Methods for assessing influenza vaccination coverage in target groups

Abstract

Influenza causes considerable morbidity and mortality every year. Annual influenza vaccination is the primary means of preventing influenza infection and its complications. Individuals at high risk for negative outcomes from influenza infection are recommended to receive influenza vaccine annually. Target groups for influenza vaccine vary by country. Understanding the extent of vaccine coverage in target groups is essential for planning purposes, assessing the impact of the programme, understanding gaps in coverage and measuring trends over time. This publication outlines different methodologies that can be used to estimate national influenza vaccine coverage among high-risk groups targeted for vaccination. All methodologies presented here include explanations for estimating numerator and denominator data. Not all methodologies may be useful for all target groups; therefore, countries could consider using different methodologies to estimate vaccine coverage in different target groups.

Keywords

Address

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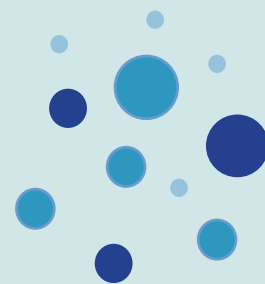
Influenza causes significant morbidity and mortality throughout the world. Every year an estimated 5–10% of adults and 20–30% of children are infected with influenza (*1*). Roughly 10% of Europe's population is infected with influenza annually, and influenza-related complications cause hundreds of thousands of hospitalizations across Europe (*2*). For the European Union/European Economic Area countries, an estimated average of 38 500 influenza-attributable deaths occur each year (estimated range: 5 400–79 200 per year) (*3*). Influenza infection may cause severe outcomes, including pneumonia, myocarditis, endocarditis and death, in particular among elderly people, young children, pregnant women and people with comorbidities (*2,4*).

Annual influenza vaccination is the primary means of preventing influenza and its complications. A recent modelling study estimated that seasonal influenza vaccination in Europe may avert between 1.6 and 2.1 million cases of influenza, and prevent between 25 200 and 37 200 deaths each year (*5*).Yet, influenza vaccine effectiveness varies depending on a number of factors, including the age and immunocompetence of the vaccine recipient and the degree of similarity between the viruses in the vaccine and those in circulation (*4*). A recent meta-analysis of a number of studies in different patient populations conducted between 2004 and 2015 showed that the pooled vaccine effectiveness of trivalent inactivated influenza vaccines ranged from 33% to 61% depending on virus type and subtypes (*6*).

WHO recommends that Member States target a number of high-risk groups for influenza vaccination, including elderly people, children aged 6 months–5 years, pregnant women, people with underlying chronic diseases and health care personnel (*1,7*).

While vaccination coverage rates vary by country, most countries in the WHO European Region do not achieve the WHO and European Union's target rate of 75% for influenza vaccination for elderly people and those with underlying illnesses (*8*) (WHO Regional Office for Europe, unpublished data, 8 June 2016).

Moreover, several countries do not monitor annual influenza vaccine coverage in a number of target groups. As countries in the Region attempt to increase influenza vaccination coverage in high-risk populations, developing valid and reliable methodologies to measure influenza vaccination coverage in these target groups is critical. Countries in Europe currently use a number of different methodologies to measure national influenza vaccine coverage in high-risk groups (*9*). Multiple methods may often be necessary to achieve accurate estimates of vaccination, as is the case in the United States of America (*10*).

This publication aims to describe methodologies that public health practitioners can use to estimate national influenza vaccination coverage in different target groups. Efforts have not been made to prioritize the different methodologies; because existing health systems and resources vary by country, certain methodologies could be more applicable in certain countries but less relevant in others.

In addition, this publication does not address issues of ethical requirements for the different methodologies. Countries should determine whether the methodologies used to determine influenza vaccine coverage require formal approval from an in-country ethical review committee.

This publication was developed by integrating data from:

→ a literature review of peer reviewed publications that describe methodologies that have been used in specific countries to measure national influenza vaccination coverage (Annex 1);

→ responses to email requests seeking information from national influenza vaccination programme leads in countries known to be currently assessing influenza vaccination coverage; and

→ a review of published reports and policy papers describing methodological approaches to estimating national influenza vaccination coverage.

The publication is divided into two sections.

Section I provides an overview of the broad methodological categories – established based on the literature review, national reports, email correspondences and telephone interviews during which country practices were reviewed – that can been used to estimate influenza vaccine coverage.

Section II breaks down various approaches to estimating influenza vaccine coverage by the following target groups: elderly people, health care professionals, pregnant women, people with chronic health conditions, children and residents of long-term care facilities.

Section 1. Influenza vaccination coverage methods currently used by countries

Based on a review of published literature and reports from a number of countries in the WHO European Region, as well as interviews with national focal points for influenza and influenza vaccination, five broad methodological categories that rely on different data sources for estimating influenza vaccination coverage were identified:

- analysis of data from national health insurance records;
- analysis of administrative data from well-documented national or private vaccination programmes targeting specific smaller groups like health care professionals;
- evaluation of national vaccine registries; and
- national surveys of individuals.

Each methodology is explained below with examples of how the approach has been used and a brief summary of the strengths and weaknesses. A summary of each methodology is included in Table 1.

