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Clinical outcomes and healthcare use in provincially medically uninsured populations in Canada: A descriptive systematic review

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Sophiya Garasia

McMaster University

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Sophiya Garasia[1*]

1. PhD Student in Health Policy Program, Department of Health Research Methods, Evidence and Impact, McMaster University

*Corresponding author : Sophiya Garasia, Department of Health Research Methods, Evidence and Impact, 1280 Main Street West Hamilton, Ontario, Canada L8S 4M4, garasis@mcmaster.ca

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Abstract

Uninsured groups without provincial or territorial medical coverage are often reported to delay using healthcare services due to financial costs and face subsequent grave health consequences that could have been prevented had they been insured. This is not only a health equity issue but poses an economic cost to the health care system as well as it is more expensive to provide treatments for complex or life-threatening problems. As such, this systematic review sought to capture and synthesize all primary quantitative literature on the topic in order to gain a comprehensive understanding of health outcomes and trends in healthcare use in provincially medically uninsured groups in Canada, as well as associated healthcare costs. Nine studies were deemed relevant after screening articles retrieved from the database search. Data extracted from these studies showed that differences exist amongst insured groups versus uninsured groups in reported health outcomes and healthcare use in Canada. No quantitative studies on economic costs were captured in the search. These results can be used to prioritize future research in the area.

Keywords: Medically uninsured, health, Canada

1.0 Introduction

Despite having a universal health care system, there are several individuals residing in Canada who do not have healthcare coverage (Government of Canada, 2017). Due to limited data collection methods and ethical reasons, the total number of individuals who are medically uninsured in Canada is unknown, although the number is estimated to be between 200 000 to 500 00 people in Ontario alone (Health for All, 2017). The impact of lack of health care insurance on these individuals is an area that has been understudied in Canada to-date (Brabant & Raynault, 2012).

Under the Canada Health Act, Canada's national health insurance program Medicare, was designed to provide all residents reasonable access to medically necessary hospital and physician services (Government of Canada, 2017). The federal government was made responsible to fund the provinces and territories which in turn were assigned responsibility for providing health care insurance plans to their residents. Since it was left to the provinces and territories to decipher what "medically necessary" means, coverage and eligibility for coverage differs across the country (Allin, 2008).

Since healthcare is allocated based on resident status, there are many groups of individuals who remain uninsured. One such group is the "undocumented" who do not have authorization by Citizenship and Immigration Canada to reside in the country. The majority of the undocumented individuals in Canada are those who entered Canada legally, but lost their legal immigration status over time (Magalhaes, Carrasco, & Gastaldo, 2010). Asylum-seekers waiting for the government's decision and refugees whose claims have been rejected for the Interim Federal Health Programme benefits are also uninsured (Caulford & D'Andrade, 2012). Moreover, newly arrived immigrants to Ontario, Quebec and British Colombia have to wait three months upon arrival before obtaining provincial healthcare insurance (Elgersma, 2008). Other reasons for lack of provincial coverage include being a visitor, international student, temporary worker or an individual who has lost their documentation for accessing coverage (Bunn, 2013). Many of these groups are eligible to purchase private health insurance but may not do so because of multiple barriers including health illiteracy and high cost of private insurance (Caulford & D'Andrade, 2012).

Previously conducted Canadian reviews have captured mainly qualitative studies to show that those who lack insurance coverage have poorer health outcomes and inadequate experiences with the Canadian health care system. A scoping review conducted on health, access to services and working conditions in undocumented migrants in Canada showed that being non-status affected one's mental health conditions and had the largest impact on women during gestational periods and children (Magalhaes, Carrasco, & Gastaldo, 2010). Likewise, a scoping review conducted on health status of new permanent residents during the three-month wait for Ontario Health Insurance Plan (OHIP) highlighted that women who are pregnant during the three-month wait do not receive adequate prenatal care (Sanchez, Cheff, Hassen, & Katakia, 2016). Their review also highlighted that new permanent residents experience difficulties in paying out-of-pocket for healthcare and tend to use community health centers more. Moreover, quantitative research from United States of America (USA) and Europe has constantly shown lack of medical insurance to be associated with poor health outcomes and underutilized health services (Mornin, Adams, Shinohara, Frangakis, Brem, & Quinones-Hinojosa, 2012; Baicker, Taubman, Allen, Bernstein, Gruber, Newhouse, et al., 2013; Siddiqi, Zuberi, & Nguyen, 2009; Wolff, Staider, Epiney, Walder, Irion, & Morabia, 2005).

Provincially uninsured individuals when accessing primary physician or hospital care in Canada have to pay through private insurance or out-of-pocket. Previous literature has clearly shown that due to the financial burden, uninsured individuals do not access healthcare services and if they do, it is delayed for a given health problem (Caulford & D'Andrade, 2012). Not only is this a health equity issue, but it can pose a serious economic burden on the healthcare system given that a delay in healthcare access can lead to more severe health outcomes and a higher cost. As Canada has a large number of individuals who are provincially uninsured and the number is expected to grow with migration, it can be expected that the demands of medically uninsured populations on the Canadian healthcare system will also grow. An understanding of what the literature shows in terms of out-of-pocket expenditures of the provincially medically uninsured and the associated healthcare system costs would help address policy issues related to the uninsured. For instance, the 3-month waiting period was implemented in Ontario in 1994 as a cost-saving measure (i.e. Ontario relative to other provinces in Canada receives a lot of immigrants and it was anticipated that this could be costly) but its impact is unknown (Goel, Bloch, & Caulford, 2013). The literature synthesis on costs can help to evaluate whether such policies remains effective.

As uninsured individuals face barriers towards access to healthcare resulting in poorer health outcomes and migration continues to increase in Canada, it is important to gain a more comprehensive understanding of health outcomes and healthcare utilization trends in all medically uninsured populations in Canada. A greater knowledge of literature can help researchers and policymakers to understand where the gaps are in research as well as what the priority needs are. As such, this review sought to synthesize the quantitative peer-reviewed literature on 1) health outcomes in medically uninsured populations 2) healthcare utilization trends in medically uninsured populations and 3) out-of-pocket expenditures of medically uninsured populations and/or cost to healthcare system to provide care to medically uninsured populations.

