false positives and false negatives); validity of data collection instruments; data coverage as well as the quality of the death certification and medical coding processes.
c. The cultural norms that can affect the correct completion of death certificates can also lead to errors in classifying certain characteristics of deaths (causes, circumstances, etc.).
d. The patients' desire for confidentiality (in cases such as suicide, HIV infection, illegal abortion, etc.), resulting in an omission of certain health-related events in surveys, death certificates, and other sources of mortality data.

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[5] Underlying cause of death has been defined as "(a) the disease or injury which initiated the train of events leading directly to death; or (b) the circumstances of the accident or violence which produced the fatal injury."

e. The training of the certifier and medical coder regarding the correct methods to complete and code deaths using the ICD guidelines.

f. The competitive risk: depending on the age structure of the population and the most frequent causes of death in the younger age groups, certain causes of death may be obscured (reducing the probability that they will be noted), due to what is called "competing mortality[6] risks." *(6)* For example, in a population with high numbers of death due to road traffic accidents, mortality among young men, and mortal events at more advanced ages, such as deaths from prostate cancer, are less likely to be noted. Examining age- and sex-specific rates can help minimize the effect of competing risks and foster a better understanding of mortality risks in the population.

Table 2 on page 25 shows three categories of mortality indicators according to the underlying cause of death based on absolute numbers of deaths, and in relative terms (proportional mortality per hundred deaths and mortality per 10,000 inhabitants).

Some examples of mortality indicators are listed below:

INFANT MORTALITY RATE

- ***Calculation method:*** number of deaths of children under 1 year of age (per thousand) divided by the total number of live births in the population during a given year.
- ***Common sources***: The data for this indicator's numerator normally come from national mortality systems and vital registration systems, while the data for the denominator come from national live birth records systems and vital registration.
- ***Examples of interpretation:*** This indicator estimates the risk that infants born alive will die during the first year of life. Analysis of this estimate over time and in relation to different causes and age subgroups (neonatal, early neonatal, late neonatal, post-neonatal) makes it possible to monitor the magnitude of the indicator, while offering preliminary evidence of the effectiveness of policies, programs, and interventions to prevent infant deaths.

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[6] A competing risk is an alternative result that has a clinical importance equal to or greater than the primary result, and that changes the probability of the result in question *(6)*.

MATERNAL MORTALITY RATIO

- **Calculation method:** The number of maternal deaths—deaths of women due to causes and conditions associated with gestation, childbirth and puerperium (up to 42 days after the pregnancy is taken to term)—per thousand, divided by number of live births in the population in a given year.

- **Common sources:** The data for this indicator's numerator normally come from national mortality and vital registration systems, with supplementary information from maternal mortality surveillance, while data for the denominator are obtained from national live birth records and vital registration systems.

- **Examples of interpretation:** This indicator, albeit indirectly, estimates the risk of a woman dying from pregnancy-related causes. It reflects access to services and the quality of care provided to women during pregnancy, childbirth, and puerperium. Analysis of this estimate over time for different subgroups of causes of death and different population subgroups makes it possible to monitor the indicator's magnitude. This type of analysis provides evidence of the effectiveness of policies, programs, and interventions to prevent maternal deaths. Most of these deaths are preventable with quality ante- and post-natal care and other improvements in the health services.

MORTALITY FROM ACUTE RESPIRATORY INFECTION IN CHILDREN UNDER AGE FIVE

- **Calculation method:** The number of deaths due to acute respiratory infection (ARI) in children under age five (per thousand), divided by the number of children under five in the population in a given year.

- **Common sources:** The data for this indicator's numerator normally come from national health statistics units and national mortality data collection systems.

- **Examples of interpretation:** This indicator estimates the risk of death from ARI in children under age five, and reflects the quality of care provided to children. Analysis of this estimate over time and in different population subgroups makes it possible to monitor the indicator's magnitude. Additionally, the indicator provides preliminary evidence of the effectiveness of policies, programs, and interventions to prevent mortality from this cause.

PROPORTIONAL MORTALITY FROM ILL-DEFINED CAUSES

- **Calculation method:** The number of deaths from ill-defined causes (per hundred), divided by total number of deaths in the population in a specified year.
- **Common sources:** Data for this indicator's numerator and denominator normally come from national health statistics units and national mortality information systems.

- **Examples of interpretation:** This indicator estimates the proportion of deaths that occur from ill-defined causes. Analysis of this indicator over time and in different population subgroups makes it possible to monitor the quality of information on underlying causes of death as well as the accuracy of the ICD coding.

2.3.3 INDICATORS OF BEHAVIORAL RISK FACTORS

In recent decades, changes in the demographic and epidemiological profiles of populations in many countries have led to an increase in the relative importance of chronic non-communicable diseases (CNCD) and their risk factors. This poses a challenge for the adaptation of health surveillance practices which have traditionally dealt with infectious diseases.

The monitoring of mortality and morbidity due to CNCD plays an important role, but it is late in capturing the trends that reflect cumulative exposures during a lifetime. For example, the increase in mortality due to lung cancer was only observed in the developed countries decades after the epidemic increase in tobacco use, which, until then, was considered a harmless habit. Thus, health protection and promotion initiatives, in particular those related to CNCD, should focus on their more distal determinants in order to formulate and monitor risk factors indicators.

Among the determinants of CNCD is a set of behavioral risk factors associated with lifestyles that are changeable through health promotion, surveillance, and primary health care. Examples of indicators of modifiable behavioral risk factors associated with the main CNCDs are: prevalence rates of smoking, sedentary lifestyle, unhealthy eating, and excessive alcohol consumption. WHO has indicated that these four risk behaviors are associated with the four groups of causes of death with the greatest incidence worldwide (cardiovascular diseases, neoplasms, diabetes, and respiratory diseases) *(7)*.

Numerous risk factor indicators have been proposed, of which the following are examples.

PREVALENCE OF CURRENT ADULT SMOKERS
- **Calculation method**: The number of adults (18 years of age and older) who smoke—regardless of the number of cigarettes smoked and frequency of smoking, and regardless of the duration of the habit—(per hundred), divided by the number of adults (18 years of age and older), which can mean either inhabitants or interviewees.

- **Common sources:** The data for this indicator's numerator normally come from base population surveys using representative (national or local) samples. As a consequence, the indicator is a sample estimate and should be accompanied by the degree of certainty of the estimate and the amount of unexplained variability (confidence interval).
- **Examples of interpretation:** This indicator estimates the frequency of current tobacco use in the adult population (18 years of age and older). Analysis of this indicator over time and in different population subgroups (age, sex, geographic region, educational level) makes it possible to monitor the indicator's magnitude and distribution. This indicator provides preliminary evidence of the effectiveness of anti-smoking policies, programs, and interventions. It also provides input for research on associations between smoking and the incidence of pulmonary diseases, cancers, and cardiovascular and other diseases.

PREVALENCE OF INSUFFICIENT PHYSICAL ACTIVITY

- **Calculation method:** The number of insufficiently active people between the ages of 15 and 69 years (per hundred), divided by the number of interviewees between the ages of 15 and 69 years.
- **Common sources:** The data for this indicator's numerator normally come from population surveys using representative (national or local) samples. Thus, the indicator is a sample estimate and should be accompanied by the degree of certainty of the estimation and the amount of unexplained variation (confidence interval).
- **Examples of interpretation:** This indicator estimates the frequency of insufficiently active people between the ages of 15 and 69 years in the population. Analysis of this indicator over time and in different population subgroups makes it possible to monitor the indicator's magnitude. The indicator provides preliminary evidence of the effectiveness of the policies, programs, and interventions to promote regular physical activity and prevent sedentary lifestyles. Additionally, it provides input for studies on the association between insufficient physical activity and diabetes, different types of cancer, and ischemic and other diseases.

PREVALENCE OF REGULAR CONSUMPTION OF FRUITS AND VEGETABLES

- **Calculation method:** The number of adults (15 years of age and older) who report regular consumption of fruits and vegetables (per hundred), divided by the number of adults (15 years of age and older) interviewed. Regular consumption of fruits and vegetables is defined as consuming these foods five or more days per week.
- **Common sources:** The data for this indicator's numerator normally come from population surveys using representative (national or local) samples. Thus, the indicator is a sample estimate and

should be accompanied by the degree of certainty of the estimate and the amount of unexplained variability (confidence interval).

- **_Examples of interpretation:_** This indicator estimates the frequency of regular consumption of fruits and vegetables in the adult population (15 years of age and older). Analysis of this estimate over time and in different population subgroups makes it possible to monitor the indicator's magnitude. The indicator provides preliminary evidence of the effectiveness of policies, programs, and interventions to promote the consumption of fruits and vegetables. Additionally, it provides input for studies of the association of irregular or no consumption of fruits and vegetables with overweight and obesity as well as with the incidence of non-communicable diseases.

PREVALENCE OF EXCESSIVE ALCOHOL CONSUMPTION

- **_Calculation method:_** The number of people 15 years of age and older who report having engaged in excessive consumption of alcoholic beverages in the last 30 days (per hundred), divided by the number of people 15 years of age and older. The numerator is obtained by multiplying the number of drinks consumed on the same day multiplied by the number of days on which this occurred, divided by the number of days in the reference period. The WHO definition of excessive consumption of alcoholic beverages is more than two drinks daily for men and more than one drink daily for women *(8)*.

- **_Common sources:_** The data for this indicator's numerator normally come from population surveys employing representative (national or local) samples. Thus, the indicator is a sample estimate and should be accompanied by the degree of certainty of the estimate and the amount of unexplained variability (confidence interval).

- **_Examples of interpretation:_** This indicator estimates the frequency of excessive consumption of alcoholic beverages in the population 15 years of age and older. Analysis of this estimate over time and in different population subgroups makes it possible to monitor the indicator's magnitude. The indicator provides preliminary evidence of the effectiveness of policies, programs, and interventions to prevent excessive consumption of alcoholic beverages. Additionally, it provides input for studies designed to analyze the association between excessive alcohol consumption and the incidence of diseases associated with excessive alcohol consumption, such as, alcoholic cirrhosis, alcoholic pancreatitis, dementia, polyneuropathy, myocarditis, malnutrition, hypertension, myocardial infarction, and certain types of cancers (oral, pharynx, larynx, esophagus, liver), among other diseases.

