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BORN Information System: A Data Quality Assessment for Public Health Monitoring

Technical Report
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Public Health Ontario

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Main Messages

The Better Outcome Registry and Network (BORN) Information System (BIS) provides **high quality and timely data** for a number of core reproductive health indicators as demonstrated by this quality assessment. Overall, BORN can be considered as an **important data source for public health monitoring** of reproductive health information in Ontario. However, as with any new data source, the **characteristics and limitations of BORN must be well understood** to ensure proper interpretation.

PHO's data quality assessment highlighted two key limitations to the data for public health monitoring and planning for delivery of equitable programs and services that address the needs of priority populations in these communities:

- A number of indicators have a high level of missing data which could limit data accuracy.
- Suppression of Aboriginal data affects the quality of the results in certain public health units (PHUs).

BORN data was found to **align highly with other databases used for monitoring reproductive** health, with the exception of the Canadian Community Health Survey (CCHS). This **difference between BORN and the CCHS** may be due to limitations related to capturing reproductive health information in the CCHS, such as surveying mothers up to five years after birth. BORN data may provide an opportunity for monitoring certain reproductive health indicators in a way that overcomes some of the limitations of the CCHS.

BORN data users should also be aware that although data in the public health data cube is **refreshed daily, there is a considerable lag time of up to 15 months**, before data can be considered 99% complete. **Large variations in timeliness** exist between public health units. Users should be mindful of data completeness when extracting data and when making comparisons between PHUs.

This quality assessment took into account a broad range of measures of data quality that are relevant to public health practitioners in Ontario. However, this data quality assessment did not examine every potential issue related to data quality and public health units are encouraged to assess data quality for factors unique to their public health unit (e.g., specific populations of interest that may be excluded).

Executive Summary

Background

As our understanding of the link between reproductive and child health to life-long health grows,[1] monitoring trends in reproductive health and gaps in reproductive care becomes increasingly important. The Better Outcome Registry and Network (BORN), created in 2009, is a birth registry that covers all births in Ontario and collects information related to a number of important reproductive health and maternal health indicators. The BORN Information System (BIS) contains accurate and timely reproductive health data which can be used in population health assessment, surveillance, and planning of programs and services. The BORN public health data cube is an online platform for customized queries of data in the BORN Information system. As part of our ongoing data quality efforts for integrating new data sources, Public Health Ontario (PHO) undertook an assessment of the data quality of the BORN public health data cube in relationship to core public health indicators currently used for monitoring reproductive health. The aim of the data quality assessment was to ensure that the data are of high quality, to assist in future interpretation and reporting, and to identify potential areas for improvement. PHO's access to BORN data for Ontario overall and for each individual public health unit (PHU) facilitated our examination of overall data quality, as well as variations in quality between PHUs.

Approaches and Limitations

Data quality was assessed based on four of the five dimensions in the quality assessment framework developed by the Canadian Institute for Health Information[2] and the BORN data quality framework[3]:

- data relevance
- timeliness
- accuracy
- usability

It was found that within a public health framework, the fifth dimension of comparability would be better captured by other data quality indicators, accuracy and relevance. These dimensions were further adapted to examine data quality using a public health perspective with a focus on health equity.

To examine **data relevance**, the data cube and metadata were searched to see if its indicators and data definitions aligned with the reproductive health core indicators as defined by the Core Indicators for Public Health in Ontario developed by the Association of Public Health Epidemiologists in Ontario (APHEO[4]). Though this list of indicators does not represent all those which may be relevant for effective monitoring of reproductive health, it provides a starting point to assess whether data in BORN is useful for public health monitoring.

In assessing **timeliness**, data on the number of births in a given month were extracted using the data cube on a weekly basis for a period of nine months (from October 2014 to June 2015). Weekly changes in the number of births in a given month were calculated and examined according to the time to extraction (i.e., the time between the birth and appearance in the database), and the time to zero weekly change in the data was assessed. Per cent completion of data was calculated by comparing the

number of births in a given month against the number of births at the last extraction. The time after which all data were 99% complete or greater was assessed. For this section, data were only extracted over a limited time period and therefore may not provide a full representation of time to completeness.

Three elements of **data accuracy** were identified: level of data missingness (i.e., per cent of missing data), comparability to other databases, and population under-coverage. To assess the level of data missingness, missingness for the APHEO core reproductive health indicators with high missing data (i.e., greater than 5%) was stratified by PHU, peer group, and an area based measure of socioeconomic status (SES) known as the Ontario Marginalization Index (ON-Marg). Data comparability was examined by comparing rates for core indicators found in BORN to values found using other population-level reproductive health databases in Ontario, including the Discharge Abstract Database (DAD) sourced from the Ministry of Health and Long-Term Care's IntelliHEALTH system, the Healthy Babies Healthy Children-Integrated Services for Children Information System (HBHC-ISCIS) and the Canadian Community Health Survey (CCHS). BORN documents and metadata were then reviewed to assess the potential for population under-coverage and exclusion of certain sub-groups and the health equity implications from excluding certain sub-groups within BORN were explored. It is recognized that Ontario has no universally recognized gold standard database for calculating reproductive health indicators. Therefore, differences between BORN and other reproductive health databases do not necessarily indicate inaccuracies in BORN. For this section, level of missing data and comparability was assessed for a limited number of key indicators.

Usability of the data cube was assessed by taking notes on ease of performing tasks while conducting analyses using BORN. This section highlights usability issues in the data cube which may affect ability to access and properly interpret BORN data. It does not constitute a comprehensive list of all issues that public health users of the data cube may be experiencing, notably omitting experiences specific to the public health unit level.

While a broad range of data quality factors have been examined, public health professionals are encouraged to further assess data quality for factors unique to their setting (e.g., specific populations of interest that may be excluded, level of missing data).

Results

Relevance: Data from BORN was found to be highly relevant for public health monitoring of reproductive health in Ontario. All but one of the current reproductive health indicators in APHEO (i.e., neonatal and infant mortality) listed BORN as a potential data source. A limited number of APHEO indicators could not be calculated using BORN, including age of father at infant's birth. Certain indicators were difficult to calculate in BORN, including congenital anomalies and infections, due to differences in definitions between BORN dimensions and APHEO core indicators. In addition, certain important stratifiers to assess health equity such as measures of individual SES were not available in the data cube.

In terms of data **timeliness**, changes in number of births were observed after a longer than expected lag time (expected lag time was six months).[5] While data were over 90% complete in BORN after a lag time of six months, the lag time after which all data were over 99% complete in Ontario was about 15 months. In the data cube, a small number of births were being added as long as 32 months later. This varied considerably between PHUs with some showing very timely and complete data input (e.g., within less than two months), while for a number of PHUs, important under-coverage of births (i.e., greater than 3%)[3] was observed over a year later.

Accuracy: Data from BORN was generally very accurate, with high alignment between values in BORN and other reproductive health databases (with the exception of the CCHS) as well as expected values from the literature. However, the level of missing data was high for a number of core indicators. Missing data varied by factors such as geography and SES as measured by the Ontario Marginalization Index (ON-Marg), though the relationship between data missingness and SES was not consistent across PHUs. Aboriginal populations were under-represented as data for babies born to mothers living in postal codes where the majority of the population live on reserves are suppressed in the public health data cube. In PHUs with large Aboriginal communities, the numbers of births were often lower and rates for indicators such as low birth rate and preterm birth were higher as compared to those measured using reproductive health databases without suppression of Aboriginal data. This may have important implications on data accuracy for certain PHUs with high Aboriginal populations living on-reserves, notably those in northern Ontario, and may limit the ability of the public health sector to contribute to effective and equitable reproductive health policies and programs in these geographic areas.

Regarding **usability**, difficulties were encountered when performing a number of basic tasks in the data cube. Major concerns included difficulty in accessing detailed BORN data definitions in the data dictionary, and problems finding specific indicators in the data cube. Currently, no documentation is available to guide users to find specific indicators in the data cube and contacting staff at BORN is often necessary to find specific data definitions.

Conclusions

A significant opportunity exists to use BORN for public health monitoring of reproductive health data. BORN covers many reproductive health indicators, most importantly, maternal risk factors and maternal health indicators not previously captured in other population data sources. Furthermore, data quality in BORN is likely better than other sources currently being used to monitor reproductive health information. This is because it includes births that occur outside of hospitals which are missed in other population data sources and captures information on maternal health as recorded by health professionals during pregnancy, limiting recall bias. Notwithstanding, there are a number of limitations to consider when using and interpreting the data. Considerations when using BORN include long lag times between births and appearance in the dataset, high missingness of certain indicators, and purposeful exclusion of on-reserve Aboriginal data. Improvements are routinely being made to BORN data, allowing for the expanded use of BORN as a reliable and important data source for reproductive health monitoring in Ontario.

Introduction

The Better Outcome Registry and Network (BORN) represents an opportunity for public health professionals in Ontario to obtain accurate and timely reproductive health data which can be used in population health assessment, surveillance, and planning of programs and services. Before adopting BORN as a primary and authoritative data source for reproductive health information, Public Health Ontario (PHO) undertook an assessment of the data quality of BORN data available in the public health data cube in relationship to core public health indicators currently used for monitoring reproductive health. Access to BORN data through the BORN Information System (BIS) was offered to PHO and all public health units (PHUs) in Ontario in April 2014. PHO's access to BORN data for Ontario overall as well as each individual PHU, facilitated an examination of overall data quality, as well as variations in quality between PHUs. Four indicators of data quality were chosen for this quality assessment based on the Canadian Institute for Health Information data quality framework adapted by BORN including: relevance, timeliness, accuracy, and usability.[2,3] These quality dimensions were further adapted to incorporate a public health lens that considers health equity.

As the link between reproductive and child health to life-long health becomes clearer,[1] monitoring trends in reproductive health and gaps in reproductive care becomes increasingly important. The Ontario Public Health Standards (OPHS), which establish the minimum requirements for public health programs and services in Ontario, mandate that PHUs conduct epidemiological analysis of surveillance data in the area of reproductive health outcomes.[6] The Core Indicators for Public Health in Ontario are identified by the Association of Public Health Epidemiologists in Ontario (APHEO) in order to address the requirements of the OPHS.[4]

The Better Outcomes Registry and Network (BORN) was created in 2009 to collect and share data about pregnancy, birth, and childhood in Ontario.[7] BORN's mission is to be an authoritative source of accurate, trusted and timely information to monitor, evaluate and plan for the best possible beginnings for life-long health.[7] The BIS enables both the collection of and access to data on every birth in Ontario. The data is received from hospitals, labs, midwifery practice groups and clinical programs through a variety of mechanisms. The BORN analytical report tool (or public health data cube) can be accessed through the BIS, a secure server on the BORN website, and allows registered users to perform custom queries of BORN data which is updated daily.[8] The public health data cube consists of a number of measures (e.g., the number of live births, the number of women who gave birth) which can be stratified according to a wide variety of dimensions (e.g., date of birth, public health unit).

Standard reports of BORN data are also available to public health professionals through the BIS. These reports show values and calculated rates for a number of common reproductive health indicators at the PHU level. Though issues of data quality would apply to data in the data cube as well as the standard reports, this quality assessment focuses specifically on issues related to the data cube and not on the standard reports.

The Core Indicators for Public Health in Ontario list fourteen general indicators related to reproductive health (e.g., fertility rates), each one comprised of one or more specific indicators (e.g., general fertility rate, adolescent fertility rate, age specific fertility rate). The reproductive health indicators were last updated January, 2013, though the congenital infections indicator is still under revision. The child and adolescent health indicator, breastfeeding initiation and duration, was last updated in 2004, and its status is listed as "in need of update".[4] Work is currently underway updating the APHEO reproductive

health indicators with new indicators. There are five indicators being proposed for addition as core indicators (or the proposed indicators), including: gestational weight gain, maternal obesity, maternal alcohol use, maternal substance misuse, and maternal mental health; these indicators have identified BORN as a primary data source and often the only data source available.[8] Table 1a lists the general APHEO reproductive and child health indicators which name BORN as a data source. Table 1b lists the proposed reproductive health indicators that name BORN as a potential data source (for all current indicators general and specific, see Appendix A).

Table 1a: Current APHEO reproductive and child health core indicators[4,9]

Current indicators	Names BORN as a data source
Crude Birth Rate	Yes
Fertility rate	Yes
Total fertility rate	Yes
Pregnancy rate	Yes
Preterm birth rate	Yes
Multiple birth rate	Yes
Birth weight	Yes
Congenital anomalies	Yes
Congenital infections	Yes
Perinatal mortality and stillbirth rate	Yes
Neonatal and infant mortality rate	No
Age of parent at infant's birth	Yes
Folic acid supplementation	Yes
Smoking during pregnancy	Yes, only source
Breastfeeding initiation and duration	For breastfeeding initiation only

Table 1b: Proposed APHEO reproductive health core indicators[4,9]

Proposed indicator	Names BORN as a potential data source
Gestational weight gain	Yes
Maternal obesity	Yes
Maternal alcohol use	Yes
Maternal substance use	Yes
Maternal mental health	Yes

BORN has many advantages over other Ontario data sources which contain reproductive health information (e.g., the discharge abstract database (DAD)) as data is updated frequently and births which occur inside and outside of hospitals are included.[8] However, as for any data source, the limitations and data quality issues must be well understood to help in making key decisions related to the calculation of reproductive health indicators, such as whether to explore using other data sources for certain indicators, the timing of data extractions, as well as help to understand any issues or data gaps, which is important for correct interpretation and application of the data.

According to the Canadian Institute for Health Information (CIHI),[2] as adapted in the BORN data quality framework, elements of a high quality database include:[3]

- relevance
- timeliness
- accuracy
- comparability
- usability

To perform a data quality assessment of the BIS that is relevant to public health practitioners in Ontario, the BORN data quality framework was adapted using a public health lens with a focus on health equity. It was found that within a public health framework, the comparability of the data, which looks at consistency over time and between datasets, would be better captured by other data quality indicators, accuracy and relevance. The accuracy section will examine aspects of comparability such as how BORN data matches other important data sources, and the relevance section will examine consistency of data with the accepted APHEO definition. The public health data quality framework as adapted from the BORN data quality framework is shown in Table 2.

Table 2: Public Health Data Quality Framework

Data Quality Indicator	BORN Data Quality Framework definition	Public health data quality assessment focus
Relevance	The degree to which the data meets the users' needs	a) Can all of the APHEO core reproductive health indicators be calculated using the data cube? b) Do the BORN data dictionary definitions match the definitions of the APHEO core indicators?
Timeliness	Whether data is current at the time of release	a) Are births added steadily over time or in a particular pattern? b) After what duration can data be considered stable and usable for calculating core indicators? Does this differ by local geography?
Accuracy	Whether information reflects the reality it was designed to measure	a) Does high missingness affect validity? And are different subgroups more likely to have missing information? b) Is the data comparable with similar databases used to calculate reproductive health indicators? c) Is the population being measured representative of the overall population of Ontario?
Comparability	Consistency of data over time and comparability to other datasets	NA -Will be assessed under the accuracy and relevance sections of the public health quality assessment
Usability	Ease with which data can be understood and accessed	Ease with which the data cube and metadata were accessible and interpretable

This report will discuss the methods used and results found in an assessment of each of the four public health data quality dimensions: relevance, timeliness, accuracy, and usability using a health equity lens. The final section will include a discussion of uses and limitations.