Table 1. Methodologies for estimating influenza vaccine coverage among target groups

Methodology	Methodology description	Numerator	Denominator
Analysis of data from health care facilities or health care providers	Health care facilities or health care providers compile and report information about vaccine coverage	Facility or provider collects information about vaccines administered in or outside the clinic for all people in the catchment area	The number of individuals in the catchment area of the health care facility or health care provider
Analysis of data from national health insurance records	Data collected from national health insurance company/ies – either a single-provider government-sponsored insurance system or multiple private insurance companies	National health insurance company collects information on vaccine status of all individuals enrolled	The total number of people from each target group registered with the insurance system
Analysis of administrative data from well-documented national vaccine programmes targeting specific smaller groups like health care professionals	Relevant when the government assumes responsibility for purchasing and distributing the vaccine for a certain target group (i.e. health care professionals), reporting can be incorporated into the specific programme	Programme requires collection and reporting of number of individuals in target group that have been vaccinated	The total number of individuals in the target group identified by the national programme

Table 1. Methodologies for estimating influenza vaccine coverage among target groups

Methodology	Methodology description	Numerator	Denominator
Evaluation of national vaccine registries	Nationwide data on vaccinations administered recorded through immunization registry	Total number of persons vaccinated as recorded in the registry	Census data or another national data source would need to be used unless immunization information systems capture denominator data
National surveys of individuals	Nationally representative surveys that target the entire population or specific target groups	The number of individuals in the survey sample belonging to the target group(s) who say that they have been vaccinated	The total number of individuals in the survey sample belonging to the target group(s)

Analysis of data from health care facilities or health care providers

Influenza vaccination coverage in target groups can be compiled and reported by health care facilities or individual health care providers. This information can be sent to regional level, or directly to national level, where estimates can be combined in order to obtain national estimates of coverage among the target groups.

These reports can be web-, telephone- or paper-based. Standardized spreadsheets for data reporting, attached as email files or web-based data applications, can be shared with health care providers or focal points at health care facilities. Reports should be completed by a focal point of a clinic or hospital, but may also be completed by an individual health care provider (doctor or nurse) or administrator.

Table 2 is an example template/spreadsheet that could be completed by a focal point at a clinic or hospital, or a health care provider or administrator.

Table 2. Template to calculate influenza coverage in a catchment area

Target group	Number of people receiving an influenza vaccination between the dates of dd/mm/yyyy and dd/mm/yyyy (Numerator)	Total number of people in target group (Denominator)	Vaccination rate (%)[a]
Elderly people (e.g. ≥ 65 years)			
Health care professionals			
Pregnant women			
Adults with chronic diseases aged < 65 years[b]			
Children			
People living in long-term care facilities[c]			
Total (all target groups)			

[a] Calculated as: (number of people vaccinated/total number of people in target group)*100.
[b] Countries may choose to report rates for chronic diseases among children as a separate category if resources permit.
[c] Includes nursing homes, skilled nursing facilities, assisted living facilities and other group homes.

This approach in practice requires an electronic information technology (IT) system that categorizes patients by risk groups and can only be used if the clinic manager or the health care provider knows how many patients of the clinic or health care provider belong to the target groups of interest; this will serve as the denominator. The denominator should include all residents of the catchment area and not only patients who sought care at the clinic as this would underestimate the number of people in the target group. Efforts should be made to ensure that individuals are not counted twice.

Like all the methodologies presented in this publication, obtaining numerator and denominator data is critical. If electronic medical records are available, data collection at the facility level may not be particularly time-consuming. However, if electronic medical records are not available at the level of the health care facility, paper-based medical record review can be undertaken in order to collect numerator data for the number of individuals vaccinated. This effort could entail a comprehensive review of all relevant medical records, or alternatively a representative sample of patients from a clinical practice. Reviewing paper-based medical records can be very time-consuming and takes resources away from other operational aspects; however, in countries that lack electronic medical records, or in countries where data included in electronic medical records are not complete, reviewing paper-based medical records may be the only practical approach to collecting data on influenza vaccine coverage. To reduce the workload in countries relying on paper-based records, information on vaccination coverage by risk groups could be extracted from a representative sample of health care facilities.

Whether electronic or paper-based records are used, information on the target group (e.g. pregnancy status, presence of an underlying medical condition, health care profession etc.) should be documented for each vaccinee.

Ideally, reports should be completed by all clinics or health care providers in the country. However, if reports are completed by a representative number of clinics or health care providers in the country, and every site has access to numerator and denominator data, these coverage data can be used to estimate national levels of vaccination coverage.

Examples

This approach is currently used to determine vaccination coverage among target groups in a number of countries in the Region. Most commonly, spreadsheet templates with fields for relevant information are distributed electronically by e.g. the health ministry or the national public health institute to all or a select number of clinics throughout the country. Larger and more representative samples will provide better estimates. However, logistically it may not be simple to engage all general practitioners (GPs) or all health care clinics in the country.

