There are children not receiving a single dose of any vaccine: from ‘data to policy’ in immunisation and health systems. Data quality and socio-economic determinants of unvaccination in low- and middle-income countries
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Summary

Chapter 1. Introduction and objectives.
Health related Millennium Development Goals will not be achieved in many low- and middle-income countries (LMIC) by 2015, especially in Sub-Saharan Africa, despite the existence of effective interventions. Systematic childhood vaccination is one of the most cost-effective health interventions and has proven to save millions of lives over decades. While relatively high coverage has been achieved for most of the routine vaccines, there are major inequities between and within countries in accessing immunisation, with particularly vulnerable groups remaining unvaccinated. The Strategic Advisory Group of Experts (SAGE) at WHO is the group with an advisory role in global immunisation policies. Cognisant of the existing inequities in immunisation, SAGE called for more systematic evidence to be provided in order to describe the problem of unvaccination and to assess the socio-economic and gender-related determinants of unvaccinated children, in order to inform their decisions and global and national policies.

The overall aim of this dissertation is to bridge the evidence to policy gap in order to inform global immunisation policies on the status and determinants of unvaccinated children; i.e. those children not having received a single dose of routine vaccinations. The objectives of this project are:

1. To develop an algorithm and software to harmonise data for analyses of different designs of national representative household surveys.
2. To compare the quality of individual subjects vaccination data from household surveys with data from vaccination administrative monitoring.
3. To describe socio-demographic and gender-related determinants of unvaccination in children.
4. To assess the evidence base of immunisation related health systems strengthening for use in funding proposals.

These objectives were fulfilled by a series of analyses reported in the articles included in this dissertation. An algorithm was created to guide the harmonisation process of large amounts of data sets used in these analyses (Chapter 2); the quality and discrepancies between different vaccination data sources (routine administrative data and surveys) were described (Chapter 3); socio-demographic and gender-related determinates of vaccination were analyses using logistic regression techniques (Chapters 4 and 5); and, finally, a desk review was undertaken to assess the use of this type of evidence by countries applying to the GAVI Alliance for health systems strengthening support.

Chapter 2. Harmonisation of variables names prior to conducting statistical analyses with multiple datasets: an automated approach.

Background
Data requirements by governments, donors and the international community to measure health and development achievements have increased in the last decade. Data sets produced in surveys conducted in several countries and years are often combined to analyse time trends and
geographical patterns of demographic and health related indicators. However, since not all data sets have the same structure, variables definitions and codes, they have to be harmonised prior to submitting them to the statistical analyses. Manually searching, renaming and recoding variables are extremely tedious and prone to errors tasks, overall when the number of datasets and variables are large. This article presents an automated approach to harmonise variables names across several datasets, which optimises the search of variables, minimises manual inputs and reduces the risk of error.

Results

Three consecutive algorithms are applied iteratively to search for each variable of interest for the analyses in all datasets. The first search (A) captures particular cases that could not be solved in an automated way in the search iterations; the second search (B) is run if search A produced no hits and identifies variables the labels of which contain certain key terms defined by the user. If this search produces no hits, a third one (C) is run to retrieve variables which have been identified in other surveys, as an illustration. For each variable of interest, the outputs of these engines can be (O1) a single best matching variable is found, (O2) more than one matching variable is found or (O3) not matching variables are found. Output O2 is solved by user judgement. Examples using four variables are presented showing that the searches have a 100% sensitivity and specificity after a second iteration.

Conclusion

Efficient and tested automated algorithms should be used to support the harmonisation process needed to analyse multiple datasets. This is especially relevant when the numbers of datasets or variables to be included are large.

Chapter 3. Accuracy and quality of immunization information systems in forty-one low income countries.

Objectives

To measure the accuracy and quality of immunization information systems in a range of low-income countries eligible to receive GAVI support.