Relevance

Background

Relevance refers to the degree to which the data meet the users' needs.[3] From a public health perspective, this can be interpreted as the degree to which the public health data cube can be used to calculate the APHEO core indicators for which BORN is identified as a data source. To calculate the APHEO core indicators, it is necessary that all data required in the calculation is available in the data cube (with the exception of population denominators where applicable), and that the data available matches the accepted definition used by APHEO.

This section of the quality assessment involved searching for dimensions in the data cube and analyzing the BORN data dictionary in comparison to the APHEO core indicators definition to answer the following two questions:

a) Can all of the APHEO reproductive health core indicators be calculated from data accessible through the BORN public health data cube?
b) Do the BORN data dictionary definitions match the definitions from the APHEO core indicators?

Data and Methods

The data cube was searched for dimensions required in calculating the APHEO reproductive health core indicators (both general and specific) as well as the one child health indicator, (breastfeeding initiation), for which BORN was identified as a data source. Specific dimensions and measures to search in the data cube were determined based on the methods described in the APHEO core indicators.[4] For indicators available in the data cube, the BORN data dictionary definition was compared against the definition from the APHEO core indicators. Any dimensions which could not be accessed in the data cube as well as dissimilarities in definitions which could lead to differences in reported values were noted.

Results

Of the current APHEO core indicators, thirteen out of fourteen list BORN as a potential data source, including one indicator, smoking during pregnancy, that lists BORN as the only data source available. Additionally, all five of the proposed reproductive health indicators being considered for inclusion as APHEO core indicators (i.e., gestational weight gain, maternal obesity, substance misuse in pregnancy, alcohol use during pregnancy, and maternal mental health) list BORN as a primary data source.[9] Only one of the reproductive health indicators, neonatal and infant mortality, does not list BORN as a data source.

However, there are a number of difficulties when using the data cube for calculating certain core indicators. For example, selecting congenital anomalies in the data cube that reflect the specific APHEO indicator is often difficult to determine; more clarity is needed to sort out the dimensions in BORN which correspond to the specific anomalies identified by APHEO. Furthermore, a number of congenital infections listed as specific indicators by APHEO are not found in BORN. Another specific indicator not available in the data cube is age of father at infant's birth, which is not collected by BORN. Availability of core indicators in BORN can be found in Table 3.

In addition to the APHEO core indicators, availability of certain stratifiers, such as socioeconomic status (SES) is important to public health practice to support the assessment of health inequalities. The BIS does not include any socioeconomic information at the individual or family level. Measuring socioeconomic status using the data cube must be done through attributing area-based measures of socioeconomic status to the individual based on information on location (available at the level of dissemination area (DA)).

Table 3: APHEO reproductive core indicators availability in BORN

Legend for indicator availability:

indicates no or minimal problems, indicates caution, indicates significant problems

Indicator (Specific Indicators)	APHEO definition of indicator	Comments on availability in BORN	Indicator availability
Crude birth rate	The total number of live births per 1,000 population	All live births is available	
Fertility rate, (general fertility rate, adolescent fertility rate, age specific fertility rate	The ratio of the number of live births for a given period to the female population aged 15-49 (or female population aged 15–19, or in a given 5 year age group)	All live births filtered by maternal age is available	
Total fertility rate	The average number of children that would be born per female if all females lived to the end of their childbearing years and bore children according to the age specific fertility rate for that area and period	All live births filtered by maternal age is available	
Pregnancy rate (total pregnancy rate, teen pregnancy rate, age-specific pregnancy rate)	The number of pregnancies per 1000 females of reproductive age (15-49) (or female population age 15–19, or females of reproductive age by 5 year age group). Pregnancies include live births, stillbirths (or deliveries), and therapeutic abortions.	All women who gave birth filtered by maternal age is available **Caution: BORN has limited capture of therapeutic abortions. Definition of stillbirths in BORN can vary according to reporting source.**[10]	
Preterm birth rate	Live births with a gestational age at birth of less than 37 completed weeks per total live births	Live births and gestational age available (gestational age group 05)	
Multiple birth rate (overall, live birth weight)	The ratio of births (or live births) following a multiple gestation pregnancy per total births (or total live births)	All births (or live births) and number of fetuses is available	

Indicator (Specific Indicators)	APHEO definition of indicator	Comments on availability in BORN	Indicator availability
Birth weight (low birth weight, very low birth weight, extremely low birth rate)	The rate of live births that are less than 2500 g (or less than 1500 g, or less than 1000 g) at the time of delivery per total live births with known birth weight	Low birth rate: Live births and birth weight is available	
Birth weight (Small for gestational age (SGA), Large for gestational age (LGA))	The rate of singleton live births (22 – 43 weeks gestation) who have weights below the 10th percentile (or above the 90th percentile) for their gestational age and sex	Singleton live births and birth weight by gestational age group is available. The Kramer reference population as suggested by APHEO is used for calculating SGA/LGA **Caution: The APHEO indicator indicates including births with gestational age of 22 – 43 weeks. BORN has a number of categories available for filtering by gestational age. However, there is no option to select only births between 22 and 43 weeks. Also, multiple births are incorrectly assigned as "not SGA/LGA" instead of "not applicable"**	
Congenital Anomalies (overall, neural tube defects (NTDs), down syndrome, orofacial clefts, congenital heart defects (CHD), musculoskeletal anomalies)	Number of births (live and stillbirth) identified as having a congenital anomaly (or a specific congenital anomaly) expressed as a percentage of the total number of births (live and stillbirths)	All births and congenital anomalies available. Congenital infections are included under congenital anomalies in the data cube and these should be excluded as they are addressed under the congenital infections indicator. **Caution: discussion is needed on whether to include confirmed or suspected anomalies or both.** **In many cases it is unclear how to match the indicators in BORN with the specific congenital anomalies identified by the APHEO core indicator. Specific indicators which are difficult to match in BORN include: Neural Tube Defects, Congenital Heart Defects, and Musculoskeletal Anomalies)**	

Indicator (Specific Indicators)	APHEO definition of indicator	Comments on availability in BORN	Indicator availability
Congenital Infections (overall, rubella, cytomegalovirus, herpes, group b streptococcal, opthalmia neonatorum, gonorrhea, chlamydia, syphilis, HIV, AIDS, chicken pox* **note that this indicator is under revision	The proportion of new live born infants identified as being infected in utero or during delivery by any specific viral or bacterial agent known to have the potential to cause morbidity or mortality in fetus or infant, per 10,000 live births	All live births available **Caution: No information is available on chlamydia, gonorrhea, syphilis, and opthalmia neonatorum.** **Significant underreporting is likely according to APHEO.**[4]	
Perinatal mortality	The total number of deaths of a fetus or infant between the end of the 20th week gestation and the end of the 6th day of life in a calendar year per 100 total births	All births available and neonatal deaths is included **Caution: definition of neonatal deaths in the BORN data dictionary is <28 days, which is different from APHEO definition of <7 days**	
Crude stillbirth rate, (total number of stillbirths ≥ 500 g)	The total number of stillbirths (>20th week of gestation) (or the total number of stillbirths >= 500g and >20th week of gestation) per 1000 total births	All stillbirths filtered by before and after 20 weeks gestation and birth weight is available **Caution: Definition of stillbirths in BORN can vary according to reporting source.**[10]	
Age of parent at infant's birth (average age of mother or father at birth, Average age of mother or father at birth of first infant, median age of mother or father at birth, Proportion of births by age of mother or father)	Average age of parent as of the date of birth of their infant (or of their first infant) Or the middle age of parent for the period under study Or The proportion of births by age group of the parent	All live births and mothers age is available **Caution: Father's age is not available**	
Folic acid supplementation (prior to/prior to and during pregnancy)	Proportion of women who took a folic acid supplement before pregnancy (or before and during pregnancy)	Number of women who gave birth and folic acid use prior to pregnancy (or prior to and during pregnancy) is available	
Smoking during pregnancy	Proportion of pregnant females that smoked cigarettes at any time during pregnancy	Number of women who gave birth and sum of smoking at admission for birth and smoking at first prenatal visit is available	

Indicator (Specific Indicators)	APHEO definition of indicator	Comments on availability in BORN	Indicator availability
Breastfeeding (Intention to breastfeed, breastfeeding at discharge, breastfeeding initiation)	Proportion of mothers aged 15-49 years who breastfed their last baby (born within the last 5 years)	Number of women who gave birth, filtered by maternal age of 15-49, and mother's intention to breastfeed, or Live births filtered by maternal age of 15-49 and breastfeeding at discharge or Live births filtered by maternal age of 15-49 and breastfeeding initiation is available. **Caution: The definition by APHEO, which looks at mothers who gave birth in the last five years, is designed to reflect the CCHS survey question. This indicator could be adapted for BORN which doesn't specify mothers who gave birth in the last 5 years. Only breastfeeding initiation is available in BORN.**	

Limitations

The BORN public health data cube is generally a relevant and useful source for calculating public health indicators on reproductive health; most of the APHEO core indicators are available in the data cube and can be calculated using the appropriate definition. It is important to note that the APHEO core indicators do not constitute a comprehensive list of reproductive health information that may be relevant to monitoring and surveillance of reproductive health. However, the APHEO core indicators do provide a useful list of measures relevant to public health. This section examined whether definitions used in the BORN data dictionary match the APHEO definition. However, data dictionary definitions may differ from those used in practice (for example, due to differences in interpretation by BORN data entry operators). The BORN data quality framework, states that training is provided and data quality is monitored to ensure that data is entered correctly. However, it is still possible that errors will be made. In addition, indicator definitions are not often available in the BORN data dictionary, adding some difficulty when making comparisons between the BORN and APHEO indicators definition. Where indicator definitions were not clear, BORN was contacted for clarification.

Timeliness

Background

Timeliness refers to the delay between an event being measured and when it can be found in the data set. Time delays can occur at any number of steps in the process of updating data in a surveillance system. Assessing timeliness can in some cases identify where these delays occur and lead to improvements. The degree of need for timely data is dependent on the intended use of the data, as well as the condition being investigated.[11] For example, an infectious disease surveillance system designed to quickly detect outbreaks would require more timely information than the BORN information system which aims to help in more long-term planning. Assessing data timeliness of the BORN public health data cube includes measuring stability of the data over time, and determining the time period after which data can be considered complete (i.e., after what point in time the number of births reported can be considered an accurate representation of all births). The BORN data quality framework identifies a one month lag time for acknowledgement of hospital level data but does not identify lag times for other contributing organizations like midwifery practice groups.[3] Measuring timeliness is important as it can help to determine the best time to extract data, as well as how long a lag time is needed before extracting data.

This section will consist of two components corresponding to the following questions:

a) Does the number of births increase steadily over time or sporadically? Do increases occur in a particular pattern (i.e., once a month)?
b) How long after the fact is a birth likely to be reported to the BIS? At what point is data in a given month considered stable? This section will examine whether timeliness varies between PHUs.

A) Stability of data entry over time

DATA AND METHODS

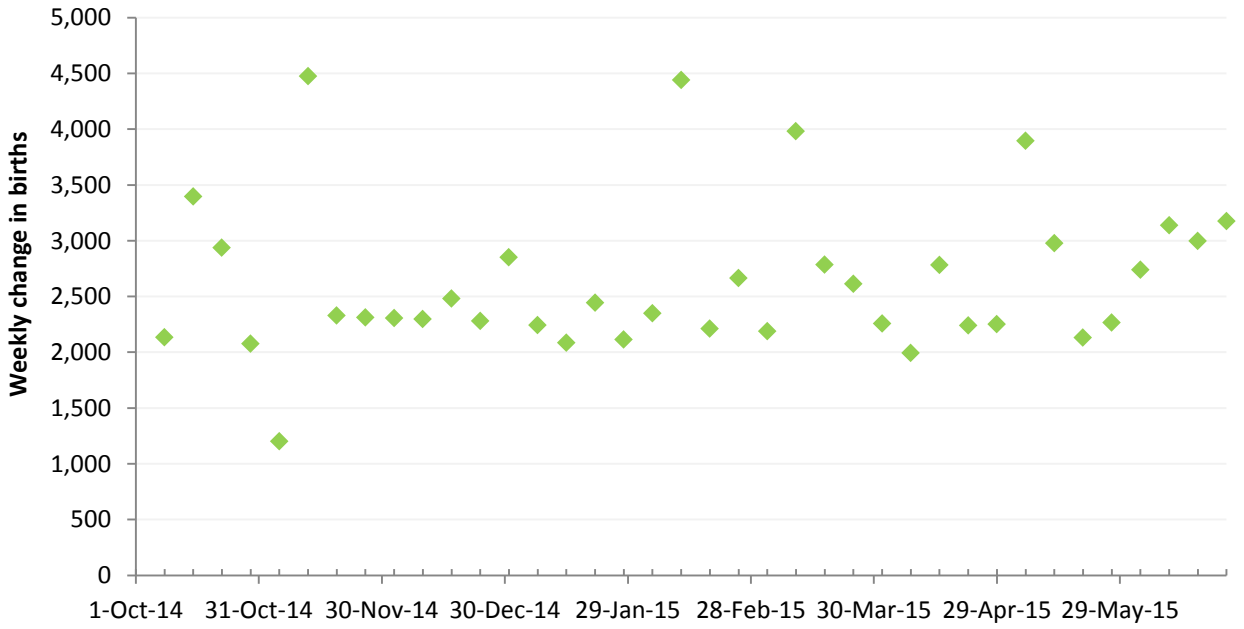
Measure: Live births
Dimension: Newborn date of birth (month)

The total number of live births in Ontario (from April, 2012 to month of extraction) was extracted from the data cube on a weekly basis each Wednesday over a period of nine months (October 1, 2014 to June 24, 2015). The weekly change in live births was plotted against the extraction date to detect the pattern of increase.

RESULTS

In examining the weekly change in births by extraction date, there was no clear pattern in how data was entered in the cube. Most weeks approximately 2,000 – 2,500 births were entered into the system. However certain weeks showed large increases (catch-up weeks) where 4–5,000 births were entered and these often occurred in the first full week following the end of the month. However, this pattern was not seen consistently and increases in births by week were seen to be sporadic (see Figure 1). For a table showing the changes in birth by week extracted, see Appendix B.

