Is a ‘convenience’ sample useful for estimating immunization coverage in a small population?

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SUMMARY

Rapid survey methodologies are widely used for assessing immunization coverage in developing countries, approximating true stratified random sampling. Non-random (‘convenience’) sampling is not considered appropriate for estimating immunization coverage rates but has the advantages of low cost and expediency. We assessed the validity of a convenience sample of children presenting to a travelling clinic by comparing the coverage rate in the convenience sample to the true coverage established by surveying each child in three villages in rural Papua New Guinea. The rate of DTP3 immunization coverage as estimated by the convenience sample was within 10% of the true coverage when the proportion of children in the sample was two-thirds or when only children over the age of one year were counted, but differed by 11% when the sample included only 53% of the children and when all eligible children were included. The convenience sample may be sufficiently accurate for reporting purposes and is useful for identifying areas of low coverage.

Introduction

In order to assess the immunization coverage in the SIL Clinic catchment area, we have collected data from the health records of children presenting at travelling clinic points over the past several years. Such a sample constitutes a ‘convenience’ sample of the population of interest (children under 5 years of age in each of 3 villages) and is a more expedient and rapid sampling method than a true random or stratified random sample. The question is whether such data correctly represent the true coverage in the communities serviced and provide a reliable basis for decisions regarding service provision.

The established World Health Organization (WHO) rapid survey methodology (the ‘30 x 7’ cluster method) is intended to approximate the true immunization coverage by ±10%. This method involves sampling 7 children from each of 30 population clusters chosen by probability proportionate to size from all non-overlapping clusters within the population of interest. Variations of the 30 x 7 method have been assessed for attaining similar accuracy while maintaining the assets of rapid survey methodologies: minimal training requirements and cost-effectiveness (1). The 30 x 7 method is only appropriate for monitoring coverage in the population as a whole (2) and is less suitable for comparing vaccination levels in different areas of the same country (3). The 30 x 7 method needs to be modified if it is to be used for other purposes (4). In many countries, the 30 x 7 methodology has resulted in lower immunization coverage estimates than official government-reported figures (5).

A second method, lot quality assurance sampling (LQAS), may be more appropriate for monitoring in small areas of high heterogeneous coverage (6) and comparing coverage rates of different areas within a country. The LQAS involves sampling a given number of children from each non-overlapping cluster within the population of interest for a binary variable such as completed immunization, in order to rate the ‘lot’ or area as having acceptable or unacceptable immunization coverage. The 30 x 7 method possibly overestimates coverage compared to the LQAS.

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methodology (6).

We wished to assess immunization coverage in the SIL Clinic catchment area and to compare coverage between villages. Clinic staff felt that the immunization rate was well below target values and the government-reported 61% DTP3 coverage (7), and that low rates were pocketed in certain villages. Village leaders would like to initiate programs to improve health in the catchment area but require specific information in order to target an awareness program.

The data collected from children's health books at the travelling clinics in the villages of interest represented 66% to 90% of the estimated population. This large a sample could be expected to be statistically similar to the larger population but the concern still remained as to whether there was bias in favour of children whose mothers brought them to the clinic points regularly and therefore were likely to achieve full immunization. Alternatively, the sample may over-represent infrequent attenders who were late in achieving full immunization. A further concern was whether this sample was biased by not including children immunized at other clinics.

In order to address these issues, we undertook a community-wide survey to record all immunizations in children aged under 5 years and compared these data to the convenience sample obtained at regular travelling clinics.

This survey was undertaken with the participation of the Community Health Board of Yomunka area, Obura-Wanenara District in Eastern Highlands Province of Papua New Guinea (PNG), and with the permission and support of the Obura-Wanaerana District Health Extension Officer and local Member of Parliament.

Background

Yomunka is a rural highlands area populated by Gadsup-speaking subsistence and market farmers. Health care is provided primarily by the SIL Clinic at Ukarumpa, approximately 12 km distant by road. The nearest hospital is at the town of Kainantu 20 km away. Travelling clinics visit 5 villages in the area once monthly from February to November unless prevented by heavy rains or clan fighting.

Methods

Three villages participated in this survey. Community Health Board volunteers from the three villages formed a focus group to discuss health issues in the area and identified 4 areas of concern: immunization rates, the number of disabled persons, barriers to health care, and unrecognized tuberculosis cases. We developed a questionnaire to assess these concerns and conducted training sessions for Board members before conducting the survey. Expatriate SIL volunteers were recruited to assist with recording and logistics.

Teams consisting of one Community Health Board member and one expatriate recorder visited each house in each village. All children aged under 5 years normally resident in the home were recorded whether at home at the time or not. The health record was examined and birthdate and the date of each immunization were recorded. Every attempt was made to extract usable data from the health record. Missing or completely illegible cards were recorded as unusable. The adults present then were questioned regarding any disabilities, chronic cough and perceived barriers to health care in their village. The community survey was carried out in October 2006.

The data recorded from the travelling clinics for August through November 2006 were used for comparison. The data for each child presenting for immunization were transcribed from the health record, including any immunizations given on that day. Duplicate records were eliminated during the analysis phase and the latest record used for comparison. The resultant group of records is the ‘convenience sample’ for the purposes of this study.

‘Completed immunization’ is defined as the 13 primary immunization shots mandated by the Papua New Guinea Department of Health for administration before 1 year of age. DTP3 coverage was calculated using two methods: firstly, the number of children over the age of 6 months who had received the 3rd DTP immunization before their first birthday divided by the total number of children over the age of 6 months at the time of the survey (ie, those eligible for having received three DTP immunizations). Secondly, we used the WHO 30 x 7 method of including only the children over the age of 12 months at the time of the survey who had received their 3rd DTP
immunization before 12 months of age.