2.3.4 HEALTH SERVICES INDICATORS

Various conceptual frameworks provide different methods of formulating indicators that measure the quality of health services. Although this publication does not attempt to review all types of health service indicators, it recognizes the importance of these indicators. Globally, health care services and systems face numerous challenges such as, rising costs and expenditures (for both government and citizens). This shift is due largely to ever-increasing innovative treatments and the use of new technologies; the need to adapt services to new demand; the challenges created by demographic transitions and aging populations; epidemiological trends and changes in the patterns of diseases; nutritional needs and other behavioral factors; the sector's role in reducing (or increasing) health inequities; pressures from market demand; and litigation. Indicators of the performance and quality of health services fulfill countless functions and are essential for institutional and social monitoring. Consequently, there has been a vast proliferation of health care quality indicators *(9)*.

In discussing health services indicators, a pertinent question is "what is quality of care?" and from whose perspective should it be evaluated: users, health professionals, the general population, managers? This question can be pursued by consulting the relevant bibliographical sources at the end of this section.

One of the most widely recognized approaches to evaluating the quality of health services uses the categories of "structure," "process," and "outcomes" proposed by Donabedian *(10-11)*. Although this author's thinking focuses on the quality of medical care, the concepts are applicable more broadly to the quality of overall care provided by the health services. His proposed framework assumes that good health care facilities increase the probability that there will be good processes, and that these in turn increase the probability of good health outcomes.

Structure indicators reflect a system's relatively fixed characteristics, including the quality of material resources (buildings, equipment, and financial resources), human resources (number and qualifications), and organizational structure (organization of medical teams, quality control methods, and reimbursement methods) *(10-11)*. Process indicators describe the important processes that contribute to the achievement of outcomes. These indicators describe the actual process of providing health care, and thus includes diagnostic activities, treatment recommendations, and care, among other factors. Health care outcome indicators reflect the state of health of patients and of the population—better knowledge on the part of patients; patients' behavioral changes related to self-care, and patient satisfaction with respect to care they have received.

Before formulating and monitoring any of the available indicators related to the quality of health services, there must be clarity regarding the expected (plausible) relationships between the structure and process indicators to be monitored, and the proposed outcome indicators. Furthermore, the concept of quality of care must guide a definition of the criteria and patterns sought by, and that are the object of, the structure and process indicators, based on an appropriate theoretical framework (valid and reasonable body of knowledge) *(10-11)*.

With regard to the difference between outcome indicators and impact indicators, while the former may be measured in the short term, the latter require a longer time for measurement. An example of this is a health promotion intervention for smoking cessation and prevention. A variable that can be used to measure outcomes could be the reduction of smoking prevalence rates and the measure of impact would be reduced lung cancer mortality.

RATIO OF HOSPITAL BEDS TO INHABITANTS

- ***Calculation method:*** The number of hospital beds (per thousand), divided by total inhabitants in a given year (typically adjusted for a six-month period).
- ***Common sources***: The data for this indicator's numerator normally come from national statistics institutes, records of health institutions, and specific research on the structure of health services.
- ***Examples of interpretation:*** This indicator estimates the relationship between the supply (or potential coverage) of hospital beds and the population. It should be noted that in some countries, only public sector beds are included in the data set. Analysis of this indicator at different points in time and in different population subgroups makes it possible to monitor the ratio. This indicator provides preliminary evidence of the effectiveness of policies, programs, and actions to expand hospital capacity for admissions. It also provides input for research on the structure of hospital care. In general, hospital beds are concentrated in urban areas. Monitoring of this indicator can help place the issue of more equitable geographical distribution of hospital beds on the national negotiating agenda.

PROPORTION OF CESAREAN SECTIONS

- ***Calculation method:*** The number of births by cesarean section (per hundred), divided by total number of births in the population during a specific year.

- **Common sources:** The data for this indicator's numerator and denominator normally come from national birth information systems as well as from demographic and health surveys.
- **Examples of interpretation:** This indicator estimates cesarean sections as a proportion of all deliveries in the population. Analysis of the indicator at different points in time and in different population subgroups makes it possible to monitor its magnitude. This indicator provides preliminary evidence of the effectiveness of policies, programs, and actions to promote natural delivery. In addition, the indicator provides input for research on a society's procedures and practices with regard to accessibility to, and utilization of health care services during childbirth.

MORTALITY FROM VACCINE-PREVENTABLE DISEASES IN CHILDREN UNDER ONE YEAR OF AGE

- **Calculation method:** The number of deaths due to vaccine-preventable diseases in children under one year of age (per 100,000), divided by total number of births in the population in a specific year.
- **Common sources:** The data for this indicator's numerator normally come from national mortality information systems, while data for the denominator come from national birth information systems.
- **Examples of interpretation:** This indicator estimates the risk that children under one year of age will die from some cause among a group of diseases for which the health service has optimal immunization programs for children. Analysis of this indicator at different points in time and in different population subgroups makes it possible to monitor its magnitude. This indicator provides preliminary evidence of the effectiveness of policies, programs, and interventions to foster expanded access to vaccines. The indicator also provides input for research on the health services' procedures and practices with regard to monitoring coverage for immunization services for infants in the first year of life. Figure 2 summarize the fifteen indicators described in this section and how they can be classified for analysis.

Figure 2. Selected indicators and their classifications

INDICATOR	MATHEMATI-CAL MEASURE	MEANS OF MEA-SURING HEALTH	EPIDEMIOLOGICAL INTERPRETATION	INDICATOR CATEGORY
Prevalence of current smokers	Proportion	Negative	Prevalence (probability that a person in the base population at a specified time is a smoker)	Risk factor
Prevalence of insufficient physical activity	Proportion	Negative	Prevalence (probability that a person in the base population at a specified time is insufficiently active)	Risk factor
Prevalence of regular consumption of fruits and vegetables	Proportion	Positive	Prevalence (probability that a person in the base population at a specified time regularly consumes fruits and vegetables)	Risk factor
Prevalence of excessive alcohol consumption	Proportion	Negative	Prevalence (probability that a person in the base population at a specified time consumes alcohol excessively)	Risk factor
AIDS incidence rate	Proportion	Negative	Incidence (risk that a person in the base population at a specified time will develop AIDS)	Health status: morbidity
Hypertension prevalence rate	Proportion	Negative	Prevalence (probability that a person in the base population at a specified time is hypertensive)	Health status: morbidity
Proportion of hospitaliza-tions for external causes	Proportion	Negative	Prevalence (probability that a hospitalized person in the base population at a specified time was hospitalized for an external cause)	Health status: morbidity
Infant mortality rate	Proportion	Negative	Incidence (risk that a live newborn in the base population will die during the first year of life)	Health status: mortality
Maternal mortality ratio	Reason	Negative	Ratio of the number of maternal deaths to the number of live births. This is an indirect mea-sure (proxy) of incidence (risk that a pregnant woman in the base population in a given time period will die from causes directly related to pregnancy)	Health status: mortality
Mortality from acute res-piratory infection (ARI) in children under age five	Proportion	Negative	Incidence (risk that a child under age five in the base population in a given time period will die from ARI)	Health status: mortality
Proportional mortality from ill-defined causes	Proportion	Negative	Probability that a person in the base population at a specified time will die from an ill-defined cause	Health status: mortality
Ratio of number of hospital beds to inhabitants	Ratio	Positive	Number of available hospital beds (potentially and on average) for every individual in the base population at a specified time)	Health services: structure
Proportion of cesarean sections	Proportion	Negative	Probability that a live birth in the base popula-tion at a specified time was by cesarean section	Health services: process

INDICATOR	MATHEMATI-CAL MEASURE	MEANS OF MEA-SURING HEALTH	EPIDEMIOLOGICAL INTERPRETATION	INDICATOR CATEGORY
Mortality from vaccine-preventable diseases in children under one year of age	Proportion	Negative	Incidence (risk that a child under the age of one in the base population in a given time period will die from a vaccine-preventable disease)	Health services: impact

2.4 PRACTICAL CRITERIA FOR THE FORMULATION OF HEALTH INDICATORS

2.4.1 DEFINING THE REFERENCE PERIOD

The reference period for the indicator is essential and should be explicitly stated when a health indicator is interpreted and disseminated; this is particularly important for the purpose of comparability. The definition of the period depends on the event being monitored and on the indicator's purpose. The period may be a year (mortality data are commonly calculated on an annual basis), a month, a week (as in the case of data from surveillance systems for communicable diseases), or a number of hours (e.g., in an outbreak of a foodborne disease).

In calculating incidence, it should be noted that new events accumulate as the observation time is extended. In addition, depending on the number of new cases, the magnitude of the rate would increase.

2.4.2 DEFINITION OF A NEW EVENT

In order to ensure that an incident event is new, the individuals being observed should have been observed at least twice. First, in the absence of the condition or event being monitored and then with the onset of the condition or event.

However, incident events can be measured indirectly when they are acute, symptomatic, and not susceptible to becoming chronic. For the purpose of epidemiological surveillance, only a single observation of the individual with the condition of interest is considered an incident event. Examples of cases of this type include certain communicable diseases and allergic reactions.

2.4.3 DEFINING THE DENOMINATOR

The denominator is the number of persons in the population of interest at the start of the observation period who are independent of any specific disease or condition. You will recall that the numerator is comprised of the individuals with some probability of becoming victims of the event. In other words, the numerator should be the population with the condition or event being observed. For example, when measuring the incidence rate for cervical cancer in a specific time period, the denominator should include only women in the population who have a uterus; and in calculating the incidence of suicide, it is advisable to exclude children under five from the denominator, since they are not usually considered capable of committing suicide.

In defining the denominators for rates (mortality, for example) on the basis of data from health information systems, the population estimates used should be as of mid-year (1 July), because: (a) estimates for the beginning of the year (1 January) do not include those born later in the year; (b) calculations made at year-end (31 December) do not include those who died in the course of the year but were part of the exposed population; and (c) the assumption is made that deaths and births are distributed uniformly over the course of the year. By convention, census estimates represent the mid-year point. Moreover, as mentioned above, the concept of an at-risk or potentially exposed population refers to those people who are potentially subject to the disease or event in question. Public health measures are more effective when focused on the population that is truly susceptible to the event being observed. However, it should be noted that not all persons considered to be within the at-risk population are, in fact, at risk. In calculating the prevalence of hepatitis B, the ideal would be to exclude people who have received the vaccine. Since such exclusion is usually not feasible in practice, the total population, as estimated by the census, is used. Similarly, in calculating suicide incidence rates, denominators usually represent the total population.

