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The impact of time since vaccination and study design on validity in parental recall of childhood vaccination status in the All Our Families cohort

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ABSTRACT

Introduction: Parental reporting of childhood vaccination status is often used for policy and program evaluation and research purposes. Many factors can bias parental reporting of childhood vaccination status, however, to our knowledge, no analysis has assessed whether time since vaccination impacts reporting accuracy. Therefore, using the Calgary electronic vaccine registry (PHANTIM) as the gold standard, we aimed to test the accuracy of parental reporting of childhood vaccination status at three different time-points since vaccination.

Methods: The All Our Families (AOF) cohort study asked parents to report their child's 2, 4, 6, 12 and 18 month vaccines (vaccination time-point) on questionnaires given when the child was 1, 2 and 3 years of age (survey time-point). We linked the AOF parental reporting of vaccination status to the PHANTIM registry and calculated the percent agreement and difference in coverage estimates between PHANTIM and AOF at each vaccination and survey time-point combination. Furthermore, we measured the sensitivity and specificity, and negative (NPV) and positive predictive values (PPV) of parental vaccine recall across time.

Results: AOF parent reports of coverage rates were consistently higher than the PHANTIM estimates. While we saw significant differences in percent agreement for certain vaccination time-points, we saw no consistent directional difference by survey time-point, suggesting that parental accuracy did not change with time. We found a uniformly high sensitivity across all vaccination and survey time-points, and no consistent patterns in the specificity, PPV and NPV results.

Conclusion: Time since vaccination may not be the most important consideration when designing and implementing a vaccination survey. Other factors that may contribute to the bias associated with parental reporting of vaccination status include the complexity of the vaccine schedule, schedule changes over time, and the wording and structure of the questionnaires.

1. Introduction

Accurate and reliable methods for measuring childhood vaccination status are essential for assessing vaccine coverage in a population and thus ensuring the optimization of vaccination programs. Parental reporting of childhood vaccination status is often used to estimate coverage and therefore guide vaccine policy, program planning and research. Examples where estimates of coverage are used in vaccine research and decision-making include

Abbreviations: PHANTIM, Primary Health Activity Network & Timely Information Management; DTaP-IPV-Hib, diphtheria-tetanus-acellular pertussis-polio-*Haemophilus influenzae* type b; MMR, measles-mumps-rubella; MMRV, MMR-varicella; MenC, Meningococcal conjugate; PCV7, Pneumococcal conjugate-7; PCV13, Pneumococcal conjugate-13.

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vaccine effectiveness studies [1,2], post-licensure vaccine safety studies [3], vaccine program evaluations [4], and recommendations for how to improve vaccine policy [5]. Inaccurate measurement of vaccine coverage may bias the results of these studies, thereby providing further incentive for understanding the bias that occurs with vaccination reporting.

Despite vaccine registries becoming increasingly commonplace, researchers frequently do not have access to these registries. Therefore, parental reporting of childhood vaccination status in surveys is still frequently used to measure vaccine coverage in Canada [5,6], the United States [7] and in many other developed countries [8]. Thus, it is important that researchers and policymakers understand potential for errors in estimates using self-report, and optimize survey design to improve coverage estimates derived from parental recall.

Many factors can contribute to the accuracy of parent-recall and self-report questionnaires on vaccination status, including demographic and psychological factors, such as ethnicity, gender, education, social desirability and recall bias [9–11]. Vaccination factors can also play a role in parent-recall, for instance the type of vaccine delivered [12], the number of doses and the complexity of the schedule [13,14], as well as the age at vaccination [14,15]. However, to our knowledge, no analysis has looked at whether the validity in parental reporting changes with time since vaccination. Such information could be useful to survey-designers and policymakers. Specifically, it could inform decisions regarding the ideal time following vaccination to ask about the vaccination status of a child, the type of prompts that may improve accuracy, and the type of bias that may be expected if a questionnaire is given to an individual days, months or years after the vaccination event.

The aim of our study was to test the accuracy of parental recall of their child's vaccination status over time. Specifically, using an electronic administrative public health vaccine registry, Primary Health Activity Network & Timely Information Management (PHANTIM), as the gold standard, we measured the accuracy of parental recall of their child's 2, 4, 6, 12 and 18 month vaccines (vaccine time-points) when the child was 1, 2, and 3 years of age (survey time-points).