2.0 Methods

2.1 Research question and protocol

The systematic review question is "what health outcomes, healthcare utilization trends and healthcare costs are reported in uninsured populations in Canada?"

For the purpose of this review, uninsured populations were defined to be individuals who are provincially medically uninsured (i.e. do not receive healthcare coverage from the province/territory they are residing in for medically necessary physician and hospital services). This includes but is not limited to permanent residents waiting for their health card during 3-month arrival period in Ontario, Quebec and British Colombia, undocumented individuals, refugees who are refused benefits under the Interim Federal Health Program, visitors, international students and individuals who have lost their provincial health card.

A systematic review protocol was created *a priori* to ensure transparency, reproducibility and consistency. The protocol, including forms for relevance screening, data extraction and risk of bias, as well as a list of definitions, is provided in the Appendix.

2.2 Search strategy

A comprehensive search algorithm was created and implemented in MedLine, EconLit, Embase and Web of

Science on November 24, 2017. The algorithm was created, in consultation with a University librarian, after searching "uninsured AND Canada AND health" in Medline and reviewing key words in the title and abstract of relevant papers until saturation was reached. The final search algorithm consisted of key terms related to "uninsured", "health" and "Canada". See Appendix for each database's search string.

In order to determine whether the electronic database search captured all relevant literature, reference lists from all included studies were reviewed. In addition, grey literature was purposively searched on November 30, 2017 on government and research organization websites (see Appendix 1 for list of organizations). The first 20 pages of Google scholar were also searched using the following search term: "uninsured AND Canada AND health*". Only literature with primary relevant results were considered for inclusion in the review.

2.3 Inclusion and exclusion criteria

An article was included if the study provided primary quantitative data on health outcomes or healthcare utilization trends in provincially medically uninsured populations in Canada or provided cost estimates of healthcare use in a population (i.e. medically uninsured population) or healthcare system context. Exclusion criteria included articles providing no data on 1) medically uninsured populations 2) health outcomes, healthcare utilization trends or cost, c) Canadian data and d) documents without primary data.

2.4 Relevance screening, data characterization and quality assessment

A single reviewer completed both the relevance screening, data characterization and quality assessment phases using forms created *a priori*. During the relevance screening stage, titles and abstracts of all unique citations identified through the literature search were screened using four questions designed around the inclusion and exclusion criteria (See Appendix). The questions were set up that one had to answer "Yes" in order to move on to the next question. For those papers that were difficult to screen on the basis of title and abstract, the full-text paper was procured and screened. If the status of medical insurance could not be determined, then the article was excluded. Data from the articles that met the inclusion criteria were then extracted during the data characterization stage. The questions were grouped with regards to four general categories 1) population demographics 2) clinical health outcomes 3) healthcare utilization, and 4) cost. All included studies were evaluated for risk of bias using a risk of bias assessment form designed after reviewing previously designed critical appraisal tools for non-randomized cross-sectional and cohort studies (Cochrane Methods, NA; National Heart, Lung and Blood Institute, 2014). Studies were given an overall score of "poor", "fair", "good" or "cannot be determined".

2.5 Review management

All citations captured using the search algorithm were imported from the bibliographic databases to RefWorks, an online citation management system, where duplicated articles were removed. The articles were then imported into an online systematic review software (DistillerSR, Evidence Partners, Ottawa, Canada) specifically designed for conducting synthesis reviews. DistillerSR was used for further de-duplication and relevance screening. Data was extracted from relevant papers and recorded in Microsoft Excel which was also used for descriptive analysis and charting.

3.0 Results

3.1 Search results

The search strategy resulted in 1894 citations, with roughly an equal proportion from each database searched (See Figure 1). After removal of 419 duplicates, 1475 citations were screened on title and abstract. A total of 1074 studies were excluded because they did not a) provide any data on medically uninsured populations (N=913), b) did provide data on medically uninsured populations but there was no data on health outcomes, healthcare utilization or cost to uninsured individual/group or healthcare system (N=56), c) did provide data on relevant outcomes of interest in medically uninsured populations but there was no data on provincially medically uninsured populations in Canada (N=100) and d) provided data on provincially medically uninsured populations in Canada but there was no primary data (N=5). During the full-text screening stage, another 392 articles were excluded because they did not a) provide any data on medically uninsured populations (N=146), b) did provide data on medically uninsured populations but there was no data on health outcomes, healthcare utilization or cost to uninsured individual/group or healthcare system (N=120), c) did provide data on relevant outcomes of interest in medically uninsured populations but there was no data on provincially medically uninsured populations in Canada (N=76) and d) provided data on provincially medically uninsured populations in Canada but there was no primary data (N=16). A total of 34 studies were unsuccessfully procured resulting in 9 relevant quantitative studies that were included in the review.

3.2 Study design, population studied, and risk of bias

The majority of studies were observational descriptive studies in which authors provided demographic data on medically uninsured populations or made descriptive comparisons between insured and uninsured groups (See Table 1; N=8). Cross-sectional results with measures of associations were provided in two studies and one study was a qualitative analysis in which the authors provided primary quantitative demographic data on provincially medically uninsured groups (Caulford et al., 2006). Studies were published between 2006 and 2017 with the most studies published in 2013 (N=4; 44%). Data was mainly obtained through existing databases such as the National Care Ambulatory Care Reporting System or hospital-based medical charts. The study locations of the publications were Toronto, Ontario (N=6), Montreal, Quebec (N=3), Calgary, Alberta (N=1), and Vancouver, British Colombia (N=1).