2.4.4 COMPARING HEALTH INDICATORS IN DIFFERENT POPULATION GROUPS

Comparing health indicators from populations that are geographically or temporally different requires special attention. Populations can differ with regard to many variables, with correspondingly different risks of illness and death. Variables such as, age, sex, ethnic origin, geographic location, and socioeconomic level greatly influence these differences.

2.4.5 STANDARDIZING MORTALITY RATES

Overall death rates in countries with different life expectancies can falsely suggest that there is a greater risk of death in the countries with large numbers of older adults. Standardizing those rates by age eliminates the effect of unequal age composition in the population and permits a better comparison. To avoid erroneous conclusions in comparing overall rates, mathematical methods for eliminating the effect of unequal demographic distributions have been used. The most commonly used method is the direct standardization of rates. Table 3 provides an example of standardization of mortality rates by age groups.

The calculation method for direct standardization of mortality rates includes the following elements:

1. Number of deaths in each age group.
2. Population in each age group.
3. Number of deaths divided by population size, for each age group.
4. The reference number is usually 100,000.
5. Specific rates for each age group, obtained by multiplying the quotient in column 4 by the base. The total is the crude rate for the entire population.
6. Standard population (in this example, the WHO standard population), presented in decimal figures to facilitate calculation.
7. To obtain the adjusted rate, first multiply the specific rate for each age group by the standard population. The age-adjusted rate per 100,000 is the sum of the product of each age group.

Table 3. Calculation methods for direct standardization of mortality rates, by age groups.

Age group	Number of deaths	Population by age group	Quotient (2)/(3)	Base	Rate/100,000 inhabitants (4)*(5)	Standard population (WHO)	Standardized rate/100,000 inhabitants
(Years)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
0-4	184	72,777,507	0.0000025	100,000	0.252825	0.08	0.0202260
5-9	71	72,994,747	0.0000010	100,000	0.097267	0.0869	0.0084525
10-14	134	72,620,391	0.0000018	100,000	0.184521	0.0860	0.0158688
15-19	385	71,001,119	0.0000054	100,000	0.542245	0.0847	0.0459281
20-24	627	66,294,501	0.0000095	100,000	0.945780	0.0822	0.0777431
25-29	1,017	6,1997,944	0.0000164	100,000	1.640377	0.0793	0.1300819
30-34	1,665	59,559,771	0.0000280	100,000	2.795511	0.0761	0.2127384
35-39	2,617	58,674,298	0.0000446	100,000	4.460215	0.0715	0.3189054
40-44	4,620	53,480,149	0.0000864	100,000	8.638719	0.0659	0.5692916
45-49	7,671	46611906	0.0001646	100,000	16.457169	0.0604	0.9940130
50-54	12,272	38,596,072	0.0003180	100,000	31.795982	0.0537	1.7074442
55-59	17,121	30,064,772	0.0005695	100,000	56.947048	0.0455	2.5910907
60-64	22,402	24,383,765	0.0009187	100,000	91.872605	0.0372	3.4176609
65-69	27,554	20,457,174	0.0013469	100,000	134.691136	0.0296	3.9868576
70-74	32,172	17,459,673	0.0018426	100,000	184.264619	0.0221	4.0722481
75-79	32,984	13,369,911	0.0024670	100,000	246.703213	0.0152	3.7498888
80+	56,820	15,118,984	0.0037582	100,000	375.818904	0.01545	5.8064021
Total	220,316	795,462,684	0.0002770	100,000	27.696585	100.00	27.72

> *Age-adjusted rates are artificial rates, used only to make comparisons. The real rate for a specified geographical area is the crude rate. When preparing tables, both rates should be calculated.*

Mortality rates calculated on the basis of the total number of recorded deaths in a specified geographical area are called crude death rates. Since age is the confounding factor, a standard population is used in order to eliminate the effects of any difference in age between two or more population groups. This technique is called *standard or age-adjusted mortality rates*. The choice of a hypothetical standard population is somewhat arbitrary and so it is advisable to use an external population. International experience indicates that once a standard population is adopted, it should be used across decades *(9)*. The use of dissimilar standard populations makes it impossible to compare rates over time. Consequently, the new WHO World Standard Population (2000-2025) is used by PAHO to calculate age-adjusted rates (using the direct method), in order to facilitate global comparisons. The PAHO Member Countries are also expected to use the WHO standard population.

2.4.6 OTHER FACTORS

The use of different case definitions, diagnostic criteria, or classifications of diseases can also compromise an indicator's ability to facilitate comparisons among populations. For example, deaths of newborns in a hospital can depend heavily on the type of facility—e.g., in the case of a general hospital versus a high-risk hospital. As such, case stratification of the rates according to birthweight or risk during pregnancy may provide more accurate comparisons.

The 11th revision of the International Classification of Diseases (ICD-11) should be launched in 2018. Therefore, with the required transition from ICD-10 to ICD-11, developers and users of indicators should be careful with respect to temporal comparisons of health indicators. These risks can be minimized by adopting a mapping (crosswalk) criteria that shows the equivalence between ICD-10 and ICD-11.

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DATA SOURCES FOR DEVELOPING HEALTH INDICATORS

Contents

Concepts of primary and secondary sources of data, identification, description, uses, and limitations of the principal data sources used in public health to develop health indicators.

Objective

To explain basic concepts as well as the advantages and disadvantages of the principal data sources used in public health to develop health indicators.

After reading this section, the reader will be able to define:
- The difference between primary and secondary data sources
- The main secondary data sources for estimating indicators
- The main criteria for assessing the quality of secondary data sources
- The effect of the quality of data sources on the quality of health indicators

When a decision is made to use indicators to monitor a given aspect of a population's health, there are two clear options:

1. To identify existing data sources which, though not formulated for the purpose, can facilitate the development of reliable indicator(s).

2. To devise specific data collection mechanisms for developing the indicator or set of indicators when there are no adequate data sources.

These two options define what is called secondary data from secondary sources and primary data from primary sources. The choice of whether to create new data sources for a given objective involving monitoring of a population's health or to use available data sources should be based on the advantages and constraints associated with these two options. It is therefore important to weigh the quality of the existing data sources against the effort required to create and maintain new data sources.

3.1 DATA SOURCES

3.1.1 PRIMARY DATA SOURCES

> *Primary source data provide direct evidence about an event. Data collection can take different forms, whether through a population census, national or local research (typically, sample-based or non-sample-based surveys). The creation of an information system to achieve specific objectives will generate primary data. In other words, indicators are said to be based on primary data if the data source was created to achieve a specific purpose.*

The objective of most countries' disease reporting systems for tuberculosis is to support surveillance and control of this disease. The indicators generated from that information system are examples of indicators produced using primary data. Similarly, a survey of schoolchildren designed to estimate prevalence rates of behavioral risks in a sample population is considered as a primary source when it is used for this purpose.

3.1.2 SECONDARY DATA SOURCES

Secondary source data are data that was originally collected for other purposes. The data from these existing sources are considered secondary data. Although these sources were not created for the purpose at hand, they facilitate the development of the required indicators. Data from a census, research, information system, etc., are secondary source data.

3.1.3 ADVANTAGES AND DISADVANTAGES OF PRIMARY AND SECONDARY DATA SOURCES

The advantages and disadvantages of using primary and secondary data sources in preparing and monitoring health indicators are shown in Figure 3.

Figure 3. Advantages and disadvantages of primary and secondary data sources for preparing and monitoring health indicators.

	SOURCES AND DATA	
Characteristics	**Primary**	**Secondary**
Advantages	• Greater control over quality, better collection with standardized procedures, better definition of variables and target population, etc. • Less difficulty in stratifying the indicators according to population subgroups (since the variables have been collected with a view to stratifying the objectives). • Greater temporal and spatial comparability of indicators, due to the feasibility of instituting more standardized definitions and procedures used for the different groups, while extending the period of analysis (which better serves the proposed objectives).	• Lower cost, and greater timeliness of data and indicators.

Disadvantages	• Greater cost in time and money to obtain the data, which can affect the timeliness of the indicator (particularly in the area of health management) and limit its potential for use.	• More analytical effort required to extract, define, and interpret the indicators, due to:
		
		  1. the possibility that they will prove inadequate (with regard to the relevant objectives and indicators) to define the case and target population;
		
		  2. doubts as to data quality (due to lack of standardization of procedures and training of those generating the data, etc.);
		
		• Greater difficulty stratifying the indicators according to population subgroups, due to the potential absence of relevant variables that allow for stratification; and
		
		• Greater difficulty making temporal and spatial comparisons of indicators, due to possible changes in definitions and procedures used.

3.2 ATTRIBUTES TO CONSIDER IN SELECTING SECONDARY DATA SOURCES

If the secondary sources of the data required to develop the indicators to be monitored, the characteristics of the data must be taken into consideration prior to their selection. The relevant attributes for selecting secondary data sources to generate population-based health indicators are described below. However, these attributes can and should be evaluated in the context of the purpose for which the data will be used. In addition, the selection of secondary source data should also consider the advantages and disadvantages outlined in section 3.1. The attributes are:

- **POPULATION REPRESENTATIVENESS:** Representativeness is an attribute that involves the absence of selection bias with respect to the population that the indicator is intended to represent. Non-representative samples (such as convenience samples or samples based on sentinel units), samples with high rates of non-response, or samples that reflect underreporting in information systems, are examples of factors that can compromise the representativeness of a data source. For example, a country's live birth information system is a universal system, because it is supposed to include all children born alive in all types of facilities or birthing sites. However, it is known that births in conditions of greater vulnerability (poorer regions, rural areas, areas with lack of housing, indigenous ethnicity, among other factors) might not be reported to the system. In such a case, there is a bias in the representativeness of those population groups. Similarly, research on victims of violence based on sentinel unit samples (reference health services serving such victims), might not be representative of the population. One reason is that this type of sampling systematically excludes victims with less severe injuries or with fatal injuries but were not treated in a health facility.

- **PERIODICITY:** Data can be compiled continuously in systems such as civil registries, cancer registries, and surveillance systems for reportable diseases. Data can also be compiled periodically, which is to say at regular intervals (for example, 10-year population census, triennial survey of schoolchildren), or without predefined periodicity; and at a particular point in time (for example, health surveys on specific subjects, academic research projects, etc.). Although specific health-related studies are recognized as useful sources of important information for developing specific indicators, their usefulness for monitoring long-term indicators is limited. Nevertheless, a combination of various specific research studies can serve to indicate trends, even if the studies do not provide for ideal methodological comparability. One example is research on the prevalence of smoking conducted with different methodologies and target populations. Such

research can, nevertheless, provide the general direction of a trend, with the caveat that the relevant limitations must be taken into account.