The estimated number of children aged under 5 years in each village was obtained from the Obura-Wanenara District Health Extension Officer using the 2002 National Census, an estimated annual birth rate of 3% and estimated proportion of population less than 5 years of age of 13.2%.

All immunization data were entered into a database and analyzed using SPSS. Due to data that were not normally distributed and unequal sample variances and sizes, we used Mann-Whitney U nonparametric analysis rather than t-tests to compare ‘mean age at completion’ between sampling methodologies. We used Fisher’s Exact Test to compare proportions of children receiving their third DTP immunization by 12 months as measured by the two methodologies in each of the three villages.

Results from the questions regarding disabilities, barriers to health care and case finding for tuberculosis will be reported elsewhere.

Results

Table 1 shows the estimated number of children aged under 5 years, the actual number found at the community survey, number of usable records and number of records transcribed at travelling clinics.

Immunization coverage data are presented in Table 2. The convenience sample accurately estimated mean age at completed immunization for two of three villages, but was inaccurate by 3.6 months (which was not considered statistically significant) in the third village. There were no significant differences in DTP3 coverage at one year between the convenience sample and community survey ($p >0.05$ for all results). The convenience sample consistently overestimated the true DTP3 coverage. The overestimation was within 10% in two villages but 11% in one village when all children over the age of 6 months were included. The overestimation was within 10% for all villages when only those children over 1 year of age at the time of survey were included.

Discussion

The number of children less than 5 years of age found in the community survey was in excess of the census-based estimate of number of children in all three villages. Two possibilities may account for the difference:

<table>
<thead>
<tr>
<th>Village</th>
<th>Amomonta</th>
<th>Onamuna</th>
<th>Akuna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Census-based estimate of number of children under 5 years of age</td>
<td>86</td>
<td>90</td>
<td>107</td>
</tr>
<tr>
<td>Total number of children under 5 years of age recorded by community survey</td>
<td>97</td>
<td>114</td>
<td>139</td>
</tr>
<tr>
<td>Number of usable records</td>
<td>89</td>
<td>90</td>
<td>124</td>
</tr>
<tr>
<td>(% of total number of children)</td>
<td>(91.8%)</td>
<td>(78.9%)</td>
<td>(89.2%)</td>
</tr>
<tr>
<td>Number of children recorded at travelling clinic (‘convenience sample’)</td>
<td>65</td>
<td>60</td>
<td>97</td>
</tr>
<tr>
<td>(% of total number of children)</td>
<td>(67.0%)</td>
<td>(52.6%)</td>
<td>(69.8%)</td>
</tr>
</tbody>
</table>
either the 2002 census did not record all residents, or the annual population growth rate and proportion of children under 5 years of age are in excess of the national average. This number undoubtedly under-represents the numbers of births during the same time period as PNG under-5 mortality rates are estimated between 65 and 93 per 1000 live births (8,9).

The convenience sample of under-5 children seen at the travelling clinics was two-thirds of the total number of children in two of the three villages, but only slightly over half the total number of children in the third village (Onamuna). DTP3 coverage was accurately assessed by the convenience sample (within 10% of the true coverage as assessed by the community survey) when only children over the age of one year were counted or when the convenience sample proportion was high (67% and 70%). The DTP3 coverage assessment differed by 11% when all children eligible for having received their 3rd DTP (those over 6 months old) were included and the convenience sample proportion was lower (53%), which, though not statistically significant at the 0.05 level, is outside the acceptable 10% margin of accuracy established by WHO.

The convenience sample accurately represented a statistically significant difference in DTP3 coverage and mean age at completion of the primary immunization series in Onamuna as compared to the other two villages (p < 0.05).

DTP3 coverage rates could be expected to be higher when recorded at the travelling clinic as immunizations given at that visit are reported whereas no immunizations were given during the community survey. Even with this apparent increase in DTP3 coverage created by the methodology, the coverage rate estimate by the convenience sample is close to that found during the community survey.

This study could have resulted in apparent improved immunization rates at travelling clinic points during the course of the fieldwork.
due to increased awareness following the community-wide survey. This possibility is consistent with the higher DTP3 coverage rate found by the travelling clinic one month after the community survey at the village with lowest DTP3 coverage (Onamuna). The travelling clinic visited one of the villages with high DTP3 coverage before the community survey (Akuna) and one after (Amomonta). There was no difference in the proportion of children in any of the villages attending the travelling clinics before and after the community survey.

Conclusions

Although convenience sampling is prone to bias, the advantages in expense and expediency make it an attractive methodology for assessing immunization coverage in areas where immunizations may be recorded as part of regular travelling clinic activities. Where the proportion of children sampled was relatively high (two-thirds or more) and the WHO age cutoffs were utilized, the estimate of true immunization coverage was within WHO rapid-assessment parameters. Where the proportion of children was 53% and all children eligible for having received the immunization in question were included, the coverage rate estimated from the convenience sample was not sufficiently accurate for reporting purposes. The data accurately reflect local differences in immunization rates and are suitable for use in targeting supplementary immunization programs and community awareness programs to villages with lower immunization coverage.

Contrary to Clinic staff perception, DTP3 coverage at 1 year of age was in excess of government estimates in two of three villages. Since under-5 mortality rates in Papua New Guinea are significantly influenced by immunization (10), full immunization of all children is an important strategy in health care. We suggest that community surveys may be a useful strategy for improving immunization rates in areas of low coverage.

ACKNOWLEDGEMENTS

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REFERENCES