Figure 1: Change in births by week extracted, Ontario, 2014–15



B) Lag time between birth and appearance in database

DATA AND METHODS

Measure: Live births
Dimension: Newborn date of birth (month)
Stratifiers: Geography (PHU)

The total number of live births for a given month (from April, 2012 to month of extraction) was extracted from the data cube on an ongoing basis from July 21, 2014 until June 24, 2015. In October 2014 the methodology for evaluating timeliness was finalized and the extraction process was changed such that data was extracted on a weekly basis, every Wednesday, up until June 24, 2015. The time to extraction was calculated as the number of days between the extraction date and the first of the month being examined, defined as the measurement date. For this section, two analyses were undertaken:

1) Time to zero weekly change

Using the data extracted weekly (from October 1, 2014 –June 24, 2015), the weekly difference in births for each month between the current week and the previous week was calculated and trends were examined. The weekly change in births per month was then plotted against the time to extraction. The number of days after which there were no more changes in the data (weekly change = 0) was calculated for Ontario and individual PHUs.

2) Time to data completeness

Another analysis was undertaken examining the time it takes before the number of births in a given month can be considered complete (i.e., greater than 99%). For this analysis, certain assumptions were made; the values extracted on June 24, 2015 were taken as the "complete" value and per cent complete was measured as the number of births in a given month divided by the number of births at the complete date of June 24, 2015. BORN identifies that data extracted within six months cannot be considered complete as all hospitals have not yet acknowledged their data,[5] therefore only data on number of births for months from April-2012 to December-2014 were included.

Data used for this analysis was extracted between July 21, 2014 and June 24, 2015. Per cent completion of births for all months was plotted against time to extraction for Ontario and PHUs where each point represents a given month at a single extraction date (e.g., for births in September 2014 as measured on October 1, 2014, time to extraction =30 days, and per cent completion = 59.6%). The time after which all values were 90% complete and 99% complete was evaluated for Ontario and each PHU. The average per cent completion at six months and one year were examined. The average per cent completion calculated at six months included all data points with a time to extraction of 6 months minus a week to 6 months plus a week and at one year included all data points with a time to extraction of one year minus a week to one year plus a week to account for variability in extraction times.

RESULTS

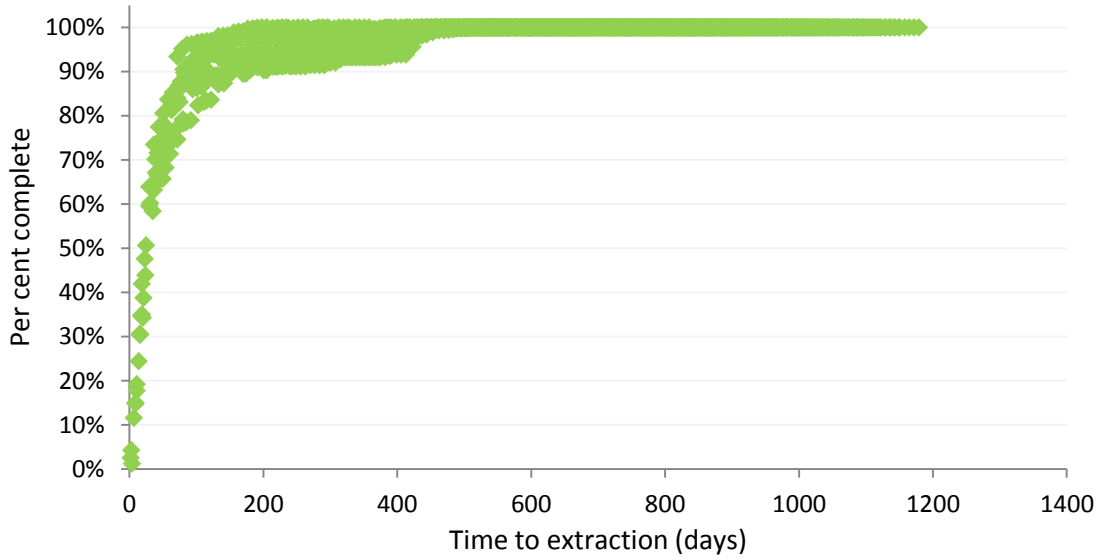
1) Time to zero weekly change

Weekly changes in births over time slowed in most situations after six months. However, in some cases there were large changes in births in a given month up to a year after the measurement date, (e.g., for Ontario an increase of 372 births was recorded for births in April-2014, for data extracted in April, 2015). Most of these large changes in births which occurred over a year after measurement were seen in Toronto and to a lesser extent, surrounding PHUs. In Ontario, there were no weekly changes in the data after 969 days (i.e., 32 months).

2) Time to data completeness

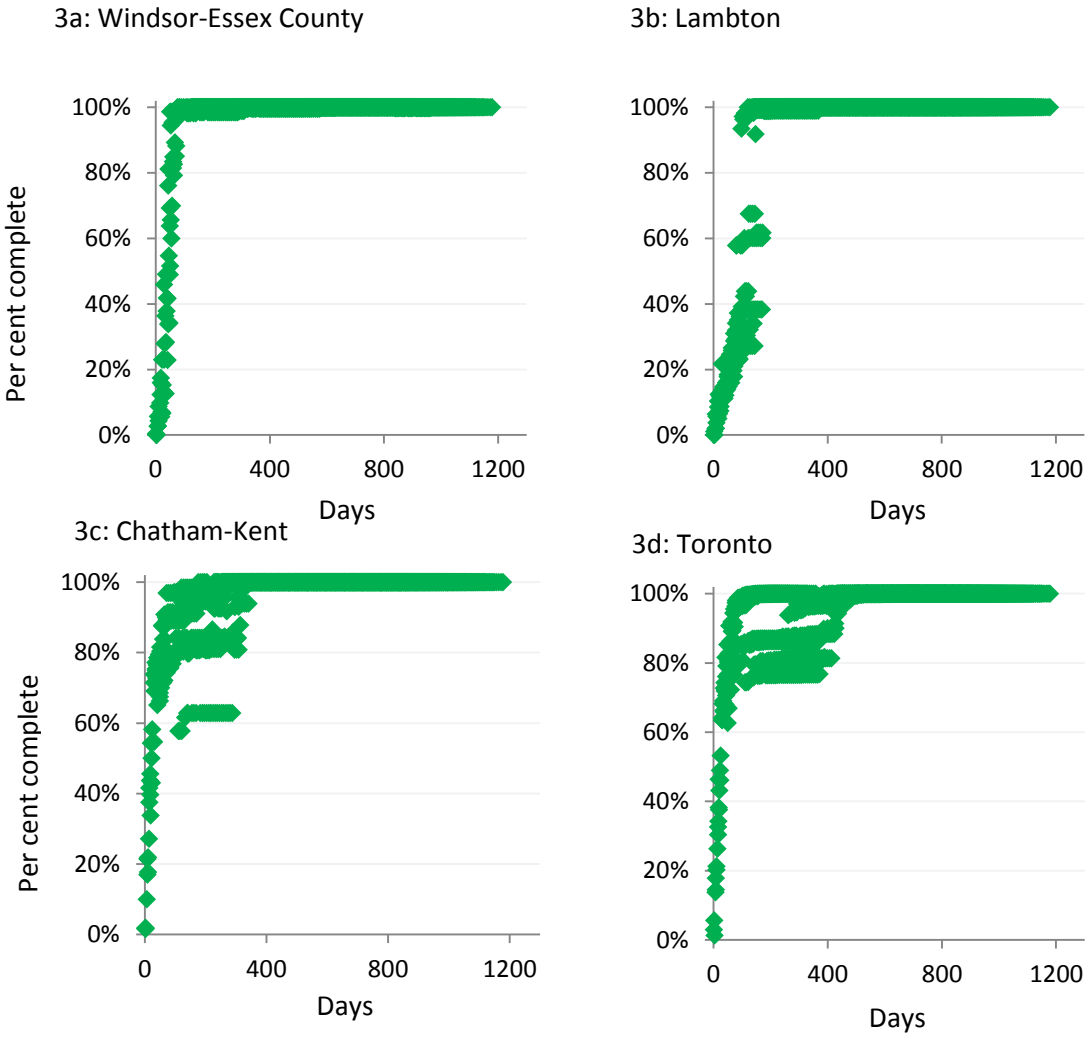
In Ontario, all births by month were over 90% complete after 174 days and over 99% complete after 453 days or about 15 months later (see Figure 2).

Figure 2: Per cent completion of births by time to extraction, Ontario



There was a large variation in timeliness patterns based on public health unit. Figure 3 shows timeliness patterns in select PHUs chosen because they demonstrated distinct patterns. In this example, Windsor-Essex County (Figure 3a) and Lambton (Figure 3b) represent timely reporting of data. In Windsor-Essex County, births are reported within two months, with very few changes afterwards; Lambton shows slower initial reporting, but almost all births are included by six months. Chatham Kent (Figure 3c) and Toronto (Figure 3d), represent different patterns of untimely reporting, in both cases, per cent completeness at six months is quite low. However, in Chatham-Kent almost all births are reported within a year, while Toronto has significant under-reporting beyond a year after the measurement date.

Figure 3: Per cent completion of births by time to extraction for select PHUs



Average under coverage at six months and one year time to extraction shows nine PHUs with per cent completion of less than 95% at six months. At one year, only two PHUs showed per cent completion of less than 95% (see Table 4). Ontario overall was found to have on average 96% per cent completion at six months and at one year time to extraction. Note that data available with a time to extraction of one year differ from data available at six months. For example, births per month that were extracted within a year of the final extraction date of June 24, 2015 would not be included in the calculation of average per cent completeness at one year time to extraction, but would contribute to the calculation of average per cent completion at six months' time to extraction. For this reason, in some instances the average per cent completion appears slightly higher at six months as compared to one year.

Table 4: Patterns of data timeliness by PHU

Public health unit	Per cent complete at 6 month time to extraction	Per cent complete at 1 year time to extraction	Number of days until zero weekly change
Huron	82.4%	98.5%	433
Ottawa	83.5%	99.7%	523
Chatham-Kent	89.9%	100.0%	349
Northwestern	91.2%	100.0%	753
Renfrew County	92.1%	99.8%	726
York Region	92.2%	85.8%	913
Perth	93.2%	98.9%	688
Leeds, Grenville and Lanark	93.8%	99.8%	402
Toronto	94.1%	88.0%	925
Durham	98.7%	97.3%	941
Oxford County	99.0%	99.8%	525
Timiskaming	99.2%	99.2%	435
Wellington-Dufferin-Guelph	99.2%	99.7%	435
Eastern Ontario	99.3%	100.0%	353
Grey Bruce	99.4%	99.5%	544
Peel	99.5%	99.1%	602
Halton	99.6%	99.2%	598
Lambton	99.6%	99.9%	374
Porcupine	99.6%	99.9%	625
Haliburton, Kawartha, Pine Ridge	99.7%	99.4%	713
Simcoe Muskoka	99.7%	99.6%	864

Public health unit	Per cent complete at 6 month time to extraction	Per cent complete at 1 year time to extraction	Number of days until zero weekly change
Windsor-Essex County	99.7%	99.8%	969
Hastings and Prince Edward Counties	99.8%	99.8%	434
Niagara Region	99.8%	99.9%	427
Peterborough	99.8%	99.7%	467
Thunder Bay	99.8%	99.8%	560
Hamilton	99.9%	99.9%	435
Kingston, Frontenac and Lennox & Addington	99.9%	100.0%	315
Middlesex-London	99.9%	100.0%	694
Sudbury	99.9%	99.8%	434
Region of Waterloo	99.9%	99.9%	500
Algoma	100.0%	100.0%	151
Brant	100.0%	100.0%	822
Elgin-St. Thomas	100.0%	100.0%	175
Haldimand-Norfolk	100.0%	100.0%	152
North Bay Parry Sound District	100.0%	99.8%	444
Ontario	**96.4%**	**96.1%**	**969**

Limitations

Data for this section was extracted between July 21, 2014 and June 24, 2015, while data measured on a weekly basis was available from October 1, 2014 to June 24, 2015. When examining trends in weekly changes over time, it is important to consider the limited time for which extracted data is available, particularly the omission of births from the summer months.

This section aimed to determine a specific lag time after which data can be considered complete and after which there were no changes in the data. The BORN data cube is considered a reporting database, meaning that those reporting births can go back at any time and update data they submitted. For this reason, small changes to the data are possible long after a birth occurs. Therefore, time to 99%

completion is preferable to zero weekly change for determining the lag time, as the time after which there was zero weekly change, was more sensitive to very small changes in the data which occurred even after data was stable for a long period of time.

One limitation of the time to data completion analysis was that data extracted on the last measurement date of June 24, 2015 was determined as the complete value. This determination may be problematic as an analysis of trends showed that there were sometimes notable changes in the data over a year later. However, a large number of data points (>1200) were recorded over a year before the "complete date" of June 24, 2015; therefore long-term trends in data completeness are likely representative of overall trends. The data extracted within a year of June 24, 2015 was included to give an idea of short term trends in data completeness (i.e., within the first six months). However, trends observed with a time to extraction of six months should be interpreted with caution as they include data which may be falsely labelled as complete.

In early 2015, BORN revised their methods for assigning postal codes which resulted in the reclassification of some births to different PHUs, including assigning births with unknown PHUs to a specific PHU.[10] At the PHU level, some changes in births by month which were seen up to a year later may be related to this change in methodology rather than untimely reporting.

Accuracy

Introduction

Accuracy refers to the degree to which the data reflect the reality it was designed to measure.[2] Data accuracy requires full coverage of the population of interest, low missingness, and validity, or in this case, alignment with other reproductive health data sources such as the Healthy Babies, Health Children Integrated Services for Children Information System (HBHC-ISCIS) and the Discharge Abstract Database (DAD) accessed through IntelliHEALTH Ontario.

This section will include an analysis of the BORN data collection procedures and processes as well as a data analysis component in order to answer the following three questions:

a) What is the level of missingness in the data? Does missingness vary by factors related to location or socioeconomic status which may affect overall accuracy?
b) Are results comparable to other databases with reproductive health information?
c) Are all populations that PHUs serve included in the database? If not, what are some health equity implications of their exclusion? For example, what is the impact of suppressing data from Aboriginal communities (the term Aboriginal is used here to refer to First Nation, Inuit and Métis peoples)?

This section will examine potential health equity impacts stemming from forms of inaccuracies in the data through examining differences by geography (i.e., PHU and geographic peer group) and by quintiles of the Ontario Marginalization Index (ON-Marg) an area level measure of socioeconomic status (SES). Measuring health inequities is important as the OPHS states that reducing inequities is fundamental to the work of public health in Ontario and that programs and services must be designed with the intention of reducing inequities in health.[6]

A) BORN data missingness

DATA AND METHODS

Measure: Live births
Dimensions: Alcohol use, intention to breastfeed, mental health concern, folic acid usage, breastfeeding at discharge, maternal weight gain, smoking during pregnancy
Stratifier: PHU, Peer group, and ON-Marg quintile

High missingness has been observed for a number of reproductive and child health indicators measured in the data cube.[12] High levels of missing data can result in inaccurate values for core public health indicators, particularly if missingness is not random but differs by important factors such as geography and socioeconomic status (SES). For example, if those of low SES are more likely to have high levels of smoking during pregnancy and are also more likely to be excluded from the data cube then calculated rates would be lower than the actual population rate.