- **VALIDITY:** This refers to the ability of the source to measure what is intended to be measured (absence of distortions, bias, or systematic errors). The most relevant biases are those related to selection of the study population and the quality of the information compiled. The data source should include the variables needed to develop the indicator. An example is a live birth information system that includes data on congenital malformations (including microcephaly). In general, observations at birth without supplementary examination and monitoring of the children tend to underestimate the prevalence of congenital malformation. Although the system may be quite valid as a database for a series of other indicators, it is not valid to estimate the prevalence of congenital malformations in children.

- **TIMELINESS:** The timeliness of the source involves the availability and reliability of the data at the time it is needed to construct the indicators. Thus, timely produced indicators provide better opportunities for making health-related decisions.

- **STRATIFICATION:** Many health-related problems require indicators that are stratified according to population subgroups or by areas of particular interest. Multiple analytical interpretations can be derived from the level of disaggregation available in the selected data source. These considerations can significantly expand or limit the use of the indicator for decision-making.

- **SUSTAINABILITY:** This attribute represents the source's potential to remain relevant and be of the quality needed to generate information over time. This depends not only on the periodicity of the data collection, but on the availability of the financial resources needed to sustain that particular source of data; the presence of a legal framework; political will, among other factors. Surveys conducted by telephone tend to be more sustainable because they require fewer resources. However, telephone surveys have limitations not found in surveys based on personal interviews and biometrical measurements.

- **PRECISION:** Some well-designed probabilistic samples that ensure representativeness have some degree of imprecision—a factor to be considered in any sample-based indicator. Imprecision may arise, for example, when calculating confidence intervals that inform the user (usually with 95% confidence) of the plausible value of an indicator as applied to the population from which the sample was taken. Indicators developed from census sources, such as, population censuses, universal data sources, and vital statistics information systems, etc., are free of imprecision.

- **ACCESS TO DATA:** This refers to ensuring the availability of data to the public through national data repositories and other means.

3.3 MAIN DATA SOURCES

The main data sources include demographic censuses, vital statistics information systems, disease reporting systems, cancer registries, population-based research, and other sample-based research—which may be local (subnational) and/or periodic (regular)—and the various information systems created by the health and other sectors for administrative purposes.

Below is a description of the most frequently used data sources for the development of health indicators:

3.3.1 DEMOGRAPHIC CENSUSES

In most countries, the demographic census is the most commonly used data source on the characteristics of a population. A census is of paramount importance for preparing indicators and planning health interventions. Other demographic data sources are household censuses, civil registries, and national estimates for variables of interest. Demographic data are necessary for calculating many health-related indicators.

The data in a national census include: (a) total population, by sex, age, and ethnic origin; (b) increase in population; (c) rural and urban distribution of the population; and (d) dependency ratio. In addition, demographic censuses become secondary data sources when used to establish the denominators of many health indicators (rates, proportions, ratios): mortality; incidence and prevalence of diseases, accidents and violent acts; prevalence of risk factors for accidents and violence, as well as sequelae of these events; and ratio of hospital beds to population.

The growing need for information has made censuses an essential tool for countries' information systems. They serve a political, administrative, technical, and scientific purpose. Such data are compiled for the entire population, through personal interviews. In most countries, censuses represent periodic data that are collected every ten years, with publication of the information they yield approximately two years later.

> *The strengths of censuses are: (1) a high degree of representativeness since they are a complete (or nearly complete) record of the total population in the country; (2) periodicity--even though the frequency of the data collection is every ten years, the time-sensitive information is useful, especially as a point of reference; (3) high sustainability since the census is the task of a governmental agency that guarantees the necessary resources and legal framework; (4) knowledge of the distribution of the population, based on major characteristics; and (5) inclusion of health-related questions.*

One limitation in the use of census data is the possibility of inaccuracies in population estimates for the inter-censal years. These estimates tend to lose accuracy the further they are from the year of the census. In addition, the calculations are subject to changes as new demographic information is generated. There are various methods for making these estimates, each based on its own assumptions, but all include the basic demographic factors of fertility, mortality, and migration *(1)*.

With major changes in the factors affecting a country's demographic structure, existing methodologies can become problematic, particularly with respect to population projections. There is the difficulty, for example, of making adequate population projections based on the 10-year demographic censuses given the steep decline in fertility rates that occurred between 1980 and 2010. Population migrations resulting from conflicts or economic factors can also affect population projections. In addition, these factors can affect estimates of health indicators since population data from demographic censuses and the corresponding projections are used as the denominator. For these reasons, if indicators are to be monitored over time, they should be recalculated retrospectively as new population projections are made.

3.3.2 HEALTH INFORMATION SYSTEMS

National health information systems provide data for health-related events; these systems also provide some census-related data. National health information systems can have sub-systems that address specific health events to include mortality, births, notifiable diseases, cancer and other disease registries.

- **Mortality information systems:** All of the countries in the Region of the Americas are required to report all deaths. In some countries, this requires the completion a form known as the "declaration of death," followed by registration of the event in the civil registry system where a death certificate (a legal document), is issued. WHO has established an international form

of medical certificate of cause of death. It contains a minimum set of variables that should be included in a death certificate. These include the underlying, intermediate, and immediate causes of death. Most countries use the International Classification of Diseases (ICD) *(2)* to code the causes of death. This permits comparisons between countries and at different points in time. In some countries, especially in remote areas, the reporting of deaths is incomplete, thereby compromising the representativeness of mortality statistics. The proportion of under-reporting of deaths and the proportion of deaths due to ill-defined causes are indicators of the quality of mortality statistics *(3-5)*.

- **Birth registration systems:** These are a source for census data and for the collection of vital statistics. In all of the countries in the Region of the Americas, it is compulsory for every live birth to be reported. In most of these countries, births occur in health facilities where a form known as the "declaration of live birth," is issued. Subsequently, the birth must be recorded in the civil registry where a birth certificate, a legal document, is issued. Declarations of births generate data for formulating indicators that are highly useful in monitoring maternal and child health during the prenatal, delivery, and perinatal periods, while also providing information on a population's fertility profile. Standardizing definitions, forms, and variables of interest facilitate comparisons between countries and over time. The main limitation in working with birth indicators is the fact that coverage may be incomplete, particularly in remote areas within certain countries thereby compromising the representativeness of the resulting statistics. The proportion of unregistered births and of incomplete information on important variables are indicators of the quality of birth registration *(6)*.

These two systems are sources of data to develop indicators. Information systems that include vital statistics, especially on mortality and births, have many strengths to include: (1) a high level of sustainability since all countries have legislation mandating the collection of vital statistics; (2) continuous periodicity as data are prepared continually, as occurrences are recorded; and (3) a high level of representativeness in nearly all of the Region (with specific problems in some areas, due to underreporting).

- **Public health surveillance systems:** According to WHO, "public health surveillance is the continuous, systematic collection, analysis, and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice." *(7)*. These systems are useful sources of data for developing morbidity indicators regarding the prevention and control of communicable diseases, noncommunicable diseases, accidents, and violence. Surveillance systems for communicable diseases play a key role in providing early warning of possible threats to public health and make it possible to monitor measures and programs for prevention and control. Effective national surveillance and response systems are therefore essential for national, regional, and global health security.

  Most of the Region's countries have national surveillance systems established by their ministries of health. These differ, however, from country to country with regard to the number of diseases under surveillance, the type of information compiled, the use of electronic or hardcopy records, and the systems' coverage. Surveillance of noncommunicable diseases can be conducted by health care services (with information from health institutions) or using population-based health surveys. Additionally, surveillance can occur through disease-specific programs such as for tuberculosis and vaccine-preventable diseases. In some countries, the surveillance of certain diseases may not be integrated into the national surveillance system. Notably, surveillance case definitions can change over time in response to changes in the characteristics of an epidemic, as in the case of HIV/AIDS and H1N1. Another surveillance tool is the International Health Regulations 2005 (IHR) which calls for the monitoring of diseases that have the potential to cross borders and threaten people worldwide.

  In recent years, surveillance systems have been used to monitor a broad range of health conditions, risk factors, and other public health issues. Some countries have implemented surveillance registries for noncommunicable diseases (cervical cancer, acute myocardial infarction, violence, diabetes, etc.) or for health problems caused by toxic substances in the environment. These registries compile information on all cases of these diseases through the health care network or through sentinel surveillance units. Such systems are a source of data on morbidity indicators that are useful in disease prevention and control efforts *(8)*.

Notable advantages of using surveillance systems as sources for developing indicators include: a) representativeness although there can be variations based on the characteristics of the country's system; b) a high level of sustainability for monitoring the diseases that are subject to regulation and/or legislation; and c) high periodicity as data are compiled continuously.

It should be noted that since the actual frequency and distribution of a population's health condition is usually estimated, it is impossible to measure precisely its representativeness.

The collection, analysis and interpretation of surveillance data and indicators on immunization were essential in formulating strategies to control and eliminate vaccine-preventable diseases in the Region. Notably, PAHO is the first WHO region certified as polio-free and the first to have interrupted the endemic transmission of measles and rubella.

- **Population-based cancer registries:** These are the gold standard for providing information on this disease. Cancer registries compile, classify, analyze and report information on all cancers occurring in a geographically defined population. The information is collected from a multiplicity of sources, including hospitals, clinical analysis laboratories, and departments of vital statistics. Routine calculation of rates (per 100,000 inhabitants) produced by population-based cancer registries provides information that can assist public health officials to better understand the disease, its treatment, and to evaluate cancer prevention and control programs. This information provides a solid basis for planning and implementation of programs to reduce the cancer burden as well as provide input for research.

3.3.3 ROUTINE DATA FROM HEALTH FACILITIES

As part of their normal activities, health facilities generate highly useful data on the delivery of services (hospitalizations, consultations, surgeries, insertion of prostheses, etc.), coverage of health interventions, resources (number of physicians, nurses, and beds, number of vaccines given, health sector expenditures, etc.), and disease patterns. For a number of indicators—such as access to health services and the cesarean-section rate—data from health facilities are the sole source. Moreover, health facilities are important

sources of subnational data, by province, region, or district that have a direct bearing on management decisions.

> *Unlike household surveys, data from health facilities are produced continuously, and can generate reports annually, or more frequently, as necessary.*

Within the Region, particularly in the Caribbean, the countries have shown an increasing interest in implementing national information systems on hospitalizations, ambulatory and emergency services, and in the use of electronic medical records. Some countries, such as Belize and Dominica, have made major investments in these areas.