Methods

The Data Quality Audit (DQA) uses a WHO validated, standard methodology to compare data collected from health unit (HU) records of immunizations administered with reports of immunizations at central level and to collect quality indicators of the reporting system. The verification factor (VF), as a measure of accuracy, expresses the proportion of immunizations reported at national level that can be tracked down to the HU. A VF of 80% or above entitles countries to receive additional GAVI financial support. Quality indicators are assigned points which were summed to obtain quality scores (QS) at national, district and HU levels. DQAs included here were conducted between 2002 and 2005 in 41 countries, encompassing 1082 primary healthcare units in 188 randomly selected districts.
Results
Almost half of countries obtained a VF below 80% and only nine showed consistently high VF and QS scores. The most frequent weaknesses in the information systems were inconsistency of denominators used to estimate coverage, poor availability of guidelines (e.g. for late reporting), incorrect estimations of vaccine wastage and lack of feedback on immunization performance. In all six countries that failed a first DQA and undertook a second DQA, the VF and all QSs improved, not all of them statistically significantly.

Conclusions
The DQA is a diagnostic tool to reveal a number of crucial problems that affect the quality of immunization data in all tiers of the health system. It identifies good performance at HU and district levels which can be used as examples of best practices. The DQA methodology brings data quality issues to the top of the agenda to improve the monitoring of immunization coverage.

Chapter 4. Quality and discrepancies of administrative and surveys immunisation data: only ‘silver’ standards.
Information on immunisation coverage at country and global levels is widely used to monitor vaccination progress and for performance-based funding schemes. There are two main sources of immunisation data: administrative data collected at the point of services delivery and surveys. Discrepancies between both sources have been described for the same countries and years. We examine the reasons for these discrepancies and challenge common assumptions on data quality. We have created a framework to describe how immunisation data is produce and have analysed the concordance of country-years DTP3 coverage between administrative and survey data from 1980 up to 2011. Given that subjects, numerators, denominators and other parameters used to estimate legitimacy differ from administrative and survey data, discrepancies are normal and expected. The direction and magnitude of discrepancies between both sources are influence by the type of survey. In conclusion, poor quality of administrative data does not explain by itself discrepancies. We suggest that discrepancies cannot be resolved just by using mathematical models, but that judgments based on data and local knowledge is necessary as well.

Chapter 5. Unvaccinated children in years of increasing coverage: how many and who are they? Evidence from 96 low- and middle-income countries.

Objective
While childhood immunisation coverage levels have increased since the 70s, inequities in coverage between and within countries have been widely reported. Unvaccinated children remain undetected by routine monitoring systems and strikingly unreported. The objective of this study was to provide evidence on the magnitude of the problem and to describe predictors associated with non-vaccination.

Methods
Two hundred and forty-one nationally representative household surveys in 96 countries were analysed. Proportions and changes in time of ‘unvaccinated’ (children having not received a single
dose of vaccine), ‘partially vaccinated’ and ‘fully vaccinated’ children were estimated. Predictors of non-vaccination were explored.

Results
The percentage of unvaccinated children was 9.9% across all surveys. 66 countries had more than one survey: 38 showed statistically significant reductions in the proportion of unvaccinated children between the first and last survey, 10 countries showed increases and the rest showed no significant changes. However, while 18 of the 38 countries also improved in terms of partially and fully vaccinated, in the other 20 the proportion of fully vaccinated decreased. The predictors more strongly associated with being unvaccinated were education of the caregiver, education of caregiver’s partner, caregiver’s tetanus toxoid (TT) status, wealth index and type of family member participation in decision-making when the child is ill. Multivariable logistic regression identified the TT status of the caregiver as the strongest predictors of unvaccinated children. Country-specific summaries were produced and sent to countries.

Conclusion
The number of unvaccinated children is not negligible and their proportion and the predictors of non-vaccination have to be drawn from specific surveys. Specific vaccine indicators cannot properly describe the performance of immunisation programmes in certain situations. National immunisation programmes and national and international immunisation stakeholders should also consider monitoring the proportion of unvaccinated children (i.e. those who have received no vaccines at all) and draw specific plans on the determinants of non-vaccination.