Each clinic, or each GP, is responsible for completing information about the numerator – the number of people in a target group who have been vaccinated – and the denominator – the total number of people in a target group who are eligible for vaccination – within the catchment area of the clinic or GP. Ideally data for reports can be collected electronically when reliable electronic medical records and documentation, particularly with regards to vaccine status,

Examples *continued...*

age, comorbidities and pregnancy status, are available. Depending on the method used, data collection can occur periodically (e.g. every two weeks or every month if an IT system is in place) during the influenza season, or once at the completion of the influenza vaccination campaign (e.g. if data are obtained through manual chart reviews).

Strengths

If the data are collected from all clinics or health care providers, although this may involve more work, the estimates will be very precise. If a nationally representative sample of clinical practices or GPs can be included, and reliable numerator and denominator data can be obtained, this approach can generate representative national estimates in a way that does not require the collection of national administrative data. If a representative sample is used, efforts should be made to ensure that the demographic and socioeconomic status of patients of the clinics is representative of the country as a whole. In addition, a representative mix of urban and rural clinics should be included. If obtaining a representative sample is not feasible, a convenience sample of GPs or GP practices can still be of value for estimating vaccination coverage among target groups, and for documenting trends over time.

Weaknesses

This approach requires that health care providers or clinic administrators take time to review electronic or paper-based medical charts in order to complete a report. The approach also requires thorough, consistent documentation of vaccine receipt in patients' medical charts, regardless of where the vaccine is administered. Finally, in order to obtain a reliable estimate, every participating facility or health care provider must be able to determine reliable denominator data for target groups within the overall population that the clinic or health care provider serves. While this may be easier for specific age groups, it may be more challenging for individuals with chronic medical conditions. It also requires that every individual is associated with one health care facility or health care provider.

In addition, if patients receive influenza vaccination in private pharmacies, private clinics, at the workplace or in any other setting other than the clinic, this information will be missed unless patients are specifically asked whether they have received influenza vaccine. Asking patients whether they received influenza vaccination outside the clinic, however, assumes that patients regularly attend the

Weaknesses *continued...*

clinic, and this approach might only be an option for target groups such as pregnant women who attend antenatal care programmes, or chronically ill patients who see a GP every month to refill a prescription, for example.

Finally, certain groups, such as residents of long-term health care facilities, are unlikely to be captured by this kind of approach.

Analysis of data from national health insurance records

If a robust national health insurance system exists – as a single-provider government-sponsored insurance system or as multiple private insurance companies that include the entire population – then using data from this system to estimate influenza vaccination coverage may be possible. In order for this approach to be accurately representative of the population, the country's national health insurance coverage must be robust, and include the vast majority of the population. In addition, national health insurance data must include information about how many people from each target group of interest are registered with the insurance system.

In addition, individualized or cumulative information regarding influenza vaccine status would be necessary. If multiple health insurance companies or health funds exist, data could be combined in order to obtain national estimates. If only one or some of the existing health insurance companies are able to provide numerator and denominator information, consideration should be given as to whether the available data are sufficiently representative of the members of target groups nationwide. Ideally, these data should be electronic; paper-based data could also be used, although data extraction for a representative cohort would be quite time-consuming.

If all adequate data are present in the system, databases could be analysed in order to generate influenza vaccination coverage estimates for specific target groups. The generalizability of these estimates would depend on:

- the proportion of people in the country who are covered by the national health insurance programme(s);
- the completeness and reliability of the data; and
- how representative the insured population is of the general population.

It is possible that such a system would be relevant for only certain target groups. For example, national insurance companies may not always have information on the professions of the people who are insured; therefore, estimates of coverage in health care professionals may be challenging. In this case, this approach could be used to estimate coverage rates for certain target groups, and other methodologies could be used to address the remaining target groups of interest.

Examples

In certain countries, all citizens have health insurance provided by the government or a government-supported private health insurance company or fund. The companies may have extensive electronic medical records that include patients' demographic information, including comorbidities. Vaccination records might also be included in the electronic medical records of all patients. If all these data are available, national health insurance data can be used to estimate vaccine coverage by target group.

Strengths

Use of national insurance data or broad-based insurance company data eliminates the need for reporting at the level of the health care facility, health care provider and regional health department. If information on age, comorbidities, pregnancy status and influenza vaccination status are included in the records of the national insurance company or fund, the process to arrive at national estimates should be relatively simple. Estimates can be re-calculated at regular intervals throughout the year without the involvement of multiple actors at multiple levels.

Weaknesses

Insurance data may not always be robust at the national level. In order for this methodology to be effective, national insurance programmes must have data on the number of people within each target group that are enrolled in their programme. If data are incomplete, this methodology will generate imprecise estimates. Finally, reliable, up-to-date data on influenza vaccine status must be available. This could be particularly challenging if patients receive vaccines privately, through pharmacies or independent clinics, and this information is then not relayed back to the nation health system database.