Since these data sources tend be created for administrative purposes rather than for monitoring of health events per se, the epidemiological data they generate may have biases that affect their coverage, quality, and usefulness. In some of the countries, these systems are fragmented, and information exchange between the public and private sectors is difficult, leading to late, incomplete, and/or incorrect reports. Despite these challenges, there is reason for optimism, given the growing introduction of new information technologies (electronic medical records, etc.) with the potential to substantially improve the quality and use of data for decision-making *(9)*.

Data on human resources in health can be obtained through professional associations. However, the data can be distorted if the information on deaths, migration, type of training, and current occupation, etc., are not periodically updated.

3.3.4 POPULATION SURVEYS

> *A national health survey is a descriptive cross-sectional epidemiological study that is useful for calculating the prevalence of self-reported events, or events measured in the course of the investigation, generally employing a representative (probabilistically chosen) sample from the population of interest.*

Population surveys have become an important source of information on health status and the social determinants of health. They can provide data for several purposes such as risk factors; access to (and use of) services; medication availability and use; morbidity, mental health; violence and injuries; disability; drug abuse; reproductive health; work conditions; lifestyles, etc.

These surveys can estimate prevalence rates for diseases, risk factors, behavior, prior conditions, situations of vulnerability, knowledge, attitudes and habits regarding various health-related practices, use of health services, etc. The target population can be a general population defined by its geographic area, or a specific population defined by some attribute of interest such as adolescents, schoolchildren, women of childbearing age, males in specific age groups, persons deprived of liberty, etc.

An example of a population survey is the Global Tobacco Surveillance System (GTSS). This is an exhaustive survey that monitors tobacco use and the policies enunciated in the WHO Framework Convention on Tobacco Control (WHO/FCTC), though that system is not designed to facilitate comparisons with other factors. An example of a multi-thematic survey is the WHO STEPwise approach to surveillance, which has the characteristics of a general survey. This survey encompasses a multiplicity of issues for monitoring within-country trends. It permits the compilation of biological and physical measures, though it provides only limited possibilities for close monitoring of the entire range of issues, a constraint that particularly affects the ability to monitor policy implementation *(10)*.

Survey data can be gathered through various types of communication, including personal interviews (household surveys), telephone interviews, and questionnaires completed by the subjects themselves. Population surveys make it possible to monitor the population over time using probabilistic samples—a method that involves lower cost and simpler fieldwork—or using a more complex and costly structure. Surveys conducted in schools have been used globally and are simple and relatively inexpensive way of surveying a population. This is in contrast to household surveys, which involve a more complex structure and process.

> *The use of population surveys has several strengths: a) data can be compiled to prepare indicators related not only to diseases but also to health-related issues, such as the proportion of vegetable and fruit intake; b) they constitute a source that complements the health information system and is an important tool for formulating and evaluating public policies; and c) they facilitate comparisons with civil registry records.*

Household surveys can be used as data sources to estimate indicators regarding determinants of health, health status, and trends in health expenditures at the national and individual levels.

Constraints in using surveys as data sources include the following:
a) people provide information based on their own evaluation of their health and illnesses; b) in terms of response rates, the success of a survey depends on its planning and on interviewees' willingness to provide information; and c) representativeness and disaggregation of data can considerably increase the cost of a survey *(10-11)*. Additionally, sustainability due to a scarcity of resources or political will can be an obstacle.

Many countries in the Region have conducted household surveys on different areas of interest. Some countries establish national health surveys as a key source of information on various health-related issues. Nevertheless, it is important that countries continue their efforts to strengthen national capacities, create sustainable surveillance systems, and provide adequate budgetary allocations to ensure the production of reliable, systematic, standardized, and timely national health information.

Figure 4 shows a selection of national and international surveys that have been conducted in the Region of the Americas to provide information on non-communicable diseases and risk factors.

Figure 4. Selection of national and international surveys on non-communicable diseases and risk factors (1)

SURVEY	TARGET POPULATION (AGE IN YEARS)	KEY COMPONENTS	ORGANIZATIONS INVOLVED
GLOBAL YOUTH TOBACCO SURVEY	13-15	Sociodemographic factors, tobacco consumption (consumption and product patterns); measures of reduced demand as envisioned by the WHO FCTC; knowledge, attitudes, and perception.	WHO/CDC
GLOBAL SCHOOL-BASED STUDENT HEALTH SURVEY	13-15 13-17	Alcohol consumption, eating behaviors, drug use, hygiene, mental health, physical activity, protective factors, sexual behaviors, tobacco use, and violence and accidental injuries.	WHO/CDC
STEPwise method	15+/18+/25+	STEP 1: Evaluation based on questionnaires. Socioeconomic data, data on tobacco and alcohol consumption; certain measures of nutritional status and physical inactivity are included as markers of current and future health. STEP 2: Simple physical measurements. Step 2 adds elements to Step 1 by including simple physical measurements such as height, weight, waistline, and blood pressure. STEP 3: Biochemical measurements.	WHO
GLOBAL ADULT TOBACCO SURVEY	15+	Sociodemographic data, tobacco consumption (patterns of consumption and different tobacco products), measures of reduced demand as envisioned in the WHO FCTC, such as those associated with second-hand exposure to smoke and corresponding policies; quitting; knowledge, attitudes, and perceptions; exposure to the media; and economic factors.	WHO/CDC
DEMOGRAPHIC AND HEALTH SURVEYS	Women ages 15 to 49 (reproductive age), and men ages 15 to 59 or 15 to 54)	Anemia, child health, domestic violence, education, environmental health, family planning, female genital ablation, fertility, gender/domestic violence, HIV infection/AIDS, characteristics of homes and interviewees, infant and childhood mortality , malaria, maternal health, nutrition (including iodized salt), tobacco use and second-hand smoke exposure, maternal mortality, anthropometry, women's empowerment, health spending).	USAID
RESEARCH ON MEASURING STANDARDS OF LIVING	Representative response of family members	Disabilities, consumption, income, labor-related elements, subjective well-being, unequal opportunity, financial services, risk and vulnerability, infrastructure, and gender.	World Bank
DRUG ABUSE SURVEY	12-65	Prevalence of alcohol, tobacco, and illicit drug consumption.	UNODC–OAS/ CICADS Agencies on drug abuse
MULTIPLE INDICATOR CLUSTER SURVEY	Women ages 15 to 49, and information on children under age 5	Infant mortality, nutrition, child health, water and sanitation, reproductive health, childhood development, education, child protection, HIV infection/AIDS and sexual behavior, access to mass media and technology, subjective well-being, tobacco and alcohol consumption.	UNICEF
SURVEY ON BEHAVIORAL RISK FACTORS	18+	Preventive health practices and risk behaviors associated with chronic diseases, injuries, and preventable infectious diseases.	CDC

Source: WHO, World Health Organization, Centers for Disease Control and Prevention (CDC); FCTC, WHO Framework Convention on Tobacco Control; United States Agency for International Development (USAID); United Nations Office on Drugs and Crime (UNODC); Organization of American States (OAS); Inter-American Drug Abuse Control Commission (CICAD); United Nations Children's Fund (UNICEF); human immuno-deficiency virus (HIV).

3.4 MAPPING OF DATA SOURCES

A mapping of data sources consists of an inventory of sources available at the level of the country, state, province, or other geographic/administrative unit *(12)*. It involves identifying and describing all the data sources available in the country in order to determine the possible sources that can be used to develop the health indicators. Mapping can help identify gaps and the need for new and/or complementary data sources to develop appropriate health indicators. If there is a paucity of data in a particular area or program component, it is important to collect the data for subsequent analysis. The mapping of data sources involves:

- Constructing a list (by type) of all available data sources used in formulating health-related indicators in the country together with the time period covered by the data set. Where relevant, preparing the same list with additional sources at the state, province, and community levels.

- Constructing a table with information on each source's level of disaggregation, insofar as this is pertinent for the analysis of health indicators.

Figure 5. Example of list of data sources available for generating indicators (using fictitious data)

SOURCE / TYPE OF SAMPLE	TARGET POPULATION	INSTITUTION RESPONSIBLE	TYPE OF DATA COLLECTION	YEAR(S) OF DATA COLLECTION	RELEVANT (POSSIBLE) BREAKDOWN
Population Census	National (universal)	National statistics institute	Periodic (10-year)	Rounds of 1990, 2000, and 2010	Sex, age, geographic unit, schooling, ethnic origin
Hospital / census information system	National (care in public hospitals exclusively)	Ministry of Health	Continuous	Since 1998	Sex, age, geographic unit, schooling
Survey of schoolchildren / Representative sample	Capital Cities (schoolchildren 10-15 years old enrolled in public and private schools)	National statistics institute and universities	One-time	2016	Sex, age, geographic unit, type of school, ethnic group, social level
System for surveillance of accidents and violence/Non-representative sample	Selected sentinel units (victims of accidents and violent acts served in selected public facilities)	Ministry of Health	Periodic (without defined intervals)	2010, 2015, and 2017	Sex, sexual orientation, age, location of the event, profile of the perpetrator, schooling

RELATED LINKS

- List of national statistics institutes in Latin America, available on the web page of the Latin American and Caribbean Demographic Centre (CELADE).
  http://www.cepal.org/celade/proyectos/censos2000/cen_ines00e.htm

- International Statistical Classification of Diseases and Related Health Problems. Tenth revision. 2008 edition. Volume 1.
  https://www.cihi.ca/en/icd_10_ca_vol1_2009_en.pdf

- Strengthening civil registration and vital statistics for births, deaths, and causes of deaths – Resources kit.
  http://www.who.int/entity/healthinfo/CRVS_ResourceKit_2012.pdf?ua=1

- World Health Organization. International Health Regulations
  http://www.who.int/ihr/IHR_2005_en.pdf

- Mortality statistics: a tool to improve understanding and quality.
  http://www.getinthepicture.org/sites/default/files/resources/Mortality%20statistics%20a%20tool%20to%20improve%20understanding%20and%20quality.pdf

- Improving the quality and use of birth, death and cause-of-death information: guidance for a standards-based review of country practices.
  http://www.who.int/healthinfo/tool_cod_2010.pdf

- Global Youth Tobacco Survey.
  http://www.who.int/tobacco/surveillance/gyts/en/ and CDC. http://www.cdc.gov/tobacco/global/