This section seeks to determine indicators with high levels of data missingness in the data cube, and how missing data is distributed in the population by geography and SES. The total number of live births in 2013 (calendar year) was extracted for dimensions used in calculating current and proposed APHEO reproductive health and child health indicators.[4,9] The rate of missing information out of the total number of live births was calculated for each indicator. For indicators with greater than 5% missing data, results were stratified by PHU, geographic peer group as defined by the MOHLTC (using 2009 classification),[13] and by a neighbourhood measure of SES - the Ontario Marginalization Index (ON-Marg), which is calculated based on data from the 2006 census, and includes four dimensions of marginalization: material deprivation, ethnic concentration, residential instability, and dependency. Quintiles of marginalization from least marginalized (quintile 1) to most marginalized (quintile 5) are assigned at the level of dissemination area (DA) in Ontario.[14] Patterns of missingness across the different indicators was determined for each stratifier.

ON-Marg quintiles were assigned based on census dissemination area of mother's residence. Per cent missing data by ON-Marg quintiles was measured and differences were examined.

The slope index of inequality (SII) is an absolute summary measure of inequality, which represents the slope of the regression comparing the mean health outcome in a socioeconomic group to the cumulative per cent of the population, ranked from lowest to highest.[15] The SII was calculated for Ontario and select PHUs to determine whether there were significant differences in data missingness across quintiles of the ON-Marg dimensions, and whether associations varied by geography. PHUs were selected so as to include at least one from each peer group, and represented PHUs with higher missing data. Negative values for the SII indicate higher levels of missing data among the most marginalized neighbourhoods and a positive value represents higher levels of missing data among the least marginalized neighbourhoods.

RESULTS

Missingness varied considerably across the current and proposed APHEO core indicators, ranging from 0% missing data for stillbirths, perinatal mortality and multiple birth rates, to 33.0% missing data for maternal weight gain group. Congenital anomalies were not considered as it appeared that "no anomalies" was often mistakenly classified as missing (98.5% missingness for this indicator). Table 5 shows missingness by indicator.

Indicators with greater than 5% missing data include: smoking at prenatal visit, alcohol use, intention to breastfeed, mental health concern, folic acid usage, breastfeeding at discharge, and maternal weight gain.

Table 5: Missingness across APHEO core indicators, Ontario, 2013

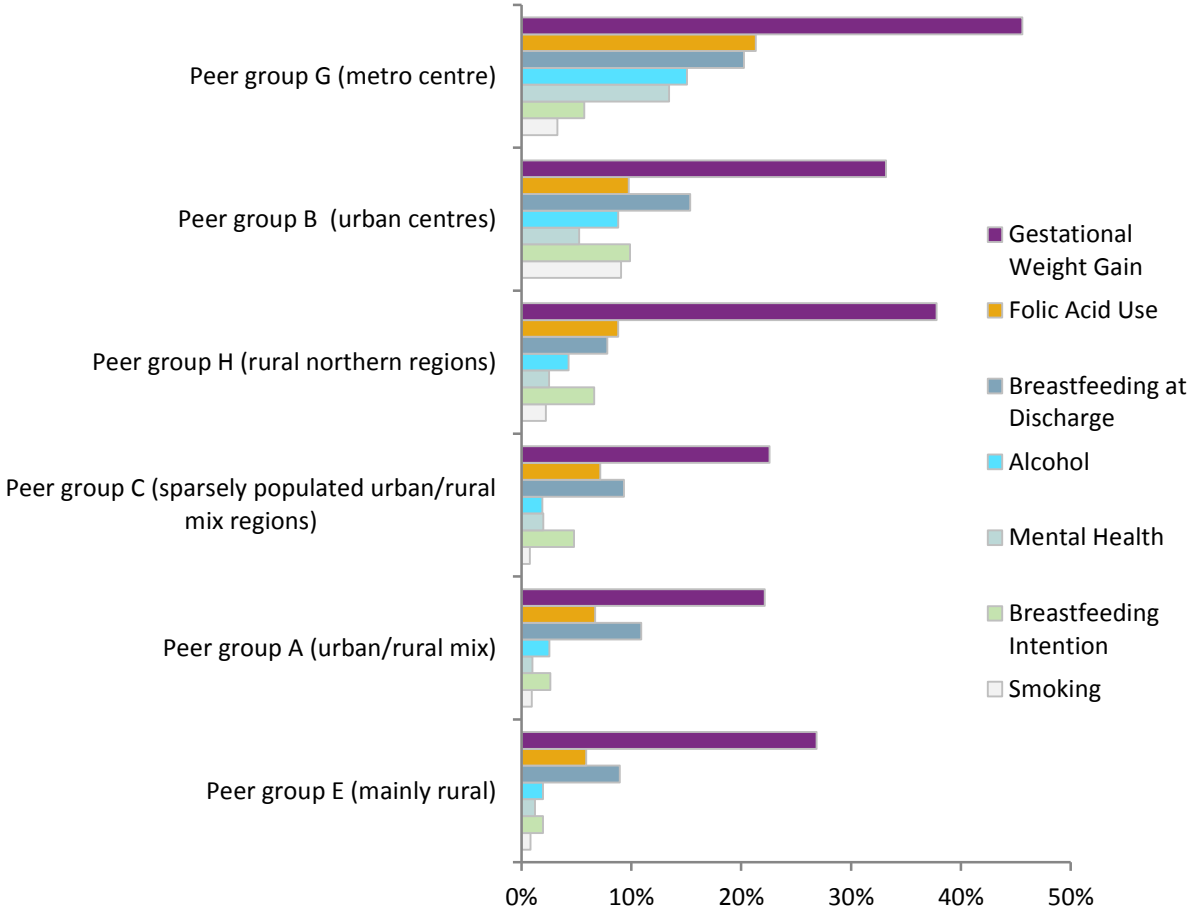
APHEO indicator	Per cent missing
Maternal weight gain	33.0%
Breastfeeding at discharge	15.0%
Folic acid usage	11.2%
Alcohol use	8.0%
Intention to breastfeed	7.1%
Mental health concern	5.7%
Smoking at prenatal visit	5.3%
Small and large for gestational age	3.9%
Smoking at admission for birth	1.9%
Mother's age at birth	0.8%
Low/high birth weight	0.1%
Stillbirths	0.0%
Perinatal mortality	0.0%
Multiple births	0.0%

Data extracted October 30, 2014

Across indicators, a number of PHUs consistently showed high missing data, in particular, Toronto and Peel. Results at the PHU level can be found in Appendix C. High missingness (> 5%) was more frequently observed in the following peer groups:[13] urban centres (peer group B), metro centres (G), and rural

northern regions (H). Lower missingness was consistently observed in urban/rural mix regions (A), sparsely populated urban/rural mix (C), and mainly rural regions (E) (see Figure 4).

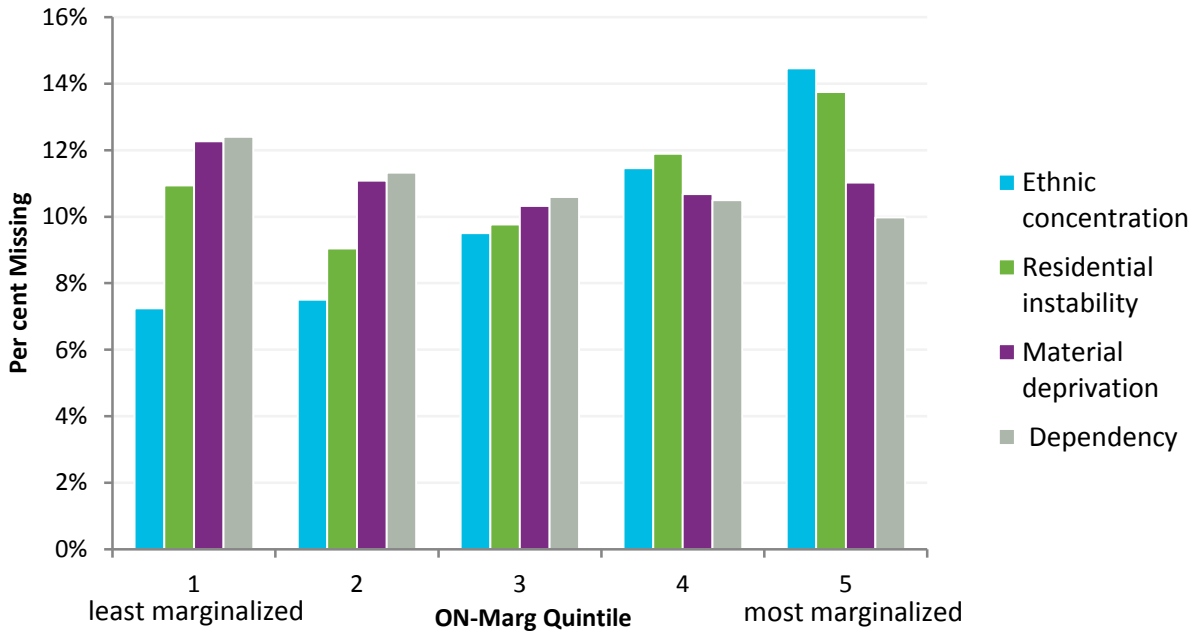
Figure 4: Data missingness by geographic peer group, 2013, Ontario



The cause of geographic variability in missingness in Ontario is related to individual hospitals with limited reporting, of which there are a number in the greater Toronto area (GTA). As a result, high missingness is seen in metro centres and urban centres. However, it is important to note that not all urban health units show high missingness, for example, missingness is relatively low for all indicators in Ottawa, and Windsor-Essex Country. In addition, high missingness in rural northern regions may be driven by high risk pregnancies being transferred to certain Toronto hospitals with limited reporting.[10]

Patterns of data missingness by socioeconomic group were generally consistent across the different core indicators. In Ontario, across all indicators, higher neighbourhood ethnic concentration was strongly associated with higher missingness and higher neighbourhood residential instability was associated with higher missingness. Higher neighbourhood material deprivation and dependency were associated with lower missingness. Figure 5 shows an example of data missingness by ON-Marg quintile for the folic acid indicator.

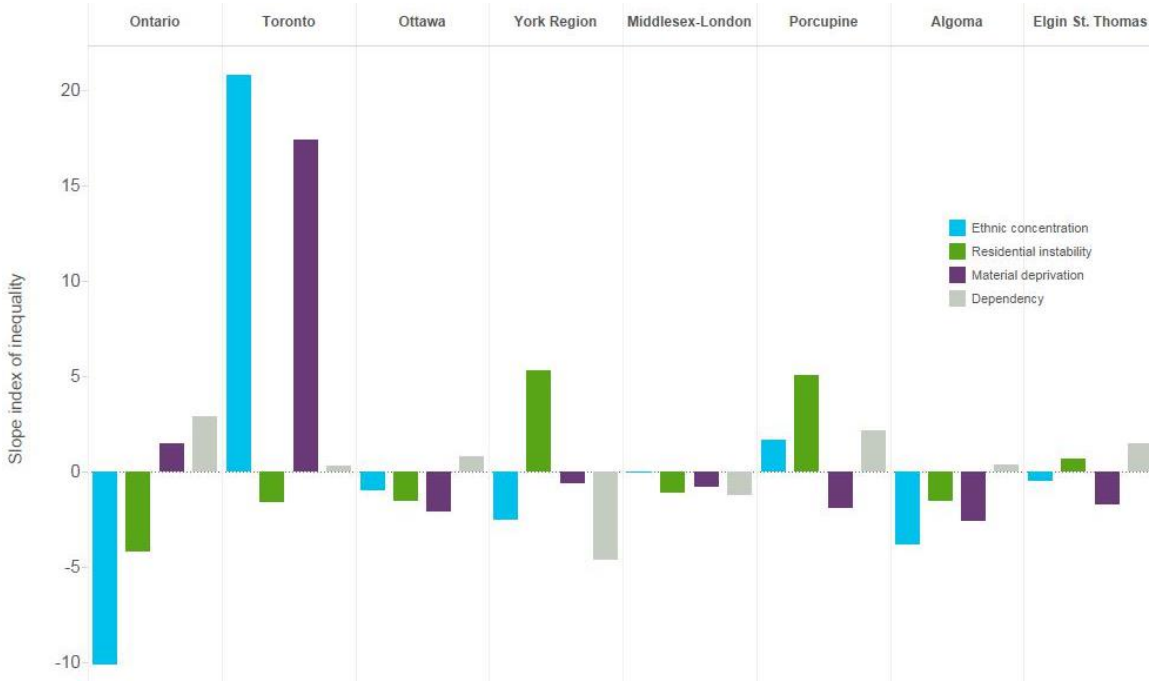
Figure 5: Percent missingness for folic acid by ON-Marg quintile



The SIIs for Ontario for each ON-Marg dimension reflects these patterns, with a strong negative SII of -10.1 across ethnic concentration quintile (i.e., missingness is 10.1% higher in the most ethnically concentrated neighbourhoods as compared to the least concentrated), to a positive SII of 2.9 for the dependency dimension (i.e., missingness is 2.9% lower in the most dependant neighbourhoods as compared to the least dependent). Similar relationships were found for all core indicators examined. SIIs were calculated for selected PHUs to determine whether the socioeconomic patterns found were influenced by geographic factors (e.g., local hospitals with limited reporting). This is possible as PHUs which were found to have high missingness in the data cube (e.g., metro and urban centres) also tend to have higher scores for ethnic concentration and residential instability, and lower scores for material deprivation and dependency.

When examining SIIs at the PHU level (Figure 6), disparities in missingness across ON-Marg dimension were sometimes strongly significant. For example, in Toronto, material deprivation and ethnic concentration quintile were strongly positively related to data missingness in BORN (i.e., those from quintiles of higher ethnic concentration and material deprivation were less likely to have missing data on folic acid use). For individual PHUs, missingness often followed similar patterns across the different core indicators being measured, indicating that individuals with missing data for one indicator were likely the same individuals with missing data for another indicator, particularly as the reporting institution is likely the same across different indicators.

Figure 6: Slope index of inequality for folic acid indicator by ON-Marg at the PHU level



SES is expected to influence data missingness of core indicators as populations from certain vulnerable sub-groups including young mothers, near-term immigrants, and low SES mothers often receive less prenatal care, and therefore experience fewer encounters where information can be collected and reported to BORN.[10] However, across different PHUs no consistent pattern in missingness by ON-Marg dimension was observed. This suggests that area-level socioeconomic factors alone do not consistently influence data missingness across Ontario. Though socioeconomic factors may not consistently influence missingness, understanding which socioeconomic groups in the population are likely to have more missing data can be important for properly interpreting information.

B) Comparability to other databases

DATA AND METHODS

Measure: Live births
Dimension: Crude birth rate, low birth weight rate, age of mother at birth, preterm birth, folic acid use, smoking during pregnancy
Filter: Calendar year 2013

Data quality can be assessed by comparing data found in BORN to rates found in other data sources which measure reproductive health indicators including the Discharge Abstract Database (DAD) accessed through IntelliHEALTH, the Healthy Babies Healthy Children-Integrated Services for Children Information System (HBHC-ISCIS), and the Canadian Community Health Survey (CCHS).