The studies altogether covered a wide scope of uninsured populations (See Table 2). The majority of studies investigated asylum seekers (N=5) followed by permanent residents waiting for provincial coverage (N=4), undocumented individuals (N=3), and Canadian individuals who have either lost their health card or it has expired (N=3). Fewer studies investigated foreign visitors (N=1), international students (N=1) and sponsored immigrants (N=1). The number of uninsured individuals studied ranged from 52 uninsured individuals sampled from one hospital in Toronto, Ontario (Bunn et al., 2013) to 140,730 uninured individuals captured in the National Ambulatory Care Reporting System over a span of nine years (Hynie et al., 2016). The majority of studies compared health outcomes, healthcare utilization and/or demographics in uninsured populations and insured populations (N=8). However, how the studies defined uninsured and insured populations differed. Jarvis et al. (2011) identified provincially medically uninsured individuals to be all those who had no valid provincial card at initial presentation and excluded those who had provincial insurance coverage, private insurance, or coverage through the Interim Federal Health Program (i.e. refugee claimants). The insured comparison population was then selected from those excluded from the definition of “provincially medically insured”. On the other hand, Bunn et al. (2013) selected uninsured individuals to be those who were billed under the

Compassionate Care Program while those who were insured were considered to be those who were not billed through that program. Two studies compared provincially uninsured populations to successful refugee claimants covered under the federal government (Rousseau et al., 2013; Gagnon et al., 2013). One study compared many groups of uninsured populations (e.g. asylum seekers, undocumented, foreign worker, etc..) to successful refugee claimants while the other study compared asylum seekers to immigrants with provincial coverage and refugees covered under the federal program. In terms of gender, age and ethnicity, most studies did not report the demographics of the uninsured population. Three studies focused on uninsured females as the objective of the studies was to assess prenatal and pregnancy outcomes and service utilization (Jarvis et al., 2011, Mattalal et al., 2017; Gagnon et al., 2013). One study focused on children exclusively (Roussea et al., 2013). Moreover, only one study provided data on ethnicities of uninsured individuals (Wilson-Mitchell et al., 2013). The study reported that the highest number of uninsured individuals were from a Caribbean background (40.4%) followed by South Asian (10.3%).

Studies ranged from having low risks of bias to having high risks of bias (See Table 2). The major risks for bias were that the studies failed to provide a clear definition for study population (i.e. who the medically uninsured were, who were insured and how they ensured that there was no overlap amongst the samples) (N=2) or they did not provide an explanation of how they randomly sampled from the populations (N=3). Many also did not describe how they selected the sample size for insured populations and how they matched the uninsured to the insured (N=4). A huge risk of bias also came from the fact that many of these studies were descriptive and, compared means between two populations without controlling for any possible confounding factors (N=4) and studying causation nor correlation. Some studies, however, did acknowledge that there were differences in the populations between hospitals. These studies garnered a higher score. Lastly, a few studies did not acknowledge the risk of missing information in the databases they used and the procedures they used to counteract it (N=2).

3.3 Health Outcomes in provincially medically uninsured individuals

A total of four studies reported health outcomes as dependent variables (See Table 3). Comparing the results from across the studies, the most common outcome reported in uninsured individuals was poor mental health (N=3). Other reported clinical outcomes included injury, respiratory conditions, gestational diabetes, abdominal pain and HIV. All four studies compared health outcomes in uninsured population to an insured population. Hynie et al. (2016) reported that while injury, poor mental health and obstetric outcomes were more frequently reported in uninsured population studied, skin disease, eye disease, and respiratory conditions were more frequently reported in the insured population. Likewise, Wilson-Mitchell et al. (2013) showed that while gestational diabetes was higher in those uninsured than in those insured, the opposite was true for hypertension where greater number of insured individuals reported hypertension. Both studies however did not test for significance. Rousseau et al. (2013) did test for significance and showed that refugee claimants were more frequently diagnosed with respiratory virus infection, abdominal pain, and appendicitis while uninsured children reported musculoskeletal injuries or lacerations and mental health conditions such as depression, post-traumatic stress disorder or suicidal thoughts more ($\chi 2 = 6.97$; $P=0.008$). Rousseau et al. (2013) also reported that for the most part the outcomes reported in uninsured and insured children were fairly similar. Again, similar to the other studies, Bunn et al. (2013) showed that there was no significant difference between the insured and uninsured groups with respect to many of the outcomes studied including hypertension, type 2 diabetes and tuberculosis. They did however report that there were a higher number of HIV-positive people amongst the uninsured group than in the insured group.

3.4 Healthcare utilization in medically uninsured populations in Canada

A greater number of studies reported on healthcare utilization than health outcomes (N=8 vs. N=4). The majority of studies focused on healthcare services targeted towards females including prenatal care, midwifery, obstetrician access, maternal care, and cervical screening (N=6). Jarvis et al. (2011) focused on studying the amount of prenatal care accessed and found that uninsured women had fewer prenatal visits than insured women. They hypothesized that this is because of the out-of-pocket financial costs incurred to uninsured women. They confirmed this hypothesis when they made comparisons of the results between hospitals. One hospital which provided financial support for some of the tests saw a greater number of females getting cervical testing done at that site compared to the site that provided no financial support. Furthermore, two studies showed that those without insurance were more likely to initiate care when it is very urgent compared to those who are insured (Hynie et al.,2016; Rousseau et al., 2013). Lastly, one study reported on duration of service to state that length of stay of uninsured mother was significantly greater than for insured mother (Wilson-Mitchell et al., 2013). The same result, however, was not seen in length of stay of their babies.

In addition, two studies investigated insurance status as the independent variable and a clinical outcome as the dependent variable. Gagnon et al. (2013) investigated the effect of health insurance on the risk of emergency caesarian section. The study found that a migrant women was at greatest risk for emergency caesarian if she was not covered by health insurance (OR=2.3, 95% CI- 1.2-6.3). Furthermore, Weidmeyer et al. (2012) investigated the probability of insured individuals getting a Pap test compared to uninsured individuals. Univariate analysis showed that that the uninsured were more likely to get Pap test done (OR=6.65; P<0.0001). However, when the regression was adjusted for other variables such as age and English-speaking ability, the strength of the association decreased and became non-significant (OR=2.71)

3.5 Cost of care

There were no quantitative studies captured that reported the out-of-pocket cost that uninsured individuals have to pay while accessing physician or hospital services. There were also no studies that detail the cost of uninsured individuals to the healthcare system. Moreover, no studies investigated whether the uninsured populations being investigated had private insurance.