2. Methods

2.1. Study design and cohort

This study was a sub-analysis of the prospective pregnancy All Our Families (AOF) cohort study [16]. A cohort of 3387 pregnant women, <25 weeks gestation, were recruited from the Calgary-area between May 2008 and Dec 2010. Mothers were mailed questionnaires to gather health information about themselves and their child at various time-points (two prenatal questionnaires and four questionnaires at 4, 12, 24 and 36 month's post-partum). Tough et al. [17] and McDonald et al. [16] report details on the AOF cohort, including information on cohort demographics, questionnaire design and study recruitment/eligibility. The AOF cohort is known to have similar sociodemographic characteristics to the average population of child-bearing women in the Calgary region of Alberta, except for being on average wealthier and more educated [16].

For the purposes of this study, we used responses from three of the AOF questionnaires, administered at three post-partum survey time-points (T1 [1 year], T2 [2 years] and T3 [3 years]). We restricted our analysis to those individuals who completed all 3 surveys (n = 988) (see Fig. 1). Mothers were asked about whether their child had received the 2, 4, 6, 12 and 18 month routine childhood vaccinations. Following the completion of all three questionnaires, the responses were then linked to the electronic administrative public health vaccination registry for the Calgary zone (PHANTIM) using deterministic linkage (see Fig. 1). As demonstrated in Saini et al. [18], AOF participants whose data was unsuccessfully linked were significantly more likely to be high income and be married/common-law.

In Alberta, routine childhood vaccinations are provided by public health nurses in community-based clinics, and funded by the province's universal health care plan. All children born in the Calgary zone are entered into PHANTIM when public health receives their notice of birth and children born outside Calgary are entered if their parent notifies or accesses public health services. Following receipt of a vaccine, the child's vaccination record is entered into PHANTIM by support staff in the public health clinics where the vaccination takes place. PHANTIM serves as a reasonable gold standard as the accuracy of this regional database is routinely audited using chart review to ensure accurate and reliable data entry. PHANTIM data was extracted and linked three months after the final questionnaire was completed to ensure that all vaccination records up until the date of the last AOF questionnaire were entered in the system. We extracted vaccination records for 2763 children in AOF for whom we had vaccine data from PHANTIM, including type, dose number, and date of vaccination for seven vaccines (Pneumococcal conjugate-7 [PCV7]/Pneumococcal conjugate-13 [PCV13], measles-mumps-rubella [MMR], varicella, MMR-varicella [MMRV], Meningococcal conjugate [MenC], and diphtheria-tetanus-acellular pertussis-polio-*Haemophilus influenzae* type b [DTaP-IPV-Hib]). Ethical approval for this study was obtained from the Conjoint Health Research Ethics Board at the University of Calgary, and parents consented to the linkage of their AOF survey results to their electronic health records.

2.2. Questionnaire design and data cleaning

For each of the AOF questionnaires, mothers were asked to answer the following question "Has your baby received the following vaccinations?" Parents were asked to indicate whether their child had received all the vaccines scheduled for a given age, i.e. for each of 2, 4, 6, 12 and 18 month time-points (vaccination time-points) listed in Table 1. The phrasing of the question meant respondents could only answer whether their child had received *all* the vaccinations at a given vaccination time-point or had received *none/some* of the vaccinations, with no opportunity for them to describe exactly which vaccines their child had missed. There was no restriction or recommendations on parents using vaccinations records (e.g. parent-held vaccination cards) to inform their response to the survey question. T1 asked about vaccinations given at 2, 4, 6 and 12 months, while T2 and T3 asked about all the vaccine time-points (2, 4, 6, 12 and 18 months). The timing of the 1 year AOF survey meant parents received the survey within two weeks after the first birthday of the child and were asked whether the child had received their 12 month vaccines, thus many children may not have received their 12 month vaccines at the time of the survey.

Over the time that the AOF questionnaires were being administered, there were notable changes to the vaccination schedule in Alberta. Specifically, MMR and varicella vaccines were replaced with the combined MMRV vaccine (Sept 1 2010); and PCV7 (4 doses at 2, 4, 6 and 18 months) was replaced by PCV13 (3 dose series at 2, 4 and 12 months) (July 1, 2010). As reported in Table 1, these schedule changes were not addressed in the questionnaires, thereby requiring us to account for these in our data cleaning. Thus, the decision rules for our analysis were: (a) a child was considered fully vaccinated for MMR and varicella if PHANTIM had a record of them receiving either MMR + varicella or MMRV; (b) any MMR vaccine documented in PHANTIM as given before age 12 months (typically for travel to a measles endemic region) was