Analysis of administrative data from well-documented national or private vaccine programmes targeting specific smaller groups

National government-sponsored vaccination programmes targeting certain small groups like health care professionals may provide an excellent opportunity to estimate influenza vaccine coverage in these target groups. If the government has assumed responsibility for purchasing and distributing the vaccine for health care professionals, reporting numerator and denominator data may be required for every health care facility in order to inform government budgets and the procurement decisions for future years. For relatively small target groups such as health care professionals or residents of long-term care facilities, this approach would greatly facilitate estimates of vaccine coverage. Additionally, while data such as comorbidities, age and pregnancy status may be routinely collected in medical records, data related to profession (i.e. health care professional) may be less likely to be collected on a routine basis.

This approach may also be more appropriate for collecting data on vaccine status of residents of long-term health facilities, because data for this population may be difficult to acquire through routine health care records of outpatient clinics. Vaccination of residents of long-term health facilities often occurs on-site and, therefore, data collection can target the facilities themselves. However, it should be noted that information on vaccination status for residents admitted to facilities during the winter season (i.e. after influenza vaccination campaigns) needs to be collected through a different mechanism (e.g. from vaccination cards).

Examples

If a country supports universal influenza vaccination of health care professionals by financing the purchase of the vaccine and overseeing its distribution to health care professionals at facilities throughout the country, it is likely that there will be a mechanism for reporting coverage. The reporting may be conducted in a way similar to the first example of facility-based reporting from health care facilities. However, in this case, data collected from the review of routine electronic medical records and vaccine registries would not likely be needed; reporting would be conducted through a separate database or registry for health care professionals. If a vaccination registry does not exist, a crude estimate of coverage among health care professionals could be calculated using the number of vaccine doses distributed to each facility minus the number of doses returned (unused vaccines) divided by the number of staff working at the facility.

Strengths

The reporting process is much easier if it is for a relatively small group, such as health care professionals (*11*), especially if it is a requirement of a government-sponsored vaccine programme. In addition, for groups such as health care professionals, more granular coverage data on specific groups such as doctors and nurses could potentially be collected.

Weaknesses

Government-funded vaccination programmes with mandatory reporting do not exist in all countries. Additionally, targeted government-financed vaccine programmes often only exist for certain target groups, such as health care professionals and residents of long term care facilities, in the country.

Evaluation of national vaccine registries

Some countries may employ national immunization registries, which capture immunization records for children and, in some cases, adults. National immunization registries can be paper-based or electronic. Data can be collected at the level of health care facility or health care provider and compiled first at facility or regional level, or sent directly to the national level. National immunization registries, if comprehensive in an entire country, provide ideal numerator data. All vaccinations that are administered to individuals are recorded in these registers, usually along with basic demographic data about the individual who received the vaccine. However, obtaining accurate denominators may be more difficult (*12–14*).

Examples

A country may currently have a national immunization registry that records vaccinations administered to all people in the country, or targets specific groups such as children or pregnant women. Influenza vaccine could be added to this registry if it is not currently included. Census data, or data from national surveys, could be used as denominator data.

Strengths

If a national registry is comprehensive and includes all relevant information to identify individuals in each risk group (comorbidities, pregnancy status, etc.), it can provide easily accessible numerator data on a national level. As long as relevant denominator data are available for each target group, estimates can be calculated relatively easily.

Weaknesses

A national immunization registry can be limited by incomplete data; health care centres or health care providers may not always report vaccinated individuals through formal immunization registries. In addition, receipt of influenza vaccine may not be reported through national immunization registries in all risk groups. Often registries are targeted towards routine childhood vaccinations and do not include vaccine data in adults. Registries also may not collect comorbidity data. Registries should ideally be linked to other electronic medical records systems in the country in order to facilitate optimal data estimates (*14*). If denominator data for the target groups are not available through a national census or survey, reliable estimates cannot be made using registry data.

National surveys of individuals

National influenza vaccine coverage can be estimated by conducting national surveys that include a representative sample of the population. The surveys can include a screening component at the beginning to screen the target population of interest. For example, if a national survey will be used to estimate coverage among people with chronic diseases, an initial question should be included about whether or not the individual has any of the chronic diseases of interest.

Consideration should also be given to include a large enough sample so that influenza vaccination coverage in smaller target groups can be measured precisely. Different survey methods can be considered, including non-probability sampling from an internet panel, telephone-based randomly sampled household surveys, stratified random sampling from state birth certificate registries and other techniques (*10,15,16*). If the overall sample is the general population, estimating vaccination coverage among target groups that compose larger portions of the population, like adults aged 65 and older and adults with comorbidities (*5*), could be more feasible.

Collecting data for some target groups, like health care professionals and pregnant women, that constitute a relatively small proportion of the population can require a particularly large sample size; in these cases, special surveys that target specific populations rather than the general population can be useful (*17,18*). For example, if pregnant women are a target group for influenza vaccination, the survey could be directed specifically to pregnant and/or post-partum women – an approach that has been used previously to evaluate various aspects of maternal health during pregnancy (*19,20*). In general, this targeted survey approach may be more practical for evaluating risk groups for which contact data for individuals may be more easily obtained. For example, data for recently pregnant women may be identified through birth certificates (*20,21*).

For either approach, consideration should be given to adding specific questions to pre-existing annual surveys used for general public health purposes. This approach minimizes the need to undertake what is often a resource-demanding operation in terms of costs and human resources. Broad-ranged survey platforms do exist (*22*), and they are often flexible to incorporate additional questions specific to different public health priorities.