DAD provides data on reproductive health information collected from hospital discharge notices and represents all births which occur in hospitals. Data are available from the Ministry of Health and Long-Term Care (MOHLTC) through IntelliHEALTH and is updated by year of discharge.[4]

HBHC-ISCIS is a database which compiles reproductive health information from screens collected and entered by public health unit staff. Each PHU has access to their own data while data sharing agreements may be made in some cases to allow sharing between PHUs. PHUs are responsible for their own information and therefore data quality may vary by PHU. PHO has access to HBHC data for all PHUs. Data is collected from those that give consent to be included in the dataset and therefore, not all births will be included. Data is reported at the end of each fiscal quarter.[4]

The CCHS is a national survey of the Canadian population aged 12 and over which is representative at the public health unit level. The CCHS makes use of a complex stratified, and cluster sampling design to achieve representativeness. Excluded from the CCHS sampling frame are individuals living on Native Reserves and on Crown Lands, institutional residents, full-time members of the Canadian Forces, and residents of certain remote regions.[16]

Live births in 2013 calendar year were extracted in February 2015 from the data cube for the indicators - crude birth rate, low birth weight rate, age of mother at birth, and preterm birth rate. Mothers who gave birth in fiscal year 2013 was extracted from the data cube in April 2015 for indicators folic acid use, and smoking during pregnancy. These indicators were selected based on the following criteria:

i. Included in current or proposed APHEO reproductive health core indicator
ii. BORN is identified by APHEO as a data source
iii. Indicator is available in the BORN public health data cube
iv. Data is available through at least one the reproductive health databases which PHO has access to 2013 data- DAD and HBHC-ISCIS or 2011–12 data in the case of the CCHS.

Data were extracted and rates for each of the indicators were calculated from the various databases according to the methods outlined in the APHEO core indicators for public health: [4] the data cube was used to calculate rates for all the indicators at the Ontario and PHU level. HBHC-ISCIS was used to calculate smoking during pregnancy. The DAD accessed through IntelliHEALTH, was used to calculate the crude birth rate, low birth weight rate, age of mother at birth, and preterm births for Ontario and PHUs. The CCHS was used to calculate the folic acid indicator at the Ontario and PHU level. Differences

between the data cube and other reproductive health databases were noted. Major differences were explored further through consulting of the metadata to determine why differences may exist.

RESULTS

The total number of births in 2013 measured in BORN as compared to DAD was relatively close with BORN showing 138,678 births as compared to 136,589 in DAD, a difference of 2089 births (see Table 6). The higher number of births in BORN is expected as births which occur outside of hospitals (including home births and at birthing centres) are captured in BORN. Most PHUs showed a higher number of births using BORN with some notable exceptions. Northern rural health units show a substantially lower crude birth rate in BORN as compared to DAD (up to 2.9 per 1000 population lower in Northwestern Health Unit, and 1.7 per 1000 population lower in Porcupine). This may be a result of having higher Aboriginal populations as on-reserve postal codes are suppressed in the data cube.[17] See Figure 7 for differences in crude birth rate between BORN and DAD by PHU.

For low birth weight rate, rates are similar between BORN and DAD with BORN showing slightly lower rates (see Table 6). Differences in low birth weight rate at the PHU level were modest ranging from a 0.7% lower rate in Kingston, Frontenac and Lennox & Addington (KFLA) to 0.9% greater rate in Porcupine. Most PHUs showed a lower rate in BORN, similar to Ontario overall, while certain PHUs, often northern PHUs showed higher rates, which may in part be attributed to Aboriginal suppression. Variation in rates is also likely related to small differences in the definition of live births between BORN and DAD.

When comparing preterm birth rate in BORN to DAD, the Ontario rates were similar, though BORN showed a slightly lower rate. Differences in preterm birth rate at the local level between BORN and DAD ranged from 2.1% lower rate in Porcupine to 2.1% higher in Northwestern.

Average age of mother at birth was similar in DAD for Ontario overall as compared to BORN. Local differences in age of mother between BORN and DAD ranged between 0.09 years younger in Windsor-Essex County to 0.95 years older in Northwestern.

Comparing maternal smoking between BORN and HBHC-ISCIS shows similar values for Ontario with 10.6% smoking during pregnancy found in BORN and 9.6% in HBHC-ISCIS. Rates varied between BORN and HBHC-ISCIS from 4.8% lower in Porcupine to 5.3% higher in North Bay Parry Sound when comparing BORN to HBHC-ISCIS. See Figure 8 for difference in smoking rates by PHU.

Rates of folic acid use prior to pregnancy varied greatly between BORN 2013 data and the 2011–12 CCHS, with the CCHS showing a much higher rate of 61.2% as compared to 34.4% in BORN. Rates by PHU varied widely between the data sources with very little correlation. Values from BORN aligned more closely with a review of the literature showing rates of folic acid in the population pre-conception to be between 0.9%–49%.[18] In BORN, there are various options for reporting folic acid use, either pre-conception only, pre and during conception or post-conception only. The CCHS only asks about use of folic acid pre-conception; it is possible though that people might report any folic acid use prior to or during conception, which may contribute to higher rates found. Biased reporting due to social desirability may also be more common in the CCHS, as opposed to reporting to care providers (used in BORN) where responses can affect the care provided. Furthermore, while BORN data is captured during pregnancy or soon after birth, the CCHS surveys all women who have given birth in the last five years, which may have implications on accurate recall of information. This difference in populations included as well as a difference in time periods measured may limit comparability between BORN and the CCHS.

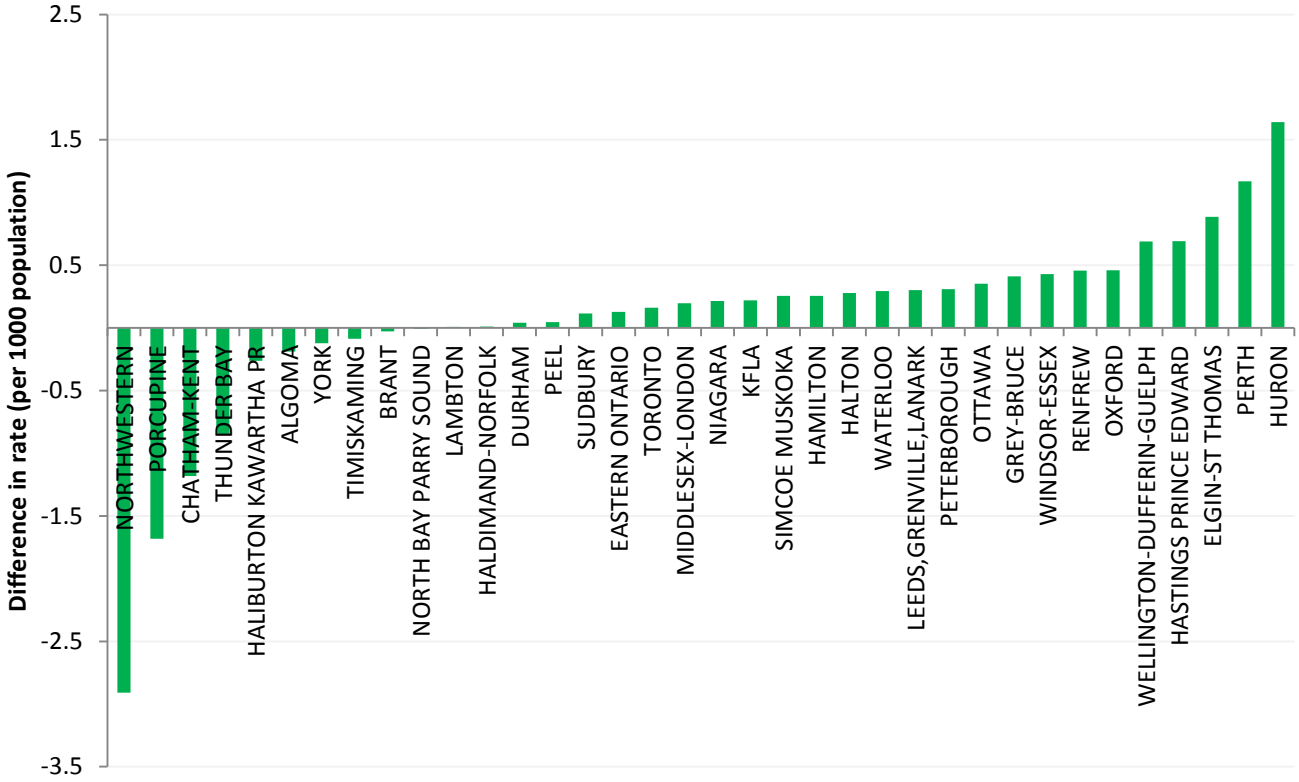
Tables showing rates for all indicators in BORN as compared to other databases at the PHU level can be found in Appendix D.

Table 6: Comparison between reproductive health databases, Ontario, 2013

Indicator	BORN	DAD	HBHC-ISCIS	CCHS
Crude births (#)	138,678	136,589	-	-
Crude birth rate (per 1000 population)	10.2	10.1	-	-
Low birth weight rate (%)	6.5	6.6	-	-
Preterm births (%)	7.9	8.1	-	-
Age of mother at birth (years)	30.4	30.4	-	-
Smoking during pregnancy (%)	10.6	-	9.6	-
Folic acid supplementation (%)	34.4	-	-	61.2

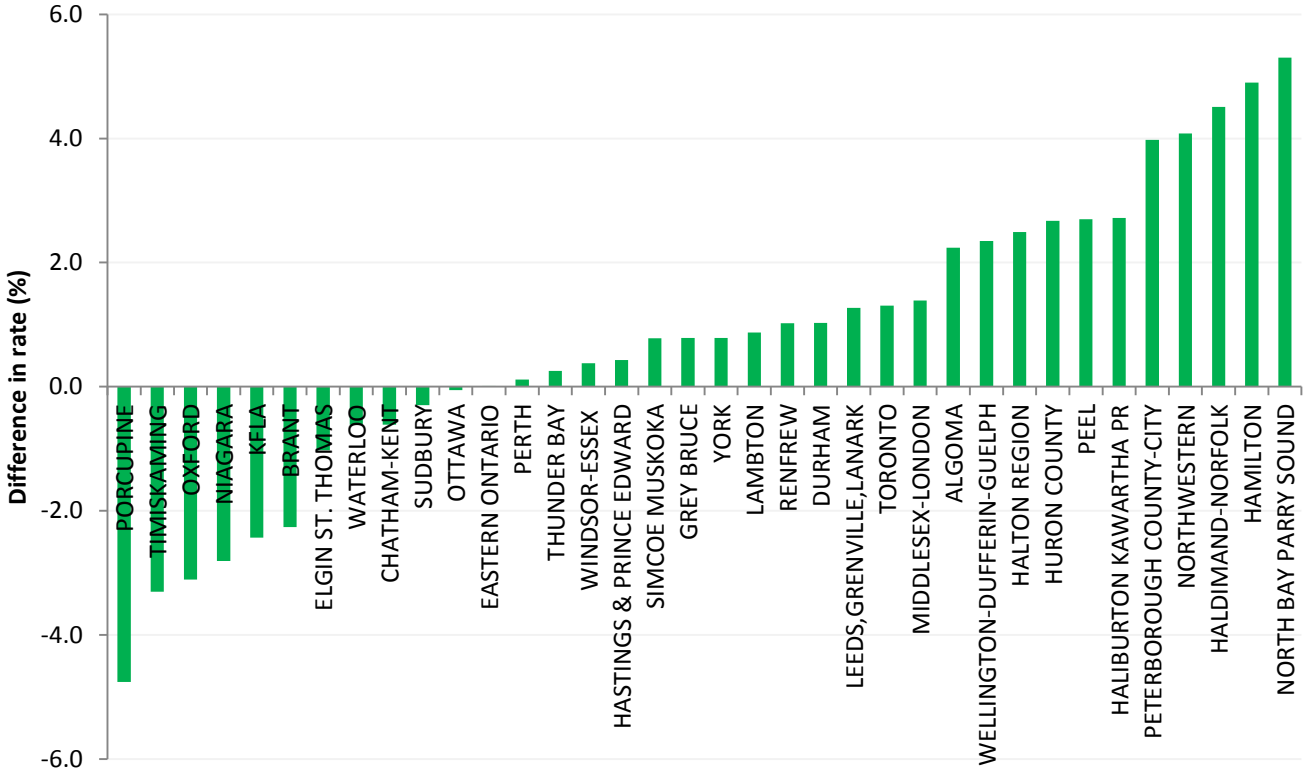
Data for calendar year 2013 on crude births, low birth weight, preterm births, and age of mother at birth was extracted February 4, 2015. Data on smoking during pregnancy for fiscal year 2013 was extracted from BORN April 8, 2015. Data for folic acid usage for fiscal year 2013 was extracted from BORN on April 16, 2015. DAD values represent 2013 calendar year. Data from HBHC-ISCIS was extracted based on six months of data collected in 2013. CCHS data is from the 2011–12 cycle.

Figure 7: Difference in crude birth rate between BORN and DAD by public health unit, Ontario, 2013



Negative values indicates lower rates in BORN

Figure 8: Difference in maternal smoking rate between BORN and HBHC-ISCIS by public health unit, Ontario, 2013



Negative values indicate that lower rates of smoking are found in BORN

C) Population coverage of BORN data

DATA AND METHODS

This section includes a search of BORN metadata to determine operating decisions and procedures which could result in the exclusion of reproductive health information from certain population subgroups. The findings of section B, examining comparability between BORN and DAD data will be interpreted in the context of the metadata.

Potential impacts on health equity from excluding data from certain population subgroups were considered. This was accomplished through careful review of the metadata, consulting the literature on reproductive health and vulnerable populations, and consulting with health equity experts at PHO.

BORN metadata was found through a search of the BORN website as well as a collection of documents distributed by BORN to public health units. Documents and data sources which provide information on BORN data collection and reporting were reviewed, including:

1. The BORN Ontario website http://bornontario.ca/en/: Describes BORN information sources and data collection principles.[7]
2. BORN Ontario Data Quality Framework (DQF) http://datadictionary.bornontario.ca/assets/documents/Data%20Quality/BORN%20Ontario%20Data%20Quality%20Framework.pdf: Provides information on data collection and quality assurance processes.[3]
3. BORN data dictionary http://datadictionary.bornontario.ca/: Provides more detailed information on how specific indicators are captured.[19]
4. Providing Geography while protecting privacy: The BORN Information System Solution for Public Health: Provides information on Aboriginal data suppression when reporting in the data cube.[17]

Information not found in these sources was found through directly contacting epidemiologists at BORN.

RESULTS

BORN makes an effort to capture all births in Ontario, including those which occur outside of hospitals. BORN data is collected through a number of sources in order to get a more complete picture of births in Ontario.