- Global school-based student health survey.
  http://www.who.int/chp/gshs/en/

- STEPwise Method (Survey of Risk Factors).
  http://www.who.int/chp/steps/en/

- Global Adult Tobacco Survey.
  http://www.who.int/tobacco/surveillance/survey/gats/en/
  http://nccd.cdc.gov/gtssdata/Ancillary/Documentation.aspx?SUID=4&DOCT=1

- Demographic Health Survey.
  http://dhsprogram.com/What-We-Do/Survey-Types/DHS.cfm

- Estudio sobre la medición de los niveles de vida.
  http://www.inide.gob.ni/Emnv/emnv2014.html

- Survey on drug abuse.
  http://cicad.oas.org/Main/template.asp?File=/oid/default_eng.asp%20&n/data-y-analysis/statistics/drug-use.html%20http://www.unodc.org/unodc/e

- Multiple Indicator Cluster Survey.
  http:/www.unicef.org/statistics/index_24302.html

- Behavioral Risk Factor Surveillance System
  http://www.cdc.gov/brfss/

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PROCESS TO EVALUATE THE QUALITY OF DATA AND HEALTH INDICATORS

Contents

Criteria, process, stakeholder involvement, and practical strategies to evaluate the quality of health indicators

Objective

To discuss strategies for evaluating the quality of health indicators

After reading this section, the reader will be able to define:

- How a health indicator is developed and validated
- Principal criteria for the quality of health indicators
- Steps involved in evaluating a health indicator
- The role of stakeholders in evaluating indicators

4.1 INTRODUCTION

Section 1 detailed the attributes of a good indicator, emphasizing that indicators should be measureable, feasible, valid, timely, replicable, sustainable, relevant, and comprehensive. In addition, indicators should be stratified by person, place, and time as desirable. This section describes some practical strategies for evaluating the quality of health indicators. It should be emphasized that sources of high quality data contribute to the development of high quality indicators. In addition to the quality of the sources and the data, the performance of the indicator should measure what it is intended to measure.

4.2 DEFINING AND CHARACTERIZING THE HEALTH INDICATOR BEING EVALUATED

In order to evaluate an indicator, its purpose and attributes must be well-defined. This involves more than simply knowing and adequately describing its numerator and denominator (assuming it is structured in that way). Some publications (RIPSA, UNAIDS, and the WHO Global Reference List of 100 Core Indicators) are useful references for this discussion. *(1-3).*

According to these publications, the following attributes of the indicator should be clearly specified:

1. The name and definition of the indicator
2. The purpose and rationale for the indicator (identification of what is to be measured)
3. The method of measurement or calculation of the indicator
4. The data sources (institutions and information systems involved) for the indicator
5. The data collection methodology
6. The frequency of data collection
7. The levels of data disaggregation required
8. The guidelines for the indicator's interpretation and use
9. The indicator's strengths, limitations, and challenges
10. Additional sources of information
11. Explanatory remarks

Examples:

Model of a technical file for defining and characterizing health indicators from the PAHO Strategic Plan (Annex. Include hyperlink in the online version) and an Excel file with selected indicators from the Global Reference List of 100 Core Indicators (include hyperlink).

4.3 KEY STAKEHOLDERS IN THE PROCESS OF EVALUATING HEALTH INDICATORS

The evaluation of health indicators should, insofar as possible, include the key stakeholders involved in the production, analysis, and interpretation of data and information. These persons should be familiar with the processes involved in monitoring local, regional, and national trends and conditions. Notably, most health data and information are generated at the local level by local health workers who are more knowledgeable about the characteristics, strengths, and limitations of the data and the derived information. Accordingly, whenever possible, it is desirable for local-level personnel to participate in the first phase of the evaluation process. Data producers, managers, and users should promote a culture that values information and is conducive to data collection and its management. Ongoing training initiatives on data collection, management, evaluation, and analysis are very important to improve national capacities, especially at the local level.

As mentioned earlier, the quality of indicators depends, to a large extent, on the quality of the data and its sources. All major stakeholders, including data producers and managers of information systems, should

be encouraged to play the role of users and critics so that they can be knowledgeable of the strengths and weaknesses of the system. Health information systems that cannot provide the underpinnings for decision-making in health contribute to a waste of scarce resources and the paucity of reliable information in the health sector. An efficient health information system generates products that are of increasing value to improvements in health care. The continuous need for quality health information is a strong motivator for strengthening and using national health information systems as well as for providing feedback about any limitation inherent in these systems.

Since the health sector is influenced by a wide range of factors, many of which fall outside the health care delivery sector, collaboration with the non-health sectors, such as in other government entities, universities, and research centers is important. Some of the core interests of the non-health sectors require defining, developing, analyzing, and using health indicators. As such, inter-sectoral collaboration will improve and optimize the quality and relevance of health indicators as well as promote evidence-informed decisions across all sectors.

4.4 STEPS FOR EVALUATING THE QUALITY OF HEALTH INDICATORS

Some authors have proposed guidelines for evaluating health data and indicators *(3-4)*. However, there are some fundamental considerations that can be applied when evaluating health indicators and these are outlined in the following steps:

Step 1. Examine the integrity of the complete and valid data on which the indicator is based

a. *Is the indicator based on data representative of the target population?* Examine in detail the population the data is supposed to describe. Avoid undue generalizations (extrapolations). Be alert to possible selection bias due to nonresponse, demand and indication biases; ascertain whether some facilities generate more reports than others (e.g., public versus private facilities).

b. *Are the variables used to calculate the indicator complete, adequate, and sufficient?* Calculate and tabulate the characteristics of the variables used to develop the indicator. Include proportions of nonresponse (if possible), invalid responses, and other losses. Identify problems in coverage of the relevant variables, taking into account low representativeness; possible selection bias in an indicator; and calculations based on non-representative data.

c. *Is the indicator based on valid data from the target population?* Were the variables used to calculate the indicator measured correctly and was a minimum standard applied? Analyze in detail how the

attributes of the variables that produced the indicator are defined, calculated, and compiled. This includes a review of case definitions, the competency of the personnel responsible for data collection, and quality of the instruments (diagnostic tests, measuring equipment, etc.) used to collect the data. Identify problems of validity in the relevant variables, and account for measurement bias in indicators based on problematic calculations.

Steps 2 to 5 are designed to evaluate the indicator's observed and expected values in different situations, according to the characteristics of person, place, and time. This evaluation will answer the following three questions:

I.   Could the discrepancies that are discovered be the result of random fluctuations of small numbers? An insufficient number of observations makes it impossible to precisely estimate an indicator.

II. Could the observed discrepancies be the result of biases (systematic errors in indicator measurements) that compromise the quality of the indicator?

III. Could the observed discrepancies be valid? Discrepancies between expected and observed values should be examined carefully so as not to overlook actual variabilities attributable to local changes.verdaderas debido a cambios o singularidades locales.

Step 2. Examine the consistency of the estimated indicator with regard to personal attributes

Is the indicator consistent based on personal characteristics? Analyze consistency, considering the personal variables (sex, age, etc.) of the data source, category by category, as relevant to the indicator in question. Observe the values of the indicator according to those variables, and analyze whether they are plausible. Are the results consistent with expectations for the given population subgroups?

For example, if the indicator is mortality from cardiovascular disease, the observed distribution of the indicator by sex and the age should, at a minimum, reflect the greater risk associated with certain groups (e.g., older men). Confirmation that the higher levels of these indicators are consistent with groups expected to be at greater risk for the disease bolsters confidence in the quality of the indicator.

Step 3. Examine the consistency of the estimated indicator with regard to place attributes

Is the indicator spatially consistent? If possible, analyze its spatial distribution (by municipality, state, urban versus rural residence, etc.). Most indicators have an expected spatial pattern that reflects the known distribution of important risk factors (e.g., poverty, young versus older populations, more or less urbanized areas, etc.). Examine the consistency of the indicator's pattern with regard to expectations, and identify signs suggesting that the quality is unreliable.

Table 4 presents average values of selected indicators for sub-regions of the Americas. These values can be used as a reference to assess the consistency of indicators in the countries. At the end of this section, there is a link to PAHO's list of core indicators and their trends.

Table 4. Selected indicators of the Region of the Americas and its subregions

INDICATORS	YEAR	THE AMERICAS	NORTH AMERICA	LATIN AMERICA	CENTRAL AMERICAN ISTHMUS	LATIN CARIB-BEAN	ANDEAN AREA	SOU-THERN CONE	NON-LA-TIN CARIB-BEAN
Life expectancy at birth (years)	2016	77.0	79.7	75.5	74.4	73.4	74.4	77.8	73.8
Maternal mortality rate reported/100 000 lb	UAD*	46.8	12.1	60.8	80.2	104.4	77.3	35.2	88.8
Maternal mortality rate estimated/100 000 lb	2015	51	13	66	87	188	87	54	105
Infant mortality rate reported/100 000 lb	LAY*	13.0	5.9	15.9	17.5	32.8	18.7	10.3	17.2
Neonatal mortality rate reported/100 000 lb	LAY*	8.2	4.0	10.0	9.8	19.1	12.0	7.1	15.8
Under-five mortality rate reported/100 000 lb	LAY*	15.9	6.9	19.6	22.2	48.9	22.9	11.9	18.9
General mortality rate/1 000 pop	2014	5.6	4.8	6.0	6.7	5.8	6.3	5.5	7.2
Mortality rate due to external causes/100 000 pop	2014	63.5	53.3	68.8	81.1	61.4	87.7	46.6	70.3
HIV incidence rate/100 000 pop	2015	12.9	13.1	12.3	12.4	18.0	18.2	15.3	56.8
Tuberculosis incidencie rate/100 000 pop	2014	22.1	3.0	33.2	28.4	58.8	45.3	20.8	15.9
Stunting in children aged < 5 years (%)	2012	10.1	2.1	13.2	30.2	13.1	16.5	7.1	6.9
Overweight in children aged < 5 years (%)	2012	7.2	6.0	7.7	5.4	7.7	6.6	10.0	6.6
Overweight in adults	2014	61.0	67.0	57.6	54.0	51.2	57.6	60.8	59.4

* LAY= Latest available year
Source: PAHO. Core indicators 2016. Health Situation in the Americas.