Examples

Surveys can be conducted a number of ways: via the telephone (*23*), via the internet, with web-based questions, via normal mail and sometimes in person (*24–26*). Surveys can also combine different modes of responses in order to reach source populations (*20*). For example, the National Immunization Survey-Flu conducted in the United States beginning with the 2010–2011 influenza season measures national and state-level influenza vaccination coverage among children aged 6 months–17 years via a random-digit dialled telephone survey. A different survey, the National Health Interview Survey in the United States, uses an in-person household survey, where interviews are conducted in respondents' homes throughout the year, to measure national level influenza vaccination coverage for both children and adults. In addition, a United States-based survey of post-partum women called the Pregnancy Risk Assessment Monitoring System identifies post-partum mothers through birth certificates, and combines two modes of data collection: a survey

Examples *continued...*

conducted by a mailed questionnaire and a survey by telephone (*20*). Finally, an internet panel survey is used to measure influenza vaccination coverage among health care professionals in the United States (*27,28*). A mixed methods approach has also been used to estimate influenza vaccination coverage among target groups in countries in Europe (*15,29*).

Regardless of the methodology, all surveys should aim to capture enough information to know which target group the individual belongs to and if and when the individual was vaccinated. For children under 9 years old, information should be obtained as to whether the child was previously vaccinated, and whether the child received one or two doses of the vaccine during the current season.

Strengths

Survey data has a few distinct advantages. First, if an adequate sample size is achieved, representative immunization coverage can be obtained even if the exact population-based denominator is unknown. Further, surveys provide an opportunity to simultaneously collect additional information, such as reasons for non-immunization or coverage by gender or socioeconomic status. Also, vaccinations given by or purchased in the private sector can be captured in surveys; these data would not necessarily be captured via patients' medical records. In addition, surveys should be able to capture persons who are uninsured, if such a population exists in the country of interest.

Weaknesses

Surveys can suffer from non-response bias and recall bias for both internet surveys and phone calls (*30,31*). Surveys can be expensive; costs to support the human resources that are required to administer phone surveys can be high compared to internet surveys (*32*). One way to cut costs is to try to add vaccine status questions to pre-existing population surveys with which the health ministry or national agencies may already be involved. This would require, however, that these surveys are carried out regularly. Finally, for annual surveys, timing of the surveys may be a consideration, and potential for recall bias should be considered. In addition, surveys should be clear about the influenza season of reference. Compared to other methods, surveys could potentially take more time to produce vaccination coverage estimates.

Section II. Special considerations for estimating influenza vaccine coverage in certain target groups

Although most methodological approaches can be used to estimate vaccination coverage for multiple target groups, other approaches are more useful for only one or two target groups. The following section outlines some of the more commonly used methodologies for estimating influenza vaccination coverage in specific target groups.

Elderly people

A variety of approaches, including use of facility-based reporting, and individual web- or telephone-based surveys, can be used to estimate vaccination coverage in this population. The choice of method requires knowledge of the population's access to web-based systems and use of, or access to, landlines and mobile phones. For the numerator, administrative data can be used; if national electronic medical records with reliable data on vaccine status are available, or if national immunization registries with data on age are available, these sources can be used. Census data or data from the national bureau of statistics can be used to estimate the national denominator for this age group in a given year.

Another approach is to request that a number of geographically and demographically representative health care facilities or GP facilities report on the percentage of elderly persons (e.g. aged 65 years or older) in their practice who have received the vaccination. A web-based survey can be sent to GPs or heads of clinical practices requesting information about the total number of people vaccinated in this age group, and the total number of patients in this age group who are served by the practice. It is essential that the denominator include not just patients who attended the clinic during the influenza season or during the year, but rather all patients in the catchment area who could be served by the clinic. This latter requirement may be challenging in places where patients are not assigned to a specific medical practice or clinic.

Finally, nationally representative surveys can be used to estimate vaccine coverage in this population. The easiest and most common approach is to use telephone-based surveys. Multiple approaches can be used. If an existing national survey is conducted by the health ministry or another national government agency or another organization, then a few questions can be added to the survey questionnaire in order to collect the relevant information. If no survey exists, a nationally representative survey can be developed and conducted. If information about other age groups and other target groups is needed, a random sample of the population can be targeted; data from respondents aged 65 years or older (or another nationally defined age) can be extracted from general results. If only information about vaccine coverage in elderly people is required, efforts can be made to specifically target households that have people in this age group.

Regardless of the survey approach, the questions can be simple; one question alone – Did you receive the influenza vaccine this season (including the dates of the season)? – can provide enough information for vaccine estimates. Consideration should be given to the definition of the influenza season and the timing of surveys. Surveys can be administered immediately at the end of the influenza season. Alternatively, questions about influenza vaccine can be added to year-round surveys.

Other survey approaches could also be used. In-person interviews, although much more labour-intensive, could be useful in this population if use of community centres or other places for social gathering are common, keeping in mind potential selection bias in that elderly people with disabilities may be less likely to attend such centres. A web-based survey may be less practical in this population. In both approaches, however, selection bias and recall bias should be considered.