4.0 Discussion

This systematic review synthesized quantitative peer-reviewed literature on health outcomes and healthcare utilization trends in provincially medically uninsured populations in Canada. The nine studies reviewed provided a picture of which medically uninsured populations are more studied than others and highlight important differences in health outcomes and healthcare utilization rates amongst insured populations versus uninsured populations. The literature search results indicated that the medically uninsured population is a very understudied population in Canada. Other Canadian reviews conducted with narrower inclusion criteria have reported similar number of included studies (Magalhaes, Carrasco, & Gastaldo, 2010; Bobadilla, Orchard, Magalhaes, & Fitzsimmons, 2016). Reasons for limited studies on medically uninsured populations reported in literature include ethical barriers to study this population and limitations of existing data collection methods (Samuel, White, & Perreault, 1987; Campbell-Page & Shaw-Ridley, 2013). That being said, comparatively, there was a greater amount of literature on uninsured populations generated in other high-income countries such as United States of America. The review excluded 176 studies that provided non-Canadian data on healthcare or

out-of-pocket costs to uninsured populations or that provided health outcomes and/or health utilization trends in medically uninsured populations. The search also highlighted that the literature is limited by the definition of medically uninsured. Although the inclusion criteria of the review ensured that only studies researching provincially medically uninsured populations (e.g. those without provincial health card) were captured, the search showed that it was still difficult to make comparisons across all studies because of the differences in how the researchers defined uninsured versus insured.

The review did not provide high quality evidence on health outcomes present in uninsured populations as half of the studies used descriptive analysis without measures of associations and tests of significance and without controlling for confounding factors. Nevertheless, the results highlighted that there are differences in the reported health outcomes in insured populations versus the uninsured populations. The differences suggested that either there are underlying sociodemographic factors influencing differential health outcomes or that the groups access healthcare for different needs, or both. The latter was shown in this review where the uninsured populations were seen to be more likely to access healthcare when the health status is urgent. A cross-sectional study involving children and youth from Ontario showed that injury rates were highest amongst immigrants living in low-income neighbourhoods (Saunders, Macpherson, Guan, Sheng & Guttmann, 2017). This study emphasized that sociodemographic differences among the uninsured and insured may be associated with an in increase in certain health outcomes. Although sociodemographic factors would be important to capture, a common limitation reported in the included studies is that many databases do not report sociodemographic data on uninsured populations similar to how it is provided in USA. Furthermore, the review showed that poor mental health was a commonly reported outcome in medically uninsured populations. This was not surprising given that similar results have been reported in other countries with high number of migrants with precarious state (Wolff et al. 2005, Gushulak et al., 2000). The growing body of qualitative Canadian studies have also reported similar findings. Interviews conducted by Goel et al. (2013) indicated that participants experienced emotional hardship during the 3-month waiting period including fear impacting their mental health.

From the studies investigating health services use, it was evident that there are differences in the use of healthcare services in medically uninsured populations compared to the insured population. For instance, a large proportion of uninsured women were accessing community clinics and midwives. Given that community clinics and midwives provide their services free-of-charge, this implied that there is a cost associated with visiting physician or hospital services that they cannot incur (Wilson-Mitchell et al., 2013). Another reason for why women could be attending these services is because they are being directed towards them either by physicians or personal social networks. Whatever the reason may be, this result has policy implications for funding of these health clinics as well as for public health programming. Inadequate use of prenatal health services reported in the included studies align with results from a systematic review conducted on the determinants of late or inadequate use of prenatal healthcare in high-income countries (Jong, Jansen, Baarveld, Van der Schans, Schellevis & Reijneveld, 2012). The review showed that in all four studies that investigated effect of health insurance on initiation of prenatal care, the result was consistent in that there was inadequate use of care amongst uninsured women.

There is a huge research gap in Canadian peer-reviewed quantitative literature on medically uninsured population's out-of-pocket costs when accessing medically necessary services. There are also no peer-reviewed economic studies that evaluate the financial impact of medically uninsured populations on the healthcare system. This is worrisome given that it restricts policy-makers from understanding the scope of the problem and

making evidence-based decisions with regards to improving the Canadian healthcare system to become more equitable. Qualitative data, however, is available. Caulford & D'Andrade (2012) have published a qualitative case study of an 18-year old female who was told her case was not an emergency when she visited the emergency department for her sickle cell crises. While waiting in triage, she fainted and was hospitalized for 3 days, costing her $5000. Quantitative economic research is conducted in USA, most likely due to the country having a substantially high number of uninsured individuals and a huge market for private insurance (Khera, Hong, Saxena, Arriena, Virani, Blackstein et al., 2017). For instance, one study was able to show that the mean out-of-pocket spending was $247 for persons without chronic condition and was $1134 for persons with 3 or more conditions. Such results have important implications for policymakers in both attempting to contain spending as well as designing cost sharing plans (Khera, Hong, Saxena, Arriena, Virani, Blackstein et al., 2017).

Overall, the results of the review aligned with previously reported Canadian reviews and global evidence that stated that being uninsured is associated with poor health outcomes and lack of health service use. This study adds to the literature on the area as it synthesizes all quantitative Canadian studies published on all provincially medically uninsured populations. Previous reviews were either too broad by providing non-Canadian data (Brabant & Raynault, 2012) or too narrow by limiting the target population (Bobadilla, Orchard, Magalhaes, & Fitzsimmons, 2016). The study's results can also be used to prioritize future research in the area as well as highlight the gaps in the Canadian healthcare system for medically uninsured populations.