Step 4. Examine the consistency of the estimated indicator with regard to temporal attributes

Is the indicator consistent over time? If possible, analyze its trends over time (years, months, weeks, etc.). Some indicators have a known seasonal cyclic pattern of variation, or they indicate historical trends that can serve as a reference for analysis. Moreover, most indicators show gradual fluctuations in temporal trends, such as slightly increasing or decreasing but no large increases, except in special situations. Major temporal fluctuations can indicate:

I. True fluctuations due to epidemics (dramatic events that alter an indicator's course). An example would be the unusual increase of microcephaly cases associated with the Zika virus epidemic in cities of northeastern Brazil.

II. Random fluctuations due to the small number of cases occurring in places with small populations (denominator) or due to a small number of events (as in the case of infrequent diseases). In these situations, the addition or subtraction of a few cases (the numerator) can produce a large increase or reduction in the resulting rate. Consequently, greater attention should be given to the absolute number of cases than to the rates since, in such situations, rates can lead to false interpretations. Situations of this type arise frequently but are easy to detect. All that is needed is an examination of the ratio of change in the rate in relation to the size of the reference population. To avoid this statistical phenomenon, the data over longer periods (e.g., three-year periods) can be combined; geographic areas (such as municipalities or similar entities close to each other) can also be combined. These adjustments make the indicator stable enough to be meaningful.

III. Fluctuations due to (non-random) error: Systematic errors in the measurement of the denominator and/or numerator at a given point in time can generate large variations in an indicator. Common examples of this phenomenon are changes in the definition of cases with the introduction of new diagnostic techniques in surveillance systems; under- or over-counting of cases beginning at a particular point in time; and problems with the methods used to estimate the population size between censuses (denominators). As indicated above, communication and partnership with the producers of the data on which the indicator was based can be helpful to provide clarification and/or retrospective correction of the phenomenon being observed.

Step 5. Examine the plausibility of the magnitude of the indicator in relation to other data sources

Compare the indicator's magnitude with existing information and evidence from other data sources. Is the result of the measurement of the indicator plausible considering what is already known about the subject? Is it plausible considering estimates made by other methods (indirect methods, research, or

other data sources)? Is it plausible considering the current conditions of the population for which it was estimated? Is it plausible considering the risk factors present in the population? Lastly, is it plausible considering the values of the same indicator as estimated for other countries, states, or municipalities with better or worse conditions?

For example, findings of low maternal mortality ratios in countries where women's health care during pregnancy, childbirth, and puerperium is precarious and where the quality of national surveillance systems is not high, should cast doubt on the quality of the indicator. Comparing it with countries that have better health care can help clarify the perceived disparity.

4.5 EVALUATION OF MORTALITY DATA

AbouZahr et al. *(4)*, proposed the following ten steps for evaluating mortality data:
1. Prepare basic tabulations of deaths by age, sex, ethnic origin, and cause of death
2. Review crude death rates
3. Review age- and sex-specific mortality
4. Review the age distribution of deaths
5. Review infant mortality rates
6. Review the distribution of the leading causes of death
7. Review the age pattern of the leading causes of death
8. Review the leading causes of death
9. Review the ratio of deaths from non-communicable diseases to deaths from communicable diseases
10. Review deaths for ill-defined causes

RELATED LINKS

- Pan American Health Organization. Core Indicators 2016. Health Situation in the Americas. http://iris.paho.org/xmlui/handle/123456789/31289

- Pan American Health Organization. Health Information Platform for the Americas (time series of core indicators, other indicators, and health information). http://www.paho.org/data/index.php/en/

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INDICATORS ESTIMATED BY INDIRECT METHODS: BASIC CONCEPTS, USES, AND LIMITATIONS

Contents

Estimation of the indicators most commonly used in public health

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Objective

To gain familiarity with estimates of the most common health indicators, their uses, and limitations

After reading this section, the reader will be able to define:

- What it means to estimate an indicator
- Main reasons for using estimates

5.1 METHODS FOR INDICATOR ESTIMATION

An estimate is an approximate value calculated on the basis of the incomplete evidence or available data.

> *In statistics and demography, estimating means determining or calculating the value of something, with a certain margin of imprecision, when the thing being examined is not known in its entirety.*

Almost all calculations of health indicators are based on estimates irrespective of whether the data was collected by direct measurements or by indirect measurement techniques; in both cases there is a margin of error. Where a direct measurement is involved, inaccuracies can stem from random errors that are inherent in the sampling processes or from systematic errors due to the procedures used to select the population, collect the data, and its subsequent analysis. In the case of estimates based on indirect measurements techniques that use mathematical or statistical models, inaccuracy can also occur because of inherent errors in the methodology owing to the assumptions and limitations of the model. Assumptions in such models are difficult to assess. This is particularly so in small populations where valid and replicable data and information are limited and, especially in the absence of sufficiently long and reliable times series.

This section uses the term estimate to refer to *estimation* by indirect methods based on techniques that employ mathematical and statistical models or other demographic techniques to adjust or correct direct data. Thus, estimates of indicators by indirect methods are in contrast to the direct calculation of indicators, which are based exclusively on data and information from primary or secondary sources of information.

5.2 USES AND LIMITATIONS OF ESTIMATING INDICATORS

In most countries, information systems and other sources of health data have improved considerably. Nevertheless, because of data gaps and measurement challenges, there is a need to calculate estimates of health indicators using different mathematical, statistical, and other methodologies. There are several reasons for using estimates for population health indicators. Following are examples of such situations:

- Total absence of information systems and other data sources to calculate core indicators of life events and other essential information for health management purposes.

- Absence of overall population data, or of population counts in the periods between censuses or in years since the most recent census (even in cases where periodic censuses are conducted).

- Gaps in health data, due to significant problems of validity and coverage at certain points in time or in particular geographic areas, as a consequence of limited technical capacity, changing political priorities, or lack of financial sustainability of health information systems, among other possible factors.

- Situations in which there are adequate data and health indicators, but they are derived from studies with probabilistic samples (partial observation of a whole), for which sampling variation needs to be incorporated through a process of estimation (statistical inference).

- The need for indicators that are of interest to international organizations in comparing and monitoring countries, as well as in producing estimates for major world regions, including countries with very different quality and coverage of health information (*1*).

The methodology that a country uses to make estimates through indirect methods to facilitate cross-national compatibility with the global indicators that are calculated by international organizations, should be viewed with caution. This issue has been widely debated (*1, 2*).

There is a consensus that direct data should, whenever possible, be assessed and evaluated continuously. Routine use of direct data can create opportunities for improving the data sources. The indiscriminate use of estimated indicators can undermine the authenticity of data and information originating directly from national health information systems. A possible consequence could be the possible reduction in the allocation of resources to improve health information systems, particularly in countries with scarce health resources.

Many indirect estimation methods (for demographic or other data) are subject to inaccuracies, especially in certain situations, such as when national data are rarely available or are incomplete. However, it is precisely in such situations that the calculation of estimates for health indicators becomes necessary. In order to overcome the problem of unavailability of data, imputed data are sometimes used to generate the data required for indirect estimation. The inherent limits of imputation are underestimated. These include lack of representativeness of a country's diversity, possible presence of undetected random error, possible presence of major systematic errors, etc. (*2*). Such errors can greatly compromise the accuracy of indirect estimates and may not necessarily be an improvement over limitations in the quality of direct data. Another relevant issue is the limited ability of most indirect techniques to accurately capture significant changes in the indicators being calculated. An example is the steep decline in fertility rates in Brazil and the inability of the government's population projection techniques to adequately explain the phenomenon, e.g., through live birth estimates.

Finally, indirect estimation processes have grown increasingly complex in recent years; this brings with it a diminished capacity for communication and replicability. In this context, the Guidelines for Accurate and *Transparent Health Estimates Reporting* (GATHER) (*3*) represent a commendable effort to formulate some guidelines.

> *These guidelines should be considered an option for addressing the paucity of reliable health data in certain contexts. However, their limitations and consequences for accurate and transparent reporting of health indicators should always be borne in mind.*

Partnerships at the local, national, and global levels should be encouraged to strengthen national health information systems and building capacity for the production, analysis, and use of data and health indicators. The efforts of international organizations (WHO and other United Nations entities), scientific institutions, and governments to support the improvement of health information systems and analytical capacity deserve recognition.

The need for valid global, national, and subnational health indicators (regardless of their origin) is of fundamental importance since these indicators shape priorities for health-related investments; facilitate the assessment of progress and effectiveness of interventions; and are necessary for organizing strategic international cooperation. Accordingly, to address the need for credible health indicators, the best available evidence at a given time must be used, even when a degree of inaccuracy is inevitable. *(4)*

Examples of such situations are:

- Where data quality does not meet minimal standards or where no country-level information is available.

- In order to verify the reliability of the events being studied, as in the case of underreporting of mortality—particularly infant and maternal mortality.

- The need, at the global or regional level, to use standardized information to calculate indicators. Discrepancies in the quality of data and information, and differences between health systems' protocols concerning population representativeness, case definition, and data collection and analysis in different places (countries), and at different points in time, can greatly compromise the ability of indicators to provide comparisons between countries and regions.

The main sources for statistical estimates are: the United Nations Population Division and the United States Census Bureau (for population estimates); the World Bank (for estimates of socioeconomic and maternal mortality indicators); WHO (for mortality figures, mortality tables, and maternal mortality rates); UNICEF, UNFPA and CELADE (for mortality figures and tables); and academic institutions, using a variety of other estimates.

PAHO, as an international organization, uses population estimates provided by the United Nations Population Division rather than from the national censuses from its Member Countries. This approach ensures comparability with data on maternal and child mortality that come from the United Nations Inter-agency Group for Child Mortality Estimation (IGME). This agency was created in 2004 to harmonize estimates within the United Nations system; improve child mortality estimation methods; report on progress toward achieving the Millennium Development Goals and now the Sustainable Development Goals; and strengthen countries' capacity to conduct timely, properly evaluated calculations on infant mortality. The IGME is headed by UNICEF and the World Health Organization (WHO), with participation by the World Bank and the United Nations Population Division (part of the United Nations Department of Economic and Social Affairs).

5.3 ESTIMATION OF MATERNAL AND INFANT MORTALITY INDICATORS

Given the need to establish a baseline for measuring progress toward Millennium Development Goal 5 (MDG-5, and now SDG-3), and the lack of reliable data on global trends in maternal mortality, it was necessary to estimate the number of maternal deaths, as well as the maternal mortality ratio (MMR).