Health care professionals

Estimating influenza vaccine coverage for health care professionals often requires a methodological approach that is slightly different than that used for other risk groups. The overall population of health care professionals relative to the entire population is small. Therefore, approaches such as population surveys may not be feasible because a very large sample would be required to estimate vaccination coverage among health care professionals. Collecting information on influenza vaccination status among health care professionals from health care providers may not be practical as a patient's profession is often not recorded in his or her medical chart. In addition, health care professionals are not always vaccinated by their health care providers. They are sometimes vaccinated at their place of employment and at other locations outside of provider clinics. For this same reason, use of national vaccine registries – where health care professionals comprise a relatively small proportion of all people vaccinated and where profession is rarely recorded – may not be a practical approach either.

Certain methodologies may be more useful for estimating vaccination rates among health care professionals. One approach is to utilize administrative data from well-documented national vaccine programmes targeting health care professionals. For example, if a government or national insurance fund provides free vaccinations to health care professionals, there may be routine, and sometimes mandatory, reporting of the number of health care professionals who have received vaccinations at the institutional level.

Often both numerator and denominator data can be obtained at each health care institution through the department for occupational health, statistics or human resources, and institutional reporting can, therefore, be an effective way to collect data on vaccination information for health care professionals (9). However, it should be noted that occupational health departments most likely will report the number of vaccines given to all health care professionals at the facility/institution including those attending from outside the facility (e.g. community health services), students or temporary staff, and that this population is not necessarily caught in the denominator provided by the human resource department at the facility. This could lead to an overestimation of the coverage.

Targeted surveys can also be used to estimate vaccine coverage among health care professionals. Existing surveys of health care professionals can sometimes be modified to include questions about vaccine status. Additionally, if contact information is available for health care professionals, new surveys, sometimes internet-based, can be developed targeting this specific population. For example, in the United States, health care professionals that participate in one survey are identified through the membership roster of a medical website (*28*).

Two other approaches may be used to collect vaccine coverage data for health care professionals. Both, however, require very robust efforts. First, data can be collected from national insurance companies or national insurance funds. If a national insurance fund has a large patient enrolment and extensive medical recordkeeping that includes a vaccinee's status as a health care professional, these data can be collected centrally. Second, if a national survey is large enough in size, it can capture data on health care professionals, who compose an extremely small segment of the population.

Estimates of vaccine coverage among health care professionals included in the national recommendations, a group which usually includes those with direct patient contact (i.e. physical or face-to-face contact with patients), should ideally include those working in all different kinds of institutions – hospitals, clinics and offices, and long-term care facilities. If estimates are skewed towards a certain category of health care professional, this bias should be explained.

Pregnant women

Most methodologies explained in Section I can be used to estimate influenza vaccine coverage among pregnant women. Estimating an appropriate denominator for this risk group will largely depend on the trimester(s) for which vaccination is recommended. If influenza vaccination is recommended for all pregnant women, regardless of trimester, the total number of new pregnancies registered in health facilities within a year can serve as the denominator. If this information is not available in the country, the total number of births (birth cohort) can approximate the number of pregnant women eligible for vaccination (denominator). The basis for including all pregnancies (or all births) in a given calendar year in the denominator is that most pregnant women will be in a certain gestational age (or in early postpartum period) during the influenza season, which typically lasts five months in the northern hemisphere (usually starting around November or December) (Fig.1).

Figure 1. Theoretical relationship between ongoing pregnancies and the influenza season
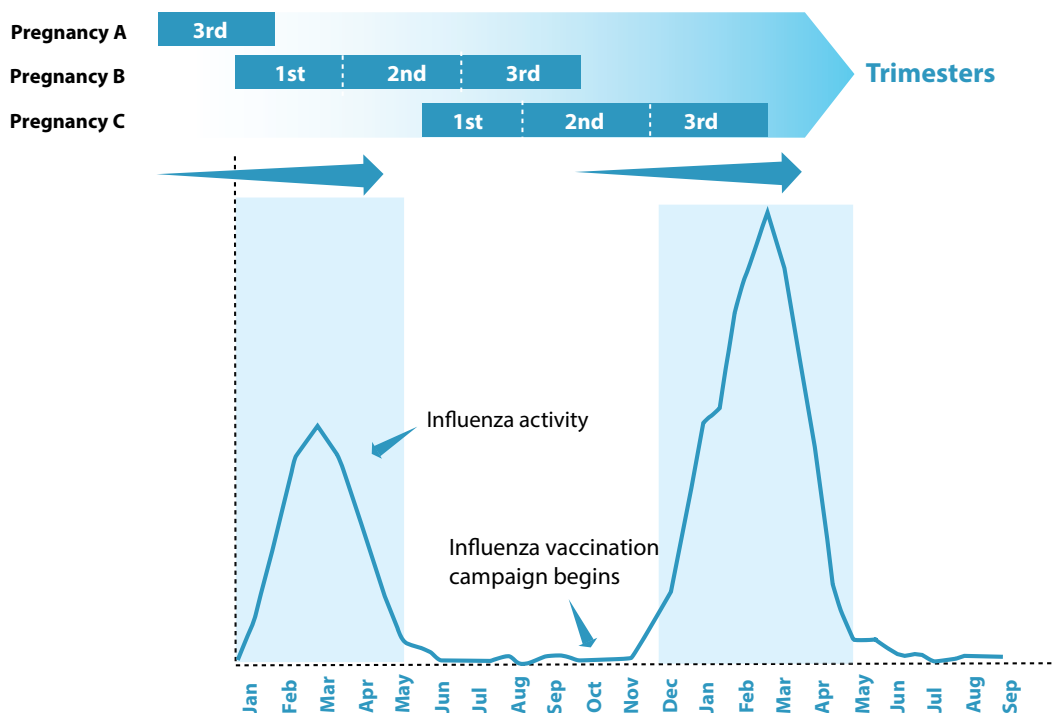
The line represents intensity of influenza transmission and the shaded area the length of a typical influenza season in the northern hemisphere. A woman delivering in January (Pregnancy A) would be eligible for vaccination as she will both be pregnant and give birth during the influenza season. A woman who conceives in early January (Pregnancy B) would be at risk of influenza during the beginning of her pregnancy (first trimester). A woman who conceives in summer (Pregnancy C) could be immunized during her second trimester (e.g. in October), protecting her and her newborn infant during the upcoming influenza season.