BORN contributors include:[7]

- hospitals (including NICU/SCN admissions)
- midwifery groups
- fertility clinics
- prenatal screening laboratories
- prenatal screening and newborn screening follow up clinics.
- newborn screening laboratories
- specialized antenatal clinics

The data cube reported 2,089 more live births in 2013 compared to the DAD. This increase is likely a result of the capture of births outside of hospitals.[8]

While BORN makes a strong effort to capture all births, including those which occurred outside of hospitals, certain population sub-groups are excluded from the data cube; births which occur to mothers with a residential postal code where the majority of the population lives on an Aboriginal reserve or community are not included, although some PHUs serve these populations.[20,21] BORN's decision to suppress Aboriginal data was based on their interpretation of the principles of OCAP which outlines the rights of First Nations, Inuit, and Métis communities to own, control, access and possess information about their populations.[17] In the BIS, births were suppressed if they occurred in a postal code area where the majority of the population live on a reserve.[17] Approximately 870 births in Ontario in 2013 were excluded from the data cube as a result of Aboriginal suppression.[17] While the overall per cent (~0.6%) of births suppressed in Ontario is small, in certain PHUs with substantial Aboriginal populations, a large per cent of births may be missed.

The BORN data quality framework classifies the rate of population under or over coverage into three categories:[3]

- None or minimal (<1%)
- Moderate (1-3%)
- Significant (>3%)

Using this classification system, significant under-coverage related to Aboriginal suppression is found in six PHUs, including:[17]

- Northwestern (31.9%)
- Porcupine (16.6%)
- Thunder Bay (6.7%)
- Brant (5.9%)
- Chatham-Kent (4.2%)
- Sudbury (3.9%)

A further three have moderate under-coverage, including:[17]

- Algoma (1.8%)
- Lambton (1.5%)
- Peterborough (1.2%)

Data quality concerns resulting from population under-coverage can be demonstrated using data from the analysis of comparability, as some of the PHUs with significant under-coverage showed the largest discordance with the DAD database, which does not suppress Aboriginal data. In particular Northwestern, Porcupine, and Thunder Bay often showed lower values for counts and higher value for rates; this is in contrast with Ontario overall where higher counts and lower rates were seen in BORN as compared to DAD. See Table 7 for differences in rates between BORN and DAD in PHUs with substantial under-coverage.

In the PHUs listed, particularly those with significant under-coverage, the rates found in BORN may not provide an accurate representation of all births, particularly as rates in Aboriginal populations differ significantly from the rest of the population. Additionally, the method for excluding Aboriginal data is not exact; in some instances, on-reserve postal codes can be missed and Aboriginal data may be included, and non-Aboriginal populations can be excluded if they live in postal codes which are majority on-reserve.[17] Data quality issues in PHUs with high Aboriginal suppression can lead to poor monitoring and limit ability to provide programs and services which correctly address the needs of these

communities. The needs of Aboriginal populations which use services provided by PHUs with high suppression are also less likely to be understood and addressed. These data quality issues can therefore have implications on health equity.

Table 7: Difference in rates between BORN and DAD in selected PHUs with substantial under-coverage

Selected PHU	Crude births	Low birth weight	Preterm birth rate	Age of mother (years)
Northwestern	-236	0.8%	2.1%	0.95
Porcupine	-146	0.9%	-2.1%	0.48
Thunder Bay	-131	0.2%	-0.4%	0.51
Brant	-4	-0.3%	-0.2%	0.33
Chatham-Kent	-125	0.8%	1.2%	0.10
Sudbury	23	-0.4%	-0.1%	0.05
Ontario (overall)	**2089**	**-0.1%**	**-0.1%**	**0.04**

Limitations

In the interest of time, only selected APHEO core reproductive health indicators were evaluated for missingness, though this does not provide a complete list of all indicators which may have problems related to high missingness in BORN. APHEO core indicators with over 5% missingness were evaluated and stratified by PHU and by area level SES. Certain indicators do show high levels of missing data in the data cube and missingness may differ by important factors such as geography and SES; therefore, when using the data cube for calculating public health indicators, the level and distribution of missingness in the population should be considered.

The ON-Marg, an area level measure of SES, was used to examine differences by SES. Currently in BORN, no individual variables on SES are available and therefore assigning area-level measures of SES to geography is the only option for stratifying by SES. Advantages of using area-level measures of SES like ON-Marg is that area level factors such as access and quality of nearby institutions may influence the measurement of reproductive health outcomes, and the level of missing information (for example if nearby institutions have poor reporting practices). However, individual socioeconomic position may not necessarily align with neighbourhood SES and therefore differences by SES should not be interpreted at the individual level. While this section looks at missingness for individual indicators, it does not account for missing data as a result of births which are not included in the database.

For those indicators reviewed, indicators captured in BORN are highly comparable with other reproductive health databases with the exception of folic acid supplementation, where large differences were seen between BORN and the CCHS. Results from BORN were found to align more closely with the literature which generally shows supplementation rates below 50%.[18] This demonstrates that BORN information is highly accurate, and in some cases may provide an opportunity to better measure metrics

which have historically been captured inaccurately. BORN data for 2013 was used in this analysis as extracted in February 2015. It is important to note that data for this time period was not considered fully complete by BORN until April 2015,[10] though only small changes were observed after February 2015. When determining data quality by making comparisons between BORN data and that of DAD, HBHC-ISCIS, and the CCHS, it is important to note that these databases do not represent a gold standard in reproductive health information. For example, DAD only includes hospital level data and therefore would miss births from home deliveries and birth centres, HBHC-ISCIS includes only those clients who consented to have their information captured and the CCHS surveys mothers as much as five years after the birth of their last child. Furthermore, differences in definitions of live births between the datasets can result in variations in rates calculated. Therefore, this section only provides a general description of data comparability between reproductive health data sources and should not be interpreted as an absolute measure of BORN data validity.

A review of the metadata may not have revealed all populations which are under-represented in the data cube, particularly if differences exist between data collection protocol and practice. However, this section is meant to give a general idea of populations that could be under-represented while applying a health equity approach to determine some of the impacts. BORN has the potential to provide better coverage than other data sources of all births in Ontario, as births which occur outside of hospitals are captured. However, Aboriginal populations are under-represented in the data cube. While BORN generally has good population coverage; there are important data quality concerns for individual public health units with large Aboriginal populations. This may have implications for programming and practice. Understanding rates and trends in Aboriginal populations is necessary for optimal programming and planning in PHUs which may provide services that are used by these populations. PHUs have the option of requesting data without suppression from BORN. To receive this data, PHUs must make a request with a letter of support from involved Aboriginal communities that demonstrate their approval and involvement in the project.[10] Unfortunately, many northern rural PHUs that serve these populations may also have less staff and epidemiological support to support additional data collection processes. Accessing data through requests can also result in considerable delays in receiving data. The health equity implications of the decision to suppress Aboriginal data should be explored further.

Usability

Introduction

Usability refers to the ease with which data can be understood and accessed. For public health practice, it is important that data in the public health data cube be accessible and easy to understand. As with any data source, proper access to and understanding of the metadata, is important for determining whether data is comparable over time and between other reproductive health datasets. Furthermore, having a data cube that is easy to understand and use is important in avoiding errors in data extraction.

This section does not involve original analysis but is based on comments recorded on issues of accessibility and understandability of the public health data cube and metadata. The following questions were explored:

a) Was the metadata accessible and understandable for all relevant data elements?
b) Was the data cube easy to use? Were there access issues related to relevant core indicators?

Data and Methods

For this section, notes were taken while using the data cube over the course of a year. Any issues related to access, or understandability, or general comments on ease of use were documented. Other users of the data cube at PHO were contacted and asked to contribute any comments related to usability.

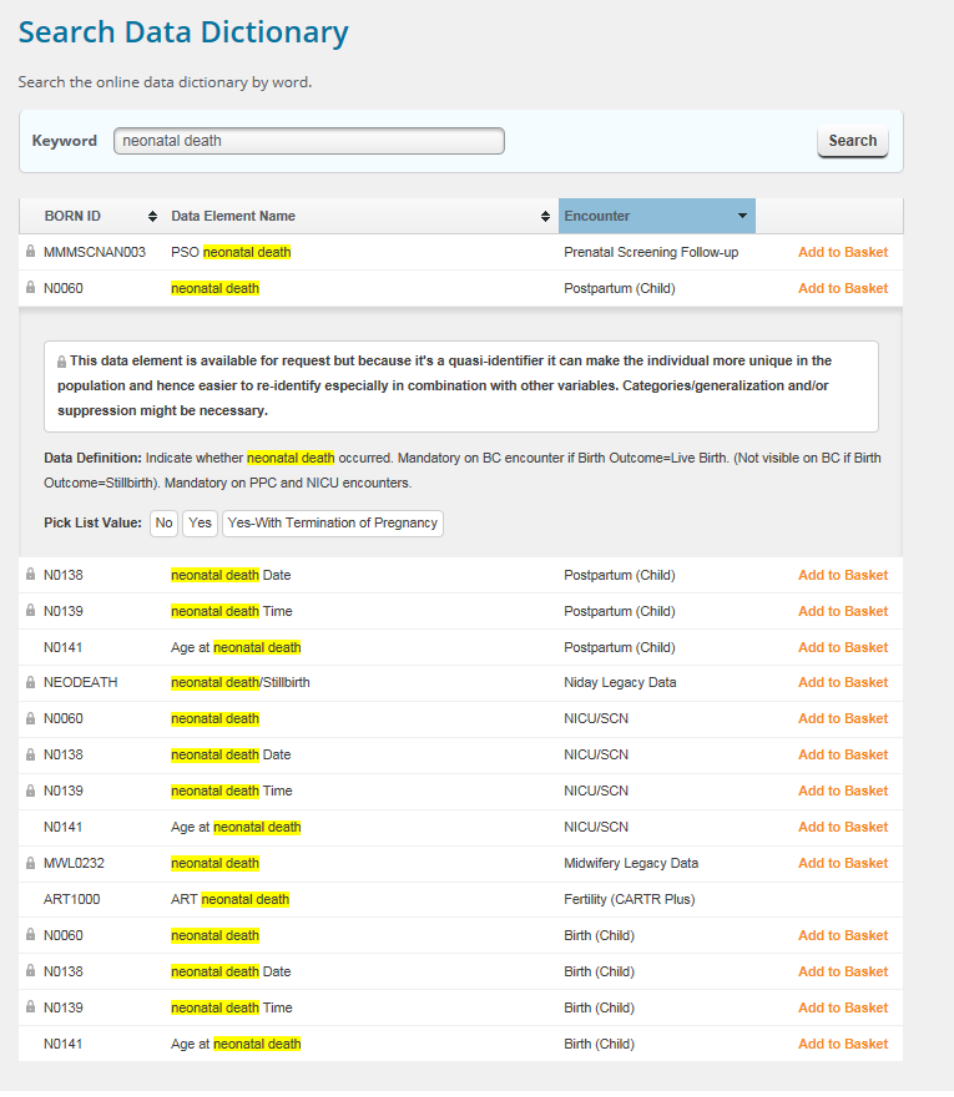
Results

There were a number of general issues relating to usability of the public health data cube. The data cube was not compatible with all internet browsers such as Google Chrome, though it did work well using Internet Explorer. A few users commented on the difficulty in accessing the cube after launching the analytical report tool on the BIS website. The cube was not immediately accessible but required clicking on the cube icon and then adding in the public health data cube. However, BORN staff were available for troubleshooting, and data cube training slides are available through local administrators or through contacting BORN.

Access to BORN metadata was a major concern related to use of the data cube. The information in the BORN data dictionary was often limited and did not provide sufficient detail about how the indicator was captured and measured. Additionally, for certain indicators, the data dictionary provides a number of choices for the same data element based on the encounter with the system where the data was captured (e.g., postpartum screen, the NICU, at birth); this was often confusing as the encounter from which information is being used is not listed in the cube (note that according to staff at BORN, the data cube uses an aggregate dataset that includes measures from all encounters).[10] Furthermore, m descriptions in the data dictionary were often non-specific and did not help in understanding how the indicator was captured. A search for the definition of neonatal death in the data dictionary is provided as an example. Neonatal deaths are commonly defined as deaths within 7 days of birth or within 28 days

of birth. As it was not clear whether deaths within 7 days or 28 days were used in the cube to define a neonatal death, the data dictionary was searched. When searching neonatal death in the data dictionary different definitions were provided for neonatal death under six different encounters, including: Prenatal screen follow up, Postpartum(Child), Niday Legacy Data, NICU/SCN, Midwifery Legacy Data, and Birth (Child). The definitions differed in their specificity with some noting the age of death, for example, for prenatal screening follow up, neonatal deaths were captured in the first 28 days, midwifery legacy data asks whether a death occurred in the first 7 or 28 days, other selections simply showed pick list values of yes, no, and yes-with termination of pregnancy, giving little detail on how the element was measured. A screenshot of the data dictionary search results can be seen in Figure 9. Additionally, definitions for measures in the cube (e.g., live births, all births) were not available in the data dictionary, leading to problems in identifying which denominator to use when calculating rates. Contacting BORN was often necessary for understanding how specific data elements were measured.

Figure 9: Example of BORN data dictionary search for neonatal death



More specific issues using the data cube related to difficulties in finding specific indicators in the cube. Dimensions in the cube must be selected through clicking through a number of dropdowns. For a number of indicators these drilldown paths were not intuitive; for example, the indicator “multiple

birth" is found through the path Pregnancy> Pregnancy History > and selecting the dimension "number of fetuses", thereby listing the status for a current birth under pregnancy history. Ability to search the drilldown path in the data dictionary or in the cube itself is a possible solution. Minor areas identified during the review relate to the lack of certain data, such as information on father's age and on socioeconomic status, though much of this data is not currently collected by BORN.

No major issues regarding loading times or difficulties downloading the data were noted.

LIMITATIONS

Only a small number of staff members at PHO were regular users of the data cube and were able to contribute comments. Therefore, this section reflects a limited number of issues regarding the use of the data cube on a limited number of devices. This is not a comprehensive list of problems in using the data cube, but highlights a few of the major issues, namely, the accessibility of metadata and difficulties accessing and drilling down to certain indicators

It is important to note that prior to this analysis, a working group within APHEO, the BORN public health working group, documented some major usability issues which have been shared with BORN. Comments from this group, including the need for better metadata are being addressed by BORN while production of a manual for use of the data cube is currently underway.

Conclusions

The BORN public health data cube represents an important public health opportunity in Ontario for monitoring reproductive health with accurate and timely information. Advantages of BORN are the availability of certain indicators, which are not captured in other population-level data sources (e.g., smoking during pregnancy), as well as its broad coverage of births in Ontario including those which occur outside of hospitals. Other data sources, such as DAD only account for births in hospitals. These factors contribute to recommending BORN as a primary public health data source for calculating reproductive health indicators and for planning effective public health policies and programs. It was therefore important to perform an assessment to ensure that the data is of high quality, document its limitations and identify potential areas for improvement.