Many countries have made important advances in detecting and recording maternal deaths and live births; they therefore have reliable, though still imperfect, data. At the same time, measuring maternal mortality continues to pose a major challenge. In 2013, according to data reported to PAHO from Member Countries, the absolute number of maternal deaths for Latin America and the Caribbean was around 6,000 per year. The actual number is probably greater, since some countries with relatively high absolute numbers of maternal deaths (Bolivia, Guyana, Haiti, and Trinidad and Tobago) did not report data. However, for the same period, the Maternal Mortality Estimation Inter-agency Group (MMEIG), which includes WHO, UNICEF, UNFPA, and the World Bank, estimated approximately 9,300 maternal deaths, while the Institute for Health Metrics and Evaluation (IHME) estimated 7,600. These three different figures create considerable consternation among the reporting countries. Although there are some similarities among the methodologies used by various groups for estimating trends in maternal mortality, the causes of the major differences merit explanation.

Due to the importance of these indicators, two methodologies that can be used to measure the accuracy of the maternal mortality ratio and of infant mortality rates calculated with country-level sources will be discussed.

5.3.1 METHODOLOGY USED BY THE MATERNAL MORTALITY ESTIMATION INTER-AGENCY GROUP (MMEIG)

The United Nations MMEIG divides countries into three groups, A, B, and C. However, the countries in the Region of the Americas are in groups A and B. Group A is composed of countries with good vital registration data. Using the MMEIG methodology, the number of maternal deaths reported by a country is multiplied by a correction factor of 1.5 to correct for misclassifications except in cases where the country corrects its own information with national data from a published study on the proportion of underreported and poorly classified cases. The 1.5 correction factor stems from two studies by Lewis London: Confidential Enquiry into Maternal and Child Health (2004 and 2007).

The countries in Group B lack complete vital registration data but they use other types of data sources. For these countries, the MMEIG methodology estimates the maternal mortality ratio using a model with three predictive factors as measures of exposure to risk. These factors are:

- Per capita gross domestic product

- Proportion of live births attended by skilled personnel

- Overall fertility rate (live births per woman in the 15 to 49 year age group).

The proportion obtained is used to estimate the total number of deaths of women of childbearing age which is then divided by the total number of births to estimate the maternal mortality ratio. These two data items are drawn from United Nations Statistical Division (UNSD).

5.3.2 THE METHO DOLOGY USED BY THE INSTITUTE FOR HEALTH METRICS AND EVALUATION (IHME)

The model used by the Institute for Health Metrics and Evaluation (IHME) does not take account of variations in the quality of information from the countries, and thus the methodology is applied to all of the countries without distinction. The predictive variables used are:

- Per capita gross domestic product

- Educational level of women, differentiated by age

- Neonatal mortality rate

- Total fertility rate

- Prevalence of HIV/AIDS (this variable represents a difference from the model used by the MMEIG, which does not consider this variable; thus, an estimate of mortality due to this cause is first performed, and the estimate is then corrected).

The IHME corrects problems of under-enumeration and poor quality records by multiplying by a correction factor of 1.4.

5.3.3 ESTIMATES OF INFANT MORTALITY IN THE REGION OF THE AMERICAS

Assessment of achievements with regard to Millennium Development Goal 4 (MDG-4) was based on analysis of under-5 mortality. However, given the differences in mortality risk and in the cause-based structure of mortality during the first years of life, analysis that permits such disaggregation is essential for analyzing the impact of specific interventions and planning future actions.

The available information comes from different sources and methodologies, whose differences need to be assessed when interpreting the data. PAHO consolidates and presents data based on the countries' mortality reports. Annual birth figures are derived from estimates made by the United Nations Population Division and by the United States Census Bureau. Infant mortality and under-5 mortality rates are based on these data sources.

At the global level, estimates are provided by the U.N. Inter-agency Group for Child Mortality Estimation (IGME), as well as by the IHME. The methodological approaches of these two sources differ with regard to the basic data, their processing, and the adjustment processes employed. The most important discrepancies in the results are attributable to changes in mortality in the countries, the corrections or adjustments applied, and the models used to obtain the estimates in response to problems in coverage of vital statistics.

As with other data sources, the usefulness of mortality statistics, as well as the accuracy of the data, depends largely on their quality, which is associated primarily with above the degree of coverage.

The mid-term evaluation of the Regional Plan for Neonatal Health included an analysis of the coverage and accuracy of information on neonatal deaths obtained from vital statistics systems. The evaluation was done using information from the databases available to the PAHO Health Information and Analysis team. The databases included information on neonatal, infant, and child deaths for 47 countries in the Region between 1995 and 2010. These databases generated indicators of neonatal, infant, and child mortality, which were compared with direct estimates based on DHS/RHS and WHO (WHOSIS) surveys, as well as with indirect estimates of the IGME, IHME, and UNICEF (MICS surveys). Similarly, the PAHO databases were used to obtain

the distribution of neonatal, infant, and child deaths by causes. In this case, direct estimation was complemented by the compilation of measures produced by the Child Health Epidemiology Reference Group (CHERG).

Based on the analyses, coverage of total deaths was determined to be good in 21 countries, satisfactory in six, and fair to deficient in 12. Thus, the average level of coverage of total deaths is high (median 94%). The consistency of the estimates is generally comparable with the data provided by UNSD for years close to the years analyzed, both with regard to the countries as a whole (median 93.5%), and to the majority of countries individually.

There is an inverse relationship between the percentage of coverage of deaths and the relative difference between the rates obtained by direct and indirect methodologies (the higher the former, the lower the latter). With regard to infant and child mortality, the correlations between the percentage of coverage and the relative difference between direct and indirectly estimated rates was greater than the indirect estimates calculated by the IHME. In the case of neonatal mortality, the association was higher in terms of the relationship between percentage of coverage and the relative difference between the direct rates and those calculated by the IGME.

It is also evident that the causes cited on declarations of death in the Region's countries are accurate to an acceptable degree, with the frequencies of ill-defined causes being less than 10%. Thus, although the quality of mortality information in the Region needs to be improved, levels of both coverage and precision are generally adequate. The better such measurements are, the greater will be the benefit of information based on direct, versus indirect, sources.

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ANNEX
File for describing indicators[7]

Name of indicator	Include the name of the indicator.
Definition of indicator	Describe how the indicator is formulated, including key parameters.
Purpose of indicator	Indicate why it is important to use the proposed indicator and/or its parameters.
Interpretation	Describe the context, when necessary, the indicator's significance, and what it measures.
Uses	Describe the indicator's main uses for public health purposes.
Calculation method	Describe how the indicator is calculated, including the numerator, the denominator, and the corresponding formula, when relevant.
Type of indicator	Indicate whether the measurement of the indicator is an absolute number, a proportion, a rate, etc.
Unit of measurement	Specify the units of measurement used for the indicator.
Frequency of measure-ment	Indicate how often data for the indicator are compiled and reported.
Area of reference	Indicate the country or geographic area to which the indicator refers.
Reference period	Specify the time period, or point in time, to which the indicator refers.
Disaggregation	Describe the levels of disaggregation that are practically available, in terms of their possible contribution to the interpretation of the data. Analytical categories: sex, age group, ethnic origin, and geographic area (state, province, urban/rural).
Data source	Identify the source of the indicator's data. Specify main data source, where applicable.
Limitations	Specify the challenges or constraints in the indicator's measurement, use, and interpretation.
Institution responsible	Include the name of the entity or unit responsible for generating, reporting, and monitoring the indicator.
Technical notes	Include all relevant matters related to the construction of the indicator that could hinder its use and interpretation.

[7]   Adapted from the Technical Files used for the PAHO Core Health Data and Country Profiles. Health Information and Analysis Unit (PAHO/CHA /HA), PAHO Strategic Plan 2014-2019 and RIPSA.

MODEL FILE

Code and name of indicator	RIT 1.1.1. "ANTIRETROVIRAL THERAPY COVERAGE (ART)"
Name of indicator	Number of countries and territories that have 80% antiretroviral therapy (ART) coverage in the eligible populations.
Definition of indicator	This indicator measures the coverage of access to antiretroviral therapy. Coverage of 80% or more among people who meet criteria for treatment is defined internationally as universal access. Until mid-2013, the criteria for eligibility were people living with HIV who had a CD4 count of 350/ml or less. On the basis of the new WHO guidelines published in June 2013, the threshold recommended for initiating antiretroviral therapy has been raised to a CD4 count of 500/ml or less, which means that the number of eligible people (the denominator) will increase. Baseline 2013: 6 countries Target for 2019: 22 countries
Purpose of the indicator	The proposed indicator is designed to monitor access to antiretroviral therapy, a key element in ongoing prevention, treatment, and care that has a strong impact on public health outcomes, including the reduction of HIV-related morbidity and mortality and the prevention of transmission.
Unit of measurement	**Calculation at the national level:** For calculation at the country level, the numerator is the number of people who receive antiretroviral therapy and derives from reports submitted by ministries of health. The denominator is an estimate of the number of people who need antiretroviral therapy. The country denominators are generated using methodologies and standardized statistical modeling instruments and are provided by UNAIDS. **Calculation at the regional level:** Having calculated the percentage of coverage at the national level, the regional indicator is obtained by counting the number of countries and territories with coverage of 80% or more. Multiple data sources are used, since not all countries are included in the various reports. At the national level, data collection is continuous, with calculation of country coverages conducted at year end.
Type of indicator	Absolute
Unit of measurement	Number of countries and territories.
Frequency of measurement	Annual, at year end.
Unit of the PASB responsible for monitoring the indicator	HIV, hepatitis, tuberculosis, and sexually transmitted infections (CHA/HT).
Data source	UNAIDS, WHO, country reports on universal access, and reports on progress in the global response to AIDS.

Limitations	There are uncertainties with respect to the accuracy of the statistical modeling in the case of smaller countries with concentrated epidemics.
	• It is difficult to make a reliable calculation of denominators for very small populations. Moreover, for some countries, including the small island states, UNAIDS does not generate denominators.
	The recommended change in the eligibility criteria from a CD4 threshold of 350/ml to one of 500/ml will increase the estimated number of eligible people (denominator), leading to an apparent reduction in coverage. The impact of this change on the monitoring of the indicator should be taken into account.
	This indicator measures total antiretroviral therapy coverage, but does not measure inequalities in coverage, in particular as this affects key populations such as MSM, sex workers, and transgender people. Local problems, such as undocumented immigration, will also influence the indicator's accuracy. Continuous monitoring of these key population groups' access to treatment, as well as care quality, is essential.
References	HIV Continuum of Care Monitoring Framework. Addendum to meeting report: Regional consultation on HIV epedimiologic information in Latin America and the Caribbean. Pan American Health Organization, 2014.