Methods for assessing influenza vaccination coverage in target groups

If influenza vaccination is recommended only during the second and third trimester, the number of pregnant women who are eligible to receive vaccination would be smaller than in the example above, and using the birth cohort as a denominator would underestimate coverage. In this case, if possible, only women that are registered as pregnant in the second and third trimester at the health facilities when influenza vaccination takes place should be included in the estimates of influenza vaccine coverage.

In some countries, like the United States, multiple methods are used to estimate influenza vaccination coverage in pregnant women (*21*). Health care facilities or health care providers can report the number of pregnant women who have received influenza vaccine during the months of the influenza season out of the total number of pregnant women who receive care at the facility. Estimations using this approach would likely be more accurate in settings where pregnant women receive their vaccine at the health care centre or through the health care provider, so that determining a patient's vaccination status would not be dependent on asking the patient about influenza vaccines received outside of the clinic.

Similarly, data from national health insurance records could be used to make estimates. Likewise, if a national influenza vaccine programme targets pregnant women, and routinely collects information on numerator and denominator status of this group, this would facilitate estimates. National facility-based vaccine registries could be used for numerator data if registries routinely record vaccines administered to pregnant women. Finally, national surveys of individuals could be undertaken. Surveys should ideally include questions about timing of pregnancy and timing of vaccination, and can be added to larger population-wide surveys, which would require a large sample size, or to more limited populations such as pregnant and/or post-partum women (*20,33*).

People with chronic health conditions

People with chronic health conditions constitute a target group that often overlaps with other target groups. Well over two thirds of people aged 65 years and older have at least one chronic health condition, and this proportion increases with increasing age (*34,35*). For this reason, a simple approach to estimating influenza vaccine coverage among people with chronic medical conditions could exclude people aged 65 years and older from the estimates of coverage rates among people with chronic disease.

Chronic diseases are still fairly prevalent among individuals under the age of 65 years. In addition, members of other target groups, such as pregnant women, children and health care workers, can have chronic medical conditions. Recent studies have shown that approximately one quarter of adults in the United States under the age of 45 years (*36*) and one quarter of adults in Germany under the age of 60 years (*37*) have at least one chronic disease. Approximately one fifth of pregnant women may suffer from chronic diseases (*38*). Because of these high rates, efforts should be made to capture the chronic disease status of people under the age of 65 years associated with other target groups when resources permit and depending on the specific priority groups for influenza vaccination in the country.

The specific chronic diseases that are relevant for influenza vaccination in individuals under the age of 65 years should be described in national guidelines. If collecting numerator and denominator data for people with a broad range of chronic disease is particularly challenging, a simpler approach could be used initially, limiting estimates to a small number of more common chronic diseases, such as cardiopulmonary disease, diabetes and other more common chronic medical conditions.

For individuals with chronic diseases, similar approaches to those previously presented for estimating vaccine coverage can be employed. Collecting information from health care facilities or health care providers is often quite practical in this target group, because patients in a catchment area will have chronic medical conditions recorded in medical charts. The same is true for national health insurance records, whether government supported or private. If national or private vaccine programmes targeting people with chronic medical conditions exist, these data could be used for estimates. Analysis of facility-based vaccination registries may be less practical unless the chronic disease status of vaccinated individuals is systematically recorded, or there is a method in place to link vaccine registries with individual medical records.