Limitations to the study should be recognized. Firstly, search terms were in English and, articles written in French may have been excluded. Also, the search string did not include search terms related to "immigrant" or "refugee" in order to not explode the search. However, considering that the process of search verification did not capture any new articles, the risk of missing articles on uninsured immigrants or refugees is low. The search string also did not include any terms related to cost. This might explain why no relevant studies on economic cost were captured. Furthermore, websites of all relevant research and governmental groups were not searched for primary literature. Another limitation was that only one reviewer screened articles, extracted data and assessed bias. As such, the reviewer may have introduced reviewer bias when synthesizing the data. Moreover, a meta-analysis was not conducted to provide overall estimates due to lack of studies with extractable data. Heterogeneity amongst the various uninsured populations was also not addressed due to barriers in how they were defined and limited data. Lastly, the review was restricted to the limits of the questions posed *a priori*.

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Figure 1: PRISMA chart of articles through the systematic review process

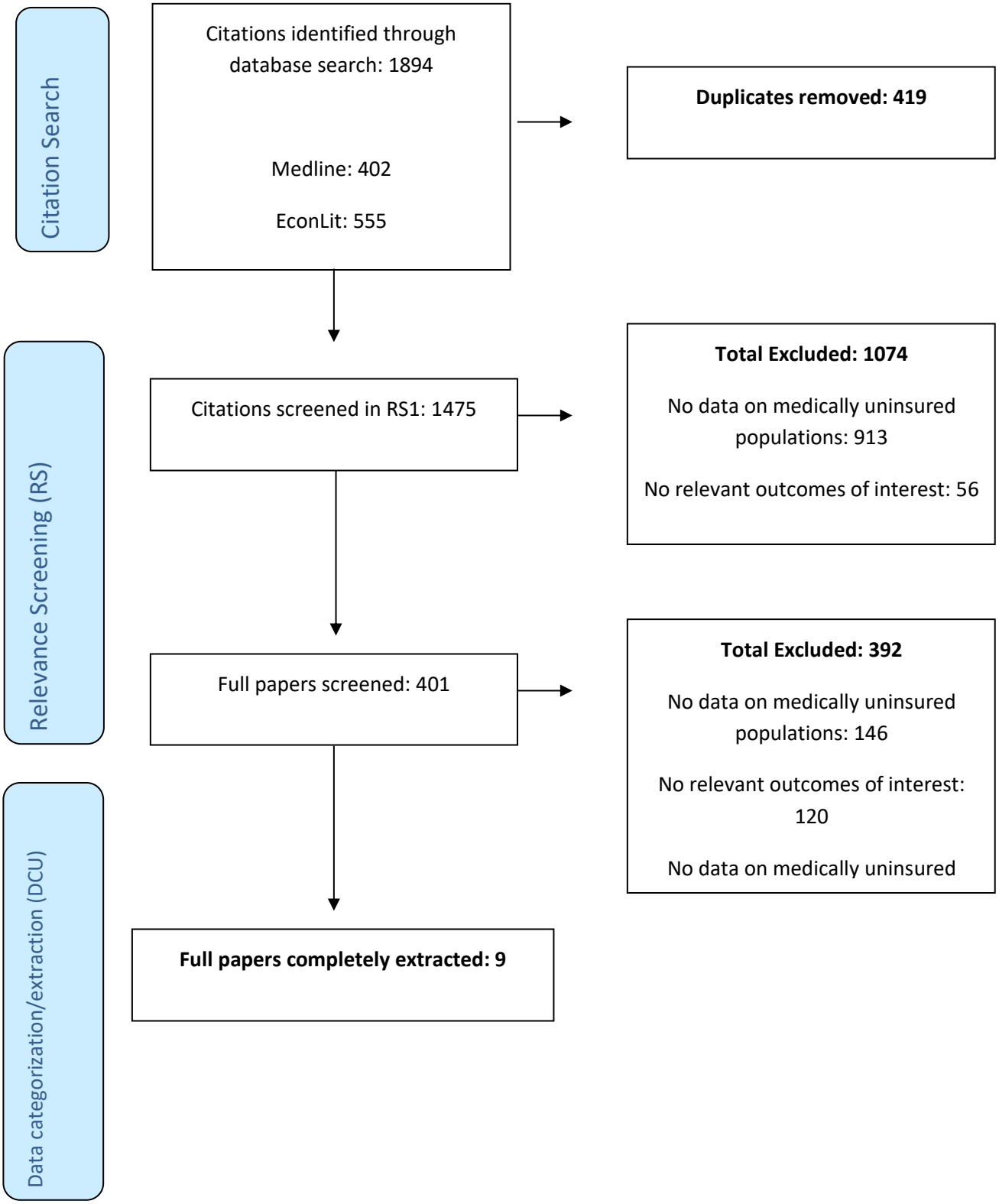

Table 1: General characteristics of nine included primary studies

Publication	Study design	Data collection years	Data source	Study location Province(City)	Risk of Bias	Publication source
Hynie et al., 2016	Cross-sectional and descriptive	2002-2010	Database: National Ambulatory Care Reporting System	Ontario	Fair	Web of Science. Medline
Rousseau et al., 2013	Descriptive	2008-2009	Medical charts: Emergency department medical files	Quebec (Montreal), Ontario (Toronto)	Fair	Web of Science, Embase, Medline
Jarvis et al.,2011	Descriptive	2004-2007	Medical charts	Quebec (Montreal)	Poor	Embase, Medline
Wilson-Mitchell et al., 2013	Descriptive	2007-2010	Medical charts	Ontario (Toronto)	Fair	Web of Science, Embase, Medline
Bunn et al.,2013	Descriptive	2005-2009	Billing records and Medical charts	Ontario (Toronto)	Fair	Web of Science, Embase, Medline
Mattatall, 2017	Descriptive	2013-2016	Database: Data Integration, Measurement, and Reporting (DIMR) from Alberta Health Services	Alberta (Calgary)	Good	Embase, Medline
Gagnon et al., 2013	Cross-sectional	2006-2009	In-hospital databases	Ontario (Toronto), Quebec (Montreal), British Colombia (Vancouver)	Good	Web of Science, Embase, Medline
Wiedmeyer et al., 2012	Descriptive	2008-2009	Medical charts	Ontario (Toronto)	Good	Web of Science, Medline