Global achievements in immunisation mask significant differences within and between countries. Household surveys can describe factors associated with children being unvaccinated, which cannot be reported from routine administrative sources. The present study investigated the role of children’s sex and gender-related factors on children not having received a single dose of any vaccine, analysing household surveys. Associations were assessed using multivariable logistic regression models producing odds ratios (OR) and meta-analyses summarising those effects. There were no overall sex differences in vaccination status between female and male children except in a few countries, sometimes favouring girls and sometimes boys. Children from disadvantaged socio-economic groups were more likely unvaccinated. Children were more likely to be unvaccinated when their caregivers justified being beaten under certain circumstances, received no cash for work, decided about health care or the use of money on their own, did not decide about daily purchases on their own, were concerned about health care issues, or thought that their partners’ sexual relations with other women justified refusing sexual intercourse. Heterogeneity between surveys was considerable suggesting great differences between countries in these associations. Given the very limited sex differences in vaccination status found, these analyses do not support systematic collection of sex disaggregated data. However, they point at the need of promoting
gender equity. Attempts to improve women’s access to healthcare continue to be crucial as well as addressing the negative effect of social norms that increase inequities on child health.

Chapter 7. Do existing research summaries on health systems match immunisation managers’ needs in middle- and low-income countries? Analysis of GAVI health systems strengthening support.

Background
The GAVI Alliance was created in 2000 to increase access to vaccines. More recently, GAVI has supported evidence-based health systems strengthening to overcome barriers to vaccination. Our objectives were: to explore countries’ priorities for health systems strengthening; to describe published research summaries for each priority area in relation to their number, quality and relevance; and to describe the use of national data from surveys in identifying barriers to immunisation.

Methods
From 44 health systems strengthening proposals submitted to GAVI in 2007 and 2008, we analysed the topics identified, the coverage of these topics by existing systematic reviews and the use of nation-wide surveys with vaccination data to justify the needs identified in the proposals.

Results
Thirty topics were identified and grouped into three thematic areas: health workforce (10 topics); organisation and management (14); and supply, distribution and maintenance (6). We found 51 potentially relevant systematic reviews, although for the topic that appeared most frequently in the proposals (‘Health information systems’) no review was identified. Thematic and geographic relevance were generally categorised as “high” in 33 (65%) and 25 (49%) reviews, respectively, but few reviews were categorised as “highly relevant for policy” (7 reviews, 14%). With regard to methodological quality, 14 reviews (27%) were categorised as “high”. The number of topics that were addressed by at least one high quality systematic review was: seven of the 10 topics in the ‘health workforce’ thematic area; six of the 14 topics in the area of ‘organisation and management’; and none of the topics in the thematic area of ‘supply, distribution and maintenance’. Only twelve of the 39 countries with available national surveys referred to them in their proposals.

Conclusion
Relevant, high quality research summaries were found for few of the topics identified by managers. Few proposals used national surveys evidence to identify barriers to vaccination. Researchers generating or adapting evidence about health systems need to be more responsive to managers’ needs. Use of available evidence from local or national surveys should be strongly encouraged.
Chapter 8. Discussion.

An unacceptable high number of children have not received any dose of routine vaccinations with marked differences between countries and within countries. We provide compelling global evidence on the magnitude of the problem and on its determinants. In this work, we have addressed each main step in the knowledge translation cycle: from data to evidence and use of evidence.

We fully acknowledge the increasing needs to produce and analyse good quality data in order to monitor and evaluate programmes performance and for accountability purposes. Major efforts are being taken at global level to improve the quality of data. We argued that the quality of both administrative and survey sources of vaccination data varies greatly in different countries and types of surveys, and that in order to produce evidence, careful judgments and local knowledge are needed to consolidate those discrepancies.

Our findings confirmed the known relationship between low socio-economic conditions and poor access to health care and pointed at specific factors such as vaccination status of mothers and gender issues. This evidence, together with research evidence on the effects of interventions and implementation issues have to inform health policies and countries requests for support. We have shown that this is not always the case.

These analyses have informed decision makers at global (e.g. WHO-SAGE) and country levels and have been widely disseminated in policy and research fora and used for teaching purposes. We acknowledge, though, the limitations of this work, mainly in relation to the availability of data for different countries and years which may affect the extrapolation of the findings to concrete contexts.

We call for renewed efforts to improve the use of evidence for decision making rather than focusing primarily in the technical quality of data; for closely monitoring inequities in access to health services; and for carefully balancing the evidence on performance with local knowledge to inform performance based schemes.