This analysis evaluated data quality by examining data relevance, timeliness, accuracy, and usability. Overall, BORN data quality was good and can be used effectively for calculating many of the core indicators for public health. However, high missingness of certain indicators may affect accuracy, and suppression of Aboriginal data has implications on measured rates in PHUs with high Aboriginal populations.

The relevance section highlights that many public health indicators could be calculated using BORN. However, BORN may have limited use in calculating the core indicators, congenital infections, and perinatal mortality due to important differences in definitions between BORN and the APHEO core indicator. Caution is advised when using BORN for calculating a number of core indicators (e.g., stillbirth rate, small and large for gestational age) due to minor differences in alignment with the APHEO definition. In addition, certain important stratifiers to assess health equity such as measures of individual SES were not available in the data cube. The core indicators provide a basic list of indicators that are relevant to PHUs in monitoring and planning effective public health programs and services; therefore, further assessment of the relevance of BORN beyond the core indicators may be warranted.

The timeliness section indicates that BORN data was complete after 15 months, with large variations in lag times between PHUs. Users of BORN data should be aware that data extracted within 15 months of a birth may be subject to change, particularly in certain PHUs where longer lag times were observed such as Toronto, and York Region. Due to time limitations, data were only extracted over the course of ten months. Future assessments may wish to extract data for a longer period of time for a fuller representation of time to completeness.

The accuracy section overall demonstrated high quality of BORN data. However, when calculating certain indicators using BORN, high levels of missing data may affect validity. For a number of core indicators, missingness was higher in Peel and Toronto which affects overall rates calculated for Ontario and limits comparability between PHUs. The cause of geographic variability in missingness in Ontario is related to individual hospitals with limited reporting, of which there are a number in the GTA.[10] Certain Toronto hospitals with limited reporting are also centres for delivery of high risk births from across the province. Therefore, limited reporting in these hospitals may result in missingness of higher risk births across the province, particularly those in rural northern regions. Data missingness was also influenced by socioeconomic group, in particular, high ethnic concentration neighbourhoods were associated with higher missingness in Ontario, though relationships between SES and data missingness varied by geography. When interpreting BORN data it is important to consider the level of missingness and how it is distributed in the population, particularly where missingness is high. The BORN data quality

framework recommends caution if missingness is greater than 10% and not reporting if missingness is greater than 30% , such as found for the gestational weight gain indicator.[3]

For a number of indicators, BORN data was found to be highly comparable to other reproductive health databases, particularly when comparing with hospitalization data. However, large variations were observed when comparing BORN and CCHS data on folic acid supplementation prior to pregnancy. A review of the literature examining worldwide prevalence of folic acid supplementation[18] suggests that BORN data likely provides a better estimate of folic acid use in Ontario. This demonstrates that BORN information is highly accurate, and in some cases may provide an opportunity to better measure indicators, including those related to maternal risk factors, which have historically been captured inaccurately. When comparing BORN to other reproductive health databases, it is important to note that BORN is expected to have better coverage than both DAD and HBHC-ISCIS and to have better standardization as compared to HBHC-ISCIS. Therefore, comparability between BORN and these databases may not necessarily indicate data accuracy in BORN.

Under-coverage of Aboriginal populations in the public health data cube, as well as inaccurate methodology for suppression, which can mistakenly suppress births of those living near reserves, can have important effects on values measured; this may affect the ability of certain PHUs to plan for and provide equitable programs and services which address the needs of the population including Aboriginal population which use reproductive health services. PHUs with large Aboriginal communities should be aware of this suppression and consider how it affects rates found in their region. PHUs may consider working together with Aboriginal communities and requesting data without Aboriginal suppression from BORN.

Notes on usability of the metadata and data cube highlighted concerns related to accessibility of the data cube, including difficulties in searching and finding indicators in the data cube and inability to find specific definitions in the data dictionary. More work is needed to provide BORN data cube users with quick and easy access to definitions of indicators and measures used in BORN. This section highlights some key usability issues observed in conducting the data quality assessment, but does not constitute a comprehensive list of issues that public health users of the data cube may be experiencing.

This report assessed a broad range of indicators of data quality as a starting point for understanding data quality in BORN. Public health professionals are encouraged to assess data quality for factors unique to their setting or planning needs (e.g., specific populations of interest that may be excluded, level of missingness).

The potential for using the BIS for public health monitoring is very strong. BORN is listed as a data source for most of APHEO's current reproductive health indicators and all of the proposed indicators.[9] Furthermore, BORN allows for the capture of many maternal risk factors and maternal health indicators not previously captured in other representative data sources. Because BORN is judged to be a reliable and high quality data source for reproductive health information, PHO will use BORN in calculating the indicators in their maternal health Snapshot. Improvements to the BIS and additions to available data in the public health data cube are on-going, positioning BORN to grow as a reliable and important data source for reproductive health monitoring in Ontario.

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Appendix A: APHEO general and specific indicators available in BORN

General Indicator	Specific Indicator
Reproductive health indicators listing BORN as a data source	
Age of parent at infant's birth	Average age of mother Average age of mother at birth of first infant Average age of father Median age of mother Median age of mother at birth of first infant Median age of father Proportion of births by age of mother Proportion of births of first infant by age of mother Proportion of births by age of father
Birth weight	Low Birth Weight Rate (LBW) Very Low Birth Weight Rate (VLBW) Extremely Low Birth Weight Rate (ELBW) Small for gestational age (SGA) Large for gestational age (LGA)
Congenital anomalies	Rate of congenital anomalies (CAs) Rate of neural tube defects (NTDs) Rate of down syndrome (DS) Rate of congenital heart defects (CHDs) Rate of orofacial clefts (OFCs) Rate of musculoskeletal anomalies (MSKs)
Congenital infections	Incidence of rubella, congenital syndrome Incidence of cytomegalovirus (CMV) infection, congenital Incidence of herpes, neonatal Incidence of Group B Streptococcal disease, neonatal Incidence of ophthalmia neonatorum (gonorrhoea and chlamydia)

General Indicator	Specific Indicator
	Incidence of congenital gonorrhoea (other than conjunctivitis)
	Incidence of congenital chlamydia (other than conjunctivitis)
	Incidence of congenital syphilis
	Incidence of congenital Human Immunodeficiency Virus (HIV) infection
	Incidence of congenital Acquired Immunodeficiency Syndrome (AIDS)
	Incidence of congenital chicken pox (varicella)
	Incidence of reportable congenital infections, total
Crude birth rate	Crude birth rate
Fertility rate	General fertility rate
	Adolescent fertility rate or teen fertility rate
	Age-specific fertility rate
Total fertility rate	Total fertility rate
Multiple birth rate	Multiple birth rate
	Multiple live birth rate
Perinatal mortality and stillbirth rate	Perinatal mortality rate
	Crude stillbirth rate
	Stillbirth rate ≥ 500 g
Pregnancy rate	Total pregnancy rate
	Age-specific pregnancy rate
	Teen pregnancy rate or adolescent pregnancy rate
Preterm birth rate	Preterm birth rate
Smoking during pregnancy	The number of females who smoked cigarettes during pregnancy as a percentage of the total number of females who gave birth (live birth or stillbirth) in a given place and time
Folic acid supplementation	Proportion of women taking folic acid supplementation prior to pregnancy
	Proportion of women taking folic acid supplementation prior to and during pregnancy

General Indicator	Specific Indicator
Child health indicators listing BORN as a data source	
Breastfeeding initiation and duration	BORN listed as a data source for breastfeeding initiation only
Reproductive health indicators that do not list BORN as a data source	
Neonatal and infant mortality rate	Neonatal mortality rate Post-neonatal mortality rate Infant mortality rate

Appendix B: Weekly change in births

Week	Weekly change in births
October-08-14	2136
October-15-14	3397
October-22-14	2939
October-29-14	2076
November-05-14	1201
November-12-14	4474
November-19-14	2330
November-26-14	2313
December-03-14	2308
December-10-14	2299
December-17-14	2482
December-24-14	2280
December-31-14	2852
January-07-15	2245
January-14-15	2085
January-21-15	2443
January-28-15	2114
February-04-15	2350
February-11-15	4440
February-18-15	2211
February-25-15	2666
March-04-15	2189
March-11-15	3983
March-18-15	2787
March-25-15	2613
April-01-15	2257
April-08-15	1994
April-15-15	2783
April-22-15	2241
April-29-15	2251
May-06-15	3897
May-13-15	2978
May-20-15	2132
May-27-15	2268
June-03-15	2739
June-10-15	3138
June-17-15	2999
June-24-15	3177

Appendix C: Missingness of core indicators by PHU

Indicator: Folic acid use

Public health unit	Per cent missing
TORONTO	21.3%
PEEL	19.6%
PETERBOROUGH COUNTY-CITY	15.5%
YORK REGION	12.1%
HALIBURTON KAWARTHA PINE RIDGE DISTRICT	12.1%
NORTH BAY PARRY SOUND DISTRICT	11.6%
NIAGARA REGION	11.3%
BRANT COUNTY	10.2%
HALTON REGION	10.2%
NORTHWESTERN	9.4%
PORCUPINE	8.4%
WELLINGTON-DUFFERIN-GUELPH	7.7%
SIMCOE MUSKOKA DISTRICT	7.2%
SUDBURY & DISTRICT	6.7%
EASTERN ONTARIO	6.1%
OXFORD COUNTY	6.1%
THUNDER BAY DISTRICT	6.0%
DURHAM REGION	5.8%
LAMBTON	5.8%
HALDIMAND-NORFOLK	5.7%
ALGOMA	5.6%
CHATHAM-KENT	5.1%
GREY BRUCE	5.0%
HASTINGS & PRINCE EDWARD COUNTIES	4.9%
TIMISKAMING	4.9%
CITY OF HAMILTON	4.6%
LEEDS, GRENVILLE & LANARK DISTRICT	4.5%
WATERLOO	4.4%
MIDDLESEX-LONDON	4.2%
RENFREW COUNTY & DISTRICT	4.0%
OTTAWA	3.6%
KINGSTON, FRONTENAC & LENNOX AND ADDINGTON	3.1%
HURON COUNTY	2.8%
ELGIN ST. THOMAS	2.5%
WINDSOR-ESSEX COUNTY	2.2%
PERTH DISTRICT	1.3%

Indicator: Smoking during pregnancy

Public health unit	Per cent missing
PEEL	29.7%
HALTON REGION	10.3%
WELLINGTON-DUFFERIN-GUELPH	7.1%
PORCUPINE	3.6%
TORONTO	3.3%
DURHAM REGION	2.6%
YORK REGION	2.2%
NORTH BAY PARRY SOUND DISTRICT	1.6%
PETERBOROUGH COUNTY-CITY	1.5%
WATERLOO	1.3%
HURON COUNTY	1.2%
CHATHAM-KENT	1.2%
MIDDLESEX-LONDON	1.2%
CITY OF HAMILTON	1.1%
HALDIMAND-NORFOLK	1.1%
SIMCOE MUSKOKA DISTRICT	1.1%
GREY BRUCE	1.0%
ALGOMA	0.9%
BRANT COUNTY	0.9%
EASTERN ONTARIO	0.9%
HALIBURTON KAWARTHA PINE RIDGE DISTRICT	0.8%
NIAGARA REGION	0.8%
PERTH DISTRICT	0.7%
HASTINGS & PRINCE EDWARD COUNTIES	0.7%
THUNDER BAY DISTRICT	0.6%
TIMISKAMING	0.6%
OXFORD COUNTY	0.5%
OTTAWA	0.5%
KINGSTON, FRONTENAC & LENNOX AND ADDINGTON	0.5%
NORTHWESTERN	0.5%
ELGIN ST. THOMAS	0.4%
LEEDS, GRENVILLE & LANARK DISTRICT	0.4%
LAMBTON	0.3%
SUDBURY & DISTRICT	0.3%
WINDSOR-ESSEX COUNTY	0.3%
RENFREW COUNTY & DISTRICT	0.1%

Indicator: Intention to breastfeed

Public health unit	Per cent missing
PEEL	26.6%
HALTON REGION	11.0%
ALGOMA	10.7%
PORCUPINE	8.8%
YORK REGION	8.2%
WELLINGTON-DUFFERIN-GUELPH	6.1%
NORTH BAY PARRY SOUND DISTRICT	5.9%
TORONTO	5.7%
DURHAM REGION	4.8%
THUNDER BAY DISTRICT	4.0%
NORTHWESTERN	3.9%
MIDDLESEX-LONDON	3.6%
CITY OF HAMILTON	3.3%
CHATHAM-KENT	3.2%
HURON COUNTY	3.2%
PERTH DISTRICT	2.6%
ELGIN ST. THOMAS	2.6%
PETERBOROUGH COUNTY-CITY	2.4%
BRANT COUNTY	2.4%
TIMISKAMING	2.4%
KINGSTON, FRONTENAC & LENNOX AND ADDINGTON	2.4%
OXFORD COUNTY	2.3%
SUDBURY & DISTRICT	2.1%
SIMCOE MUSKOKA DISTRICT	2.1%
HALDIMAND-NORFOLK	2.0%
OTTAWA	1.8%
EASTERN ONTARIO	1.8%
GREY BRUCE	1.7%
HALIBURTON KAWARTHA PINE RIDGE DISTRICT	1.7%
NIAGARA REGION	1.6%
WATERLOO	1.6%
LAMBTON	1.5%
RENFREW COUNTY & DISTRICT	1.4%
HASTINGS & PRINCE EDWARD COUNTIES	1.2%
LEEDS, GRENVILLE & LANARK DISTRICT	1.1%
WINDSOR-ESSEX COUNTY	1.0%

Indicator: Breastfeeding at discharge

Public health unit	Per cent missing
PEEL	31.8%
MIDDLESEX-LONDON	22.2%
TORONTO	20.3%
HURON COUNTY	17.9%
HALTON REGION	16.4%
YORK REGION	13.7%
PERTH DISTRICT	12.7%
OXFORD COUNTY	11.8%
ELGIN ST. THOMAS	11.4%
CHATHAM-KENT	11.4%
DURHAM REGION	11.0%
WELLINGTON-DUFFERIN-GUELPH	11.0%
SUDBURY & DISTRICT	10.3%
BRANT COUNTY	10.1%
THUNDER BAY DISTRICT	9.9%
PORCUPINE	9.7%
SIMCOE MUSKOKA DISTRICT	9.4%
LAMBTON	9.2%
HALDIMAND-NORFOLK	9.0%
GREY BRUCE	8.8%
WATERLOO	8.7%
ALGOMA	8.5%
NORTH BAY PARRY SOUND DISTRICT	8.4%
PETERBOROUGH COUNTY-CITY	8.0%
NIAGARA REGION	8.0%
KINGSTON, FRONTENAC & LENNOX AND ADDINGTON	7.9%
HASTINGS & PRINCE EDWARD COUNTIES	7.5%
CITY OF HAMILTON	7.4%
RENFREW COUNTY & DISTRICT	7.4%
HALIBURTON KAWARTHA PINE RIDGE DISTRICT	7.0%
TIMISKAMING	6.8%
OTTAWA	6.5%
LEEDS, GRENVILLE & LANARK DISTRICT	6.2%
WINDSOR-ESSEX COUNTY	5.8%
NORTHWESTERN	5.5%
EASTERN ONTARIO	5.1%