Table 2: General description of populations investigated in the nine included studies

Publication	Data source	Medically uninsured	Insured	Gender	Age	Ethnicity
Hynie et al.,2016	Database recording hospital visits	Not specified uninsured group who do not have health card number [N=140,730 (0.32%)]	Insured individuals in database who had health card number [N=44 349 020 (99.7%)]	All	All age groups	Not specified
Rousseau et al.,2013	2 hospitals in Montreal and 1 hospital in Toronto	Asylum seekers Undocumented New permanent residents during 3-month waiting period Foreign worker Temporary suspension of removal [N=786]	Successful refugee claimants covered under federal government [N=904]	All	Children (0-18 years old)	Not specified
Jarvis et al.,2011	Prenatal care office at 2 family practice centres	Visitor Foreign student Women awaiting sponsorship Undocumented immigrants Asylum seekers Refused refugee claimants Canadian citizens who let the provincial health insurance lapse [N=71]	Provincially insured [N=72]	Female	Adults	Not specified

Wilson-Mitchell et al., 2013	2 general hospitals	New permanent residents during 3-month waiting period Asylum seekers Refugees refused benefits Undocumented [N=175]	Provincially insured [N=278]	All	Adult women and their babies	African (7.1%), South Asian (10.3%), Middle Eastern (9.6%), Eastern European (3.2%), Western European (3.2%), South American (0.6%), Central American (2.6%), Caribbean (40.4%), East Asian and pacific (8.4%), Canadian (0.6%) and other (11.5%)
Bunn et al.,2013	1 Hospital	New permanent residents during 3-month waiting period Lost or expired health card Visitor No reason provided [N=52]	Insured patients from the Department of Community Medicine	All	Adults	Not specified
Mattatall, 2017	Alberta Health Services	Not specified Canadian and non-Canadian uninsured populations who self-payed bills [N=68]	Insured populations whose bills were paid by Alberta government, other province, or federal government [N=419]	Female	Not specified	Not specified
Gagnon et al.,2013	Databases of 12 hospitals	Asylum speakers [N=371]	Immigrants with provincial coverage and refugees covered under federal program [N=654]	Female	Not specified	Not specified

Wiedmeyer et al.,2012	Community health center	Not specified uninsured group [N=83]	Insured group [N=274]	Female	Not specified	Not specified
Caulford et al.,2006	Community health center	Asylum seekers New permanent residents during 3-month waiting period Sponsored immigrants People whose health card was lost or stolen and Other (46%, 36%, 6%, 3% and 9% respectively)	No comparative group	All	Not specified	Not specified

Table 3: Health outcomes reported in four relevant studies included in review

Publication	Clinical outcomes reported in medically uninsured women	Description of result
Hynie et al.,2016	Injury, mental/behavioural condition, respiratory condition, digestive issue, genitourinary condition, muskoskeletal/connective tissue condition, skin disease, diseases of eye and obstetric outcomes	Injury (28.37% in uninsured vs. 24.49% insured), mental/behavioural condition (10.47% vs. 3.48%), respiratory condition (8.14 vs. 11.21%), digestive condition (5.38% vs. 5.88%), genitourinary condition (4.50% vs. 4.50%), muscoskeletal/connective tissue condition (3.63% vs. 5.96%), diseases of skin (3.07% vs. 3.60%), disease of eye (2.93% vs. 4.67%), and obstetric outcomes (5.56% vs. 2.69%). No statistical test performed.
Rousseau et al., 2013	Mental health problems, respiratory virus infection, sickle cell anemia, and appendicitis	Refugee claimant children were more frequently diagnosed with respiratory virus infection ($\chi2[1] = 11.2$; P=0.001), abdominal pain ($\chi2[1] = 4.44$; P=0.035), sickle cell anemia ($\chi2[1] = 7.85$; P=0.005) and appendicitis ($\chi2[1] = 6.85$; P=0.009), while uninsured children presented more often for musculoskeletal injuries or lacerations ($\chi2[1] = 27.74$; P<0.001), depression ($\chi2[1] = 16.99$; P<0.001), post-traumatic stress disorder ($\chi2[1] = 13.19$; P<0.001), or suicidal thoughts ($\chi2[1] = 6.97$; P=0.008)

Wilson-Mitchell et al.,2013	Gestational diabetes, chronic hypertension, postpartum hemorrhage	Gestational diabetes was 4.2% and 3.2% in uninsured and insured respectively. Chronic hypertension was 2.7% and 4.9% in uninsured in insured respectively. Postpartum hemorrhage rates in insured and uninsured were 4.0% and 3.8% respectively. No statistical test performed.
Bunn et al.,2013	Hypertension, type 2 diabetes, tuberculosis, mental health disorder and HIV	There was no significant difference between insured and uninsured groups in the prevalence of hypertension, type 2 diabetes, TB, or mental health disorder ($P>0.05$) . A significant difference ($P = 0.004$) was found in the proportion of HIV-positive patients between the uninsured and insured groups.