In addition, national surveys of individuals can be conducted to estimate vaccine coverage in people with chronic medical conditions. Because of the prevalence of chronic disease in adults under the age of 65 years, representative national surveys can be a practical methodology to achieve coverage data in this target group (*37*). Both numerators (those vaccinated) and denominators (people with chronic disease) can be estimated from nationally representative telephone, internet or in-person surveys. Because identifying people with chronic diseases from existing national databases or registries is often difficult, designing targeted surveys that only interview people with chronic diseases may be more challenging. If robust population-level numerator data for vaccination coverage in people with chronic diseases can be obtained, countries can use information from periodically administered demographic and health surveys in order to establish denominators, which are unlikely to change dramatically from year to year (*39*).

Children

Estimating vaccination coverage among children can be conducted using similar methodologies to those employed for elderly people. The advantage in both of these groups is the potential opportunity to use census data to obtain accurate denominators for the target group. If reliable national numerator data are available from vaccine registries or other national-level administrative data, census data can be used as the denominator. The possibility of obtaining administrative data, including vaccine registry data, may be more of an option among children, because routine childhood vaccinations are often recorded in registries at health facilities and vaccination clinics, and during vaccination campaigns.

Other methodologies – reporting from health facilities or health care providers, analysis of national health insurance data or targeted vaccine campaign data, such as school-based vaccination programmes – may also be options. Finally, surveys are another useful method to obtain very timely and precise influenza vaccination coverage estimates for children; estimates can be obtained for one influenza season prior to the start of the following influenza season, which can be useful for planning immunization programmes.

Residents of long-term care facilities

Estimating vaccine coverage among residents of long-term care facilities (nursing homes, skilled nursing facilities and assisted-living facilities) requires a slightly different approach compared to other target groups. This population will not be captured in routine visits to clinics or national population-based surveys.

This target group is best captured by systematic reporting of numerator and denominator data by the long-term care facilities themselves. Such an approach, which is similar to the methodology that could be used for health care professionals, could be achieved more easily through a national vaccine programme targeted toward residents of these facilities. In addition, national insurance agencies or private insurance companies may include residents of long-term care facilities among their insured population, in which case data could be collected through analysis of these records.

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Annex 1.
Literature review

A literature review was conducted to identify published manuscripts that addressed methods for estimating seasonal influenza vaccination uptake. The search terms "influenza", "vaccine" and "coverage" were used in the PubMed database. From the PubMed search, abstracts were included if they addressed influenza vaccine coverage at a national level and focused on at least one of the following target groups: elderly people, pregnant women, young children, people with chronic disease, residents of long term care facilities or health care professionals. Abstracts were excluded if they described studies that were specific to one city, region or hospital, rather than the entire country, or if they did not describe coverage among target groups. When multiple abstracts described vaccine coverage for the same population using the same methodology but during different time periods, only one abstract was retained. If methodologies could not be adequately evaluated based on the abstract alone, the full manuscript was reviewed.

This initial search resulted in 1414 titles. After the 1414 titles and abstracts were reviewed, 78 abstracts were included. The most common target groups were persons with underling medical conditions. Thirty-three out of 78 studies described vaccine coverage for multiple target groups (Table A1.1).

Table A1.1. Published articles on vaccine coverage, by target group

Target group	# articles[a]
People with chronic health conditions[b]	**38**
Elderly people	**30**
Health care professionals	**29**
Children	**14**
Residents of long-term care facilities[c]	**5**
Pregnant women	**4**

[a] Articles whose methodologies were applied to more than one target group are counted once per target group.
[b] Countries may choose to report rates for chronic diseases among children as a separate category if resources permit.
[c] Includes nursing homes, skilled nursing facilities, assisted living facilities and other group homes.

The published literature used a number of different methodologies to collect data on vaccine coverage uptake. The articles were sorted into categories based on similar methodologies (Table A1.2).

Table A1.2. Published articles sorted by coverage uptake methodology categories

Methodology	No. of articles
National surveys of individuals	**48**
National surveys of health care facilities or health care providers	**16**
Outpatient or inpatient medical records	**5**
Data from national health insurance records	**4**
Disease surveillance data	**3**
Administrative data from well-documented national or private vaccine programmes	**2**
Administrative data from vaccine registries	**0**

Informal requests for relevant information

Emails requesting information about methods used nationally to estimate influenza vaccination coverage were sent to national influenza programme leads in countries known to be currently conducting influenza vaccine uptake monitoring among target groups for vaccination. In addition, the Pan American Health Organization (PAHO) was contacted, because of its current regional efforts to measure vaccine coverage in high-risk groups.

General information was requested regarding each country's approach to the collection of coverage data. Influenza programme leads were asked whether the collection process was electronic or web-based, what their sources of coverage data were (for example: general practitioners, pharmacies, health insurance companies), how numerator and denominator data were obtained, and which institutions collected and reported the data. In addition, programme leads were asked to share any relevant national guidance documents for estimating coverage, and information about the sources used to calculate numerator and denominator data for each risk-group.

Of the 14 countries that were contacted by email, 12 responded (Belarus, Croatia, Ireland, Israel, Lithuania, the Netherlands, Portugal, Romania, Slovenia, Spain, Ukraine and the United Kingdom). PAHO also replied to the request. Additional information from Israel and the Netherlands was obtained from two separate conference calls.

Summary of published reports

Overall, six documents (1-6) on national and international guidance related to influenza vaccine coverage were identified and reviewed.

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