Indicator: Maternal weight gain

Public health unit	Per cent missing
ALGOMA	57.8%
OXFORD COUNTY	55.8%
PEEL	52.2%
WELLINGTON-DUFFERIN-GUELPH	46.7%
TORONTO	45.6%
PORCUPINE	39.0%
MIDDLESEX-LONDON	38.9%
GREY BRUCE	36.4%
NORTHWESTERN	36.2%
OTTAWA	33.4%
NORTH BAY PARRY SOUND DISTRICT	33.0%
YORK REGION	30.9%
EASTERN ONTARIO	27.0%
WINDSOR-ESSEX COUNTY	27.0%
SIMCOE MUSKOKA DISTRICT	26.0%
PETERBOROUGH COUNTY-CITY	24.8%
ELGIN ST. THOMAS	24.6%
LEEDS, GRENVILLE & LANARK DISTRICT	23.2%
HURON COUNTY	23.1%
TIMISKAMING	22.9%
HALIBURTON KAWARTHA PINE RIDGE DISTRICT	22.5%
KINGSTON, FRONTENAC & LENNOX AND ADDINGTON	20.8%
DURHAM REGION	20.1%
HALTON REGION	20.0%
CITY OF HAMILTON	18.9%
NIAGARA REGION	18.7%
RENFREW COUNTY & DISTRICT	17.9%
CHATHAM-KENT	17.3%
HALDIMAND-NORFOLK	17.2%
WATERLOO	16.3%
PERTH DISTRICT	14.9%
HASTINGS & PRINCE EDWARD COUNTIES	14.3%
LAMBTON	13.6%
BRANT COUNTY	11.0%
THUNDER BAY DISTRICT	10.3%
SUDBURY & DISTRICT	7.4%

Indicator: Alcohol use during pregnancy

Public health unit	Per cent missing
WELLINGTON-DUFFERIN-GUELPH	25.0%
TORONTO	15.1%
PEEL	14.6%
PETERBOROUGH COUNTY-CITY	12.9%
YORK REGION	12.1%
HALTON REGION	7.6%
PORCUPINE	5.8%
LAMBTON	4.6%
DURHAM REGION	4.6%
HALIBURTON KAWARTHA PINE RIDGE DISTRICT	4.3%
CHATHAM-KENT	2.9%
THUNDER BAY DISTRICT	2.8%
NORTH BAY PARRY SOUND DISTRICT	2.7%
SIMCOE MUSKOKA DISTRICT	2.6%
EASTERN ONTARIO	2.6%
NORTHWESTERN	2.4%
WATERLOO	2.4%
HASTINGS & PRINCE EDWARD COUNTIES	2.2%
ALGOMA	2.1%
CITY OF HAMILTON	2.1%
HALDIMAND-NORFOLK	2.0%
BRANT COUNTY	1.8%
GREY BRUCE	1.8%
OTTAWA	1.6%
WINDSOR-ESSEX COUNTY	1.5%
TIMISKAMING	1.4%
MIDDLESEX-LONDON	1.4%
NIAGARA REGION	1.4%
KINGSTON, FRONTENAC & LENNOX AND ADDINGTON	1.2%
HURON COUNTY	1.0%
LEEDS, GRENVILLE & LANARK DISTRICT	0.9%
PERTH DISTRICT	0.8%
OXFORD COUNTY	0.8%
SUDBURY & DISTRICT	0.8%
ELGIN ST. THOMAS	0.7%
RENFREW COUNTY & DISTRICT	0.5%

Indicator: Mental health concern

Public health unit	Per cent missing
TORONTO	13.4%
PEEL	11.5%
WELLINGTON-DUFFERIN-GUELPH	7.2%
YORK REGION	5.5%
THUNDER BAY DISTRICT	5.4%
HALTON REGION	4.5%
DURHAM REGION	4.0%
LAMBTON	3.7%
PORCUPINE	3.6%
EASTERN ONTARIO	2.2%
NORTH BAY PARRY SOUND DISTRICT	2.1%
SIMCOE MUSKOKA DISTRICT	1.8%
PETERBOROUGH COUNTY-CITY	1.7%
CHATHAM-KENT	1.7%
HALIBURTON KAWARTHA PINE RIDGE DISTRICT	1.6%
OTTAWA	1.5%
NORTHWESTERN	1.2%
CITY OF HAMILTON	1.1%
WATERLOO	1.1%
GREY BRUCE	1.0%
ALGOMA	1.0%
HALDIMAND-NORFOLK	0.9%
HASTINGS & PRINCE EDWARD COUNTIES	0.9%
OXFORD COUNTY	0.8%
TIMISKAMING	0.7%
MIDDLESEX-LONDON	0.7%
NIAGARA REGION	0.6%
HURON COUNTY	0.5%
ELGIN ST. THOMAS	0.5%
KINGSTON, FRONTENAC & LENNOX AND ADDINGTON	0.4%
RENFREW COUNTY & DISTRICT	0.4%
LEEDS, GRENVILLE & LANARK DISTRICT	0.3%
BRANT COUNTY	0.3%
WINDSOR-ESSEX COUNTY	0.3%
SUDBURY & DISTRICT	0.3%
PERTH DISTRICT	0.3%

Appendix D: Comparability by public health unit

Comparisons between BORN and DAD, 2013

PHU	Crude births		Crude birth rate (per 1000 population)		Low birth weight		Preterm birth rate		Average age of mother	
	BORN	DAD	BORN	DAD	BORN	DAD	BORN	DAD	BORN	DAD
ALGOMA	1034	1056	8.87	9.06	6.8%	6.5%	10.1%	10.7%	28.2	28.1
BRANT	1378	1382	9.65	9.68	6.6%	6.9%	8.4%	8.5%	28.7	28.4
CHATHAM-KENT	937	1062	8.86	10.05	6.0%	5.2%	8.2%	7.1%	27.7	27.6
DURHAM	6515	6488	10.10	10.06	6.2%	6.3%	8.2%	8.5%	30.4	30.4
EASTERN ONTARIO	2082	2056	10.17	10.04	6.2%	6.1%	7.6%	8.2%	28.4	28.4
ELGIN-ST THOMAS	1025	945	11.34	10.45	4.6%	5.2%	5.9%	6.3%	28.5	28.6
GREY-BRUCE	1500	1433	9.21	8.80	5.9%	5.9%	7.7%	7.7%	28.5	28.5
HALDIMAND-NORFOLK	1025	1024	9.33	9.32	5.5%	6.0%	6.9%	7.3%	28.5	28.4
HALIBURTON KAWARTHA PR	1208	1255	6.75	7.01	4.9%	4.6%	6.6%	6.9%	28.5	28.5
HALTON	5695	5545	10.56	10.28	6.0%	6.2%	6.9%	7.2%	32.1	32.1
HAMILTON	5564	5425	10.20	9.94	5.5%	5.6%	7.3%	7.4%	30.1	30.0
HASTINGS PRINCE EDWARD	1576	1463	9.64	8.95	8.3%	7.3%	9.3%	9.6%	28.0	27.9
HURON	671	575	11.47	9.83	4.8%	5.0%	6.3%	6.3%	28.2	28.2
KINGSTON FRONTENAC L & A	1788	1744	8.95	8.73	6.4%	7.1%	7.6%	8.1%	29.2	29.2
LAMBTON	1121	1120	8.60	8.60	6.4%	6.4%	8.2%	7.9%	28.6	28.5
LEEDS,GRENVILLE, LANARK	1461	1410	8.63	8.33	6.0%	6.5%	9.4%	9.9%	28.7	28.6

PHU	Crude births		Crude birth rate (per 1000 population)		Low birth weight		Preterm birth rate		Average age of mother	
	BORN	DAD	BORN	DAD	BORN	DAD	BORN	DAD	BORN	DAD
MIDDLESEX-LONDON	4744	4653	10.27	10.08	6.3%	6.2%	7.8%	8.0%	29.7	29.7
NIAGARA	3834	3738	8.61	8.39	5.6%	5.9%	7.0%	7.1%	29.3	29.3
NORTH BAY PARRY SOUND DISTRICT	1083	1084	8.46	8.47	5.0%	5.5%	6.7%	7.7%	28.0	28.0
NORTHWESTERN	699	935	8.62	11.53	5.2%	4.4%	8.0%	5.9%	27.2	26.3
OTTAWA	9985	9657	10.69	10.34	6.4%	6.6%	8.4%	8.8%	31.3	31.2
OXFORD	1203	1152	10.86	10.40	4.2%	4.6%	6.7%	7.1%	28.3	28.1
PEEL	15340	15277	11.05	11.01	8.4%	8.6%	8.8%	8.9%	30.9	30.9
PERTH	864	773	11.09	9.92	4.2%	4.7%	5.4%	5.3%	28.8	28.7
PETERBOROUGH	1345	1302	9.68	9.37	5.2%	5.4%	6.8%	7.5%	29.2	29.1
PORCUPINE	856	1002	9.86	11.55	5.1%	4.2%	7.2%	9.4%	27.0	26.5
RENFREW	1174	1126	11.14	10.69	5.7%	6.1%	8.6%	9.1%	28.6	28.5
SIMCOE MUSKOKA DISTRICT	4908	4772	9.19	8.94	5.9%	5.9%	8.0%	8.3%	29.5	29.5
SUDBURY	1909	1886	9.56	9.44	6.7%	7.2%	8.1%	8.3%	28.0	27.9
THUNDER BAY	1363	1494	8.78	9.63	7.0%	6.8%	9.0%	9.3%	28.5	28.0
TIMISKAMING	337	340	9.74	9.83	5.3%	5.6%	5.9%	6.8%	27.7	27.7
TORONTO	30780	30335	11.10	10.94	6.9%	7.1%	8.0%	8.2%	31.6	31.6
WATERLOO	5860	5703	10.96	10.66	5.8%	6.2%	7.7%	8.2%	29.9	29.9
WELLINGTON-DUFFERIN-GUELPH	3135	2943	11.26	10.57	5.7%	5.9%	7.5%	7.8%	29.9	29.9
WINDSOR-ESSEX	3959	3787	9.85	9.42	6.6%	6.9%	8.5%	8.5%	29.3	29.4
YORK REGION	10511	10647	9.50	9.63	6.2%	6.3%	7.3%	7.2%	32.1	32.1

Comparisons between BORN (FY 2013) and HBHC-ISCIS (Collected over 6 months in 2013):

PHU	**Smoking**	
	BORN	HBHC-ISCIS
ALGOMA	23.7%	21.5%
BRANT COUNTY	17.8%	20.1%
DURHAM REGION	11.1%	10.1%
ELGIN ST. THOMAS	18.0%	19.0%
GREY BRUCE	14.6%	13.8%
HALDIMAND-NORFOLK	18.3%	13.8%
HALIBURTON KAWARTHA PINE RIDGE DISTRICT	18.7%	16.0%
HALTON REGION	6.4%	3.9%
CITY OF HAMILTON	14.9%	10.0%
HASTINGS & PRINCE EDWARD COUNTIES	25.9%	25.5%
HURON COUNTY	15.9%	13.2%
CHATHAM-KENT	20.5%	21.1%
KINGSTON, FRONTENAC & LENNOX AND ADDINGTON	16.6%	19.0%
LAMBTON	18.5%	17.6%
LEEDS, GRENVILLE & LANARK DISTRICT	21.7%	20.4%
MIDDLESEX-LONDON	15.0%	13.6%
NIAGARA REGION	14.7%	17.5%
NORTH BAY PARRY SOUND DISTRICT	23.3%	18.0%
NORTHWESTERN	31.6%	27.5%
OTTAWA	6.6%	6.7%
OXFORD COUNTY	12.4%	15.5%
PEEL	6.1%	3.4%
PERTH DISTRICT	9.6%	9.5%
PETERBOROUGH COUNTY-CITY	20.9%	16.9%
PORCUPINE	26.8%	31.6%
RENFREW COUNTY & DISTRICT	17.9%	16.9%
EASTERN ONTARIO	20.6%	20.6%
SIMCOE MUSKOKA DISTRICT	16.1%	15.3%
SUDBURY & DISTRICT	24.9%	25.2%
THUNDER BAY DISTRICT	27.6%	27.3%
TIMISKAMING	25.8%	29.1%
WATERLOO	11.5%	12.1%
WELLINGTON-DUFFERIN-GUELPH	11.4%	9.1%
WINDSOR-ESSEX COUNTY	10.6%	10.2%
YORK REGION	3.6%	2.8%
TORONTO	3.9%	2.6%

Comparisons between BORN (FY 2013) and CCHS (cycle 2011–12):

PHU	Folic acid use prior to pregnancy	
	BORN	CCHS
ALGOMA	37.8%	66.2%
BRANT COUNTY	28.0%	39.8%
DURHAM REGION	35.4%	62.6%
ELGIN ST. THOMAS	36.5%	65.1%
GREY BRUCE	43.2%	43.7%
HALDIMAND-NORFOLK	34.9%	38.0%
HALIBURTON KAWARTHA PINE RIDGE DISTRICT	35.1%	73.4%
HALTON REGION	47.5%	80.7%
CITY OF HAMILTON	40.3%	61.4%
HASTINGS & PRINCE EDWARD COUNTIES	21.0%	56.7%
HURON COUNTY	44.6%	90.8%
CHATHAM-KENT	22.9%	54.2%
KINGSTON, FRONTENAC & LENNOX AND ADDINGTON	45.2%	75.7%
LAMBTON	36.4%	35.6%
LEEDS, GRENVILLE & LANARK DISTRICT	48.8%	63.9%
MIDDLESEX-LONDON	44.4%	70.8%
NIAGARA REGION	34.6%	46.1%
NORTH BAY PARRY SOUND DISTRICT	27.9%	58.7%
NORTHWESTERN	20.2%	51.4%
OTTAWA	54.1%	63.5%
OXFORD COUNTY	43.6%	48.8%
PEEL	33.3%	56.4%
PERTH DISTRICT	49.7%	67.6%
PETERBOROUGH COUNTY-CITY	38.9%	66.9%
PORCUPINE	19.5%	50.1%
RENFREW COUNTY & DISTRICT	38.2%	42.9%
EASTERN ONTARIO	36.4%	56.2%
SIMCOE MUSKOKA DISTRICT	31.8%	55.9%
SUDBURY & DISTRICT	21.4%	60.2%
THUNDER BAY DISTRICT	23.0%	66.0%
TIMISKAMING	26.6%	80.6%
WATERLOO	41.7%	58.0%
WELLINGTON-DUFFERIN-GUELPH	39.0%	72.6%
WINDSOR-ESSEX COUNTY	12.0%	58.0%
YORK REGION	27.7%	68.3%
TORONTO	25.2%	59.1%

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