Table 4: Healthcare utilization trends reported in seven studies included in review

Publication	Healthcare service	Data on number/amount of visits	Data on duration of visit/time component	Data on severity of outcome at the time of service initiation
Hynie et al.,2016	Acute emergency care	NA	NA	At admission, 15.6% of uninsured and 11.2% insured individuals were triaged into one of the more severe categories (resuscitation or emergency). Those who were insured were 43% more likely to be classified as severe, even after adjusting for age and gender, compared to uninsured.
Rousseau et al., 2013	Hospitalization	NA	NA	The triage emergency ratings of refugee claimants and uninsured children were significantly different for the very urgent ($\chi 2[10] = 15,290.01$; $P<0.001$) and urgent ($\chi 2[10] = 89,055.93$; $P<0.001$) categories where

				uninsured were more likely to have a higher level of emergency.
Jarvis et al., 2011	Prenatal care	Uninsured women had fewer prenatal visits than insured women (6.6 vs. 10.7, p=0.05). The uninsured had fewer routine prenatal screening tests, including screening blood tests, ultrasound, STI screening, Pap test and genetic testing. There was no difference between groups in number of women who had a physical examination done as part of routine prenatal care (cardiovascular, respiratory, and gynecologic examination).	NA	NA
Wilson-Mitchell et al., 2013	Midwifery, obstetricians, general practitioners, medical intervention including	Uninsured pregnant women sought the services of midwives significantly more than the insured (36.35%	Length of stay of mother was significant for mean number of days. For uninsured, it was 1.76 (1.49-1.82) and for	NA

	caesarian section	versus 4%). 6.5% of uninsured women received no prenatal care at all and in contrast, all insured women received care. The number of prenatal visits reported for uninsured group (mean=6.04, t=-6.173) was significantly lower, than for the insured peers (mean=8.70).	insured, it was 2.32 (2.19-2.46). Length of stay of baby was not significant. For uninsured, it was 2.05 (1.54-2.55) and for insured, it was 2.14 (2.00-2.29).	
Bunn et al., 2013	Prenatal care, pediatric care	There was no significant difference between populations studied.	NA	NA
Matteral, 2017	Maternal care	NA	NA	NA
Wiedmeyer et al., 2012	Cervical screening	NA	NA	NA
Caulford et al., 2006	Maternity care	60% of uninsured women had deficiencies in prior ante-natal care and lacked adequate provider contact		

Appendix 1: Search Strategy

Database searches

Date	November 23, 2017
Database	Web of Science
Institution	McMaster University Library
Search string:	(((((uninsured) OR undocumented) OR non-status) OR non-citizen) AND ((((((((((canada) OR Ontario) OR Quebec) OR Alberta) OR Manitoba) OR Saskatchewan) OR Price Edward Island) OR New Brunswick) OR New Brunswick) OR Nova Scotia) OR Newfoundland)
Hits	445
Limits	None

Date	November 23, 2017
Database	EconLit
Institution	McMaster University Library
Search string:	(Undocumented OR non-status OR non-citizen OR uninsured) AND (Canada OR Ontario OR Quebec OR Alberta OR Manitoba OR Saskatchewan OR Prince Edward Island OR New Brunswick OR Nova Scotia OR British Columbia OR Newfoundland) AND health*
Hits	555
Limits	None

Date	November 23, 2017
Database	Medline
Institution	McMaster University Library
Search string:	1. exp canada/ 2. canada.cp. 3. (canada or canadian$ or alberta or british columbia or columbie britannique).af. 4. (saskatchewan or manitoba or ontario or quebec or new brunswick or nouveau brunswick).af. 5. (nova scotia or nouvelle ecosse or prince edward island or ile du prince edward or newfoundland or terre neuve or labrador or nun?v?t or nun?v?t or nwt or territoires du nord ouest or northwest territories or yukon).af. 6. (canada or canadian$ or alberta or british columbia or col?mbie brit?an?ique).in,jw. 7. (saskatchewan or manitoba or ontario or quebec or new brunswick or nouveau brunswick).in,jw. 8. (nova scotia or nouvelle ecosse or prince edward island or ile du prince edward or ile du prince edouard or newfoundland or labrador or nun?v?t or nwt or northwest territories or territoires du nord ouest or yukon).in,jw. 9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 10. uninsured.mp. or exp medically uninsured/ 11. health insurance.mp. or exp health insurance/ 12. 10 or 11 13. non-status.mp. 14. non-citizen.mp. 15. exp health care need/ or exp health care delivery/ or exp health/ or exp reproductive health/ or exp mental health care/ or exp health care disparity/ or exp "health care cost"/ or exp health care distribution/ or exp health service/ or exp women's health/ or exp primary health care/ or exp health literacy/ or exp preventive health service/ or exp mental health service/ or exp national health insurance/ or exp health equity/ or exp health care utilization/ or exp private health insurance/ or exp "social determinants of health"/ or exp adolescent health/ or exp health care access/ or exp emergency health service/ or exp sexual health/ or exp health care quality/ or exp health status/ or health*.mp. or exp family health/ or exp health insurance/ or exp child health/ or exp rural health care/ or exp mental health/ or exp health economics/ or exp health care policy/ or exp health services research/ or exp child health care/ 16. exp undocumented immigrant/ or undocumented.mp. 17. 10 or 13 or 14 or 16 18. 12 or 13 or 14 or 16 19. 9 and 15 and 18

	20. 9 and 15 and 17
Hits	402
Limits	None

Date	November 23, 2017
Database	Embase
Institution	McMaster University Library
Search string:	1.uninsured.mp. or exp medically uninsured/ 2.exp undocumented immigrant/ or undocumented.mp. 3. non-status.mp. 4. non-citizen.mp. 5. canada.mp. or exp Canada/ 6. ontario.mp. or exp Ontario/ 7. alberta.mp. or exp Alberta/ 8. british colombia.mp. 9. quebec.mp. or exp Quebec/ 10. exp health care delivery/ or exp health visitor/ or exp health/ or exp reproductive health/ or exp health disparity/ or exp mental health care/ or exp health care disparity/ or exp "health care cost"/ or exp health service/ or exp women's health/ or exp primary health care/ or exp integrated health care system/ or exp preventive health service/ or exp tertiary health care/ or exp national health insurance/ or exp health equity/ or exp health care utilization/ or exp private health insurance/ or exp "social determinants of health"/ or exp adolescent health/ or exp health care access/ or exp emergency health service/ or exp sexual health/ or exp health care quality/ or exp health status/ or exp public health/ or health*.mp. or exp health care system/ or exp family health/ or exp health insurance/ or exp child health/ or exp health care organization/ or exp health care policy/ or exp mental health/ or exp health economics/ or exp health services research/ or exp child health care/ 11.1 or 2 or 3 or 4 12.5 or 6 or 7 or 8 or 9 13.5 and 10 and 11 14.10 and 11 and 12
Hits	492
Limits	None

Grey Literature Search (November 30, 2017):

Google Scholar search string:

"uninsured AND Canada AND health*"

List of organizations whose websites were searched:

- The Wellesley Institute
- Ministry of Health and Long-Term Care
- Régie de l'assurance maladie du **Québec**
- Health for All
- Canadian Centre for Refugee and Immigrant Health Care
- Parliament of Canada
- Women's College Hospital

Appendix 2: Relevance screening (RS) form

Question	Options	Definitions/Additional notes
Does the article provide data on uninsured populations?	☐ Yes ☐ No (Exclude, submit form without answering following questions) ☐ Unsure	Examples of **uninsured** populations include but are not limited to refugees, recent immigrants, and individuals who have lost health card. To select yes, the article must specify clearly that they are studying uninsured groups/individual. This also includes individuals in Canada who are uninsured for dental care/vision care at this stage of the form. At this stage, "**data**" refers to either primary or secondary data.
Only answer the following question if the answer to above question was Yes		
Does the article have an outcome or exposure measurement relating to 1) clinical outcome(s) 2) any type of "medically necessary" health services and/or 3) cost of/to health care?	☐ Yes ☐ No (Exclude, submit question without answering following questions) ☐ Unsure	**Medically necessary** health services include inpatient care, outpatient care, and physician visits Health service outcome measurement deemed not medically necessary include dental care, vision care, chiropractic care, and prescription use.
Only answer the following question if the answer to questions 1-2 was Yes		
Does the article provide Canadian results on provincially medically uninsured populations?	☐ Yes ☐ No (Exclude, submit form without answering following question) ☐ Unsure	To say Yes, there must be data on **provincially medically uninsured** populations in Canada
Only answer the following question if the answer to questions 1-3 was Yes		
Does the article provide primary quantitative data?	☐ Yes, primary peer-reviewed paper (quantitative) ☐ Yes, grey literature with primary data (government or research reports) ☐ Yes, conference proceeding with sufficient detail ☐ No, primary peer-reviewed paper (qualitative) (Exclude) ☐ No, literature review (Exclude) ☐ No, systematic review (Exclude) ☐ No, grey literature without primary data (Exclude)	If there is any quantitative data (for example: mixed methods study), select **Primary peer-reviewed paper, quantitative** **Systematic review:** Includes systematic review, scoping review, and meta-analyses **Grey literature without primary data** includes newspaper or magazine articles

	☐ No, conference proceeding without sufficient detail (Exclude) ☐ Unsure	

Appendix 3: Full-text screening form

Question	Options	Definitions/Additional notes
Does the article provide data on uninsured populations?	☐ Yes ☐ No (Exclude, submit form without answering following questions) ☐ Unsure (Exlude)	Examples of **uninsured** populations include but are not limited to refugees, recent immigrants, and individuals who have lost health card. To select yes, the article must specify clearly that they are studying uninsured groups/individual. This also includes individuals in Canada who are uninsured for dental care/vision care at this stage of the form. At this stage, "**data**" refers to either primary or secondary data.
Only answer the following question if the answer to above question was Yes		
Does the article have an outcome or exposure measurement relating to 1) clinical outcome(s) 2) any type of "medically necessary" health services and/or 3) cost of /to health care?	☐ Yes ☐ No (Exclude, submit question without answering following questions) ☐ Unsure (Exclude)	**Medically necessary** health services include inpatient care, outpatient care, and physician visits Health service outcome measurement deemed not medically necessary include dental care, vision care, chiropractic care, and prescription use.
Only answer the following question if the answer to questions 1-2 was Yes		
Does the article provide Canadian results on provincially medically uninsured populations?	☐ Yes ☐ No (Exclude, submit form without answering following question) ☐ Unsure (Exclude)	To say Yes, there must be data on **provincially medically uninsured** populations in Canada
Only answer the following question if the answer to questions 1-3 was Yes		
Does the article provide primary quantitative data?	☐ Yes, primary peer-reviewed paper (quantitative) ☐ Yes, grey literature with primary data (government or research reports) ☐ Yes, conference proceeding with sufficient detail ☐ No, primary peer-reviewed paper (qualitative) (Exclude) ☐ No, literature review (Exclude) ☐ No, systematic review (Exclude) ☐ No, grey literature without primary data (Exclude)	If there is any quantitative data (for example: mixed methods study), select **Primary peer-reviewed paper, quantitative** **Systematic review:** Includes systematic review, scoping review, and meta-analyses **Grey literature without primary data** includes newspaper or magazine articles

	☐ No, conference proceeding without sufficient detail (Exclude) ☐ Unsure (Exclude)	

Appendix 4: Data Extraction form

Note: Not all questions apply.

Question	Options	Definitions/Additional notes
General Questions		
What is the study design? *(Check all that apply)*	☐ Observational study ☐ Cross-sectional ☐ Cohort ☐ Case-control ☐ Case study or case-series ☐ Longitudinal study ☐ Other, please specify: _____ ☐ Experimental study ☐ Randomized controlled experiment ☐ Quasi experiment ☐ Other, please specify:_____ ☐ Descriptive Study ☐ Other, please specify: ___	**Observational study** - Assignment of subjects into a treated group versus a control group is outside the control of the investigator • **Cross-sectional -** Examines the relationship of a risk factor and outcome (disease) at a point in time on representative samples of the target population • **Cohort study -** is a study in which individuals with differing exposures to a suspected risk factor are observed through time for occurrence of an outcome • **Case-control study** - compares exposure to the risk factor in subjects who have an outcome (the 'cases') with subjects who do not have the outcome, but are otherwise similar (the 'controls') and drawn from the same sampling frame • **Case or case-series -** a descriptive study of a single individual (case report) or small group (case series) • **Longitudinal study -** A research method in which data is gathered for the same subjects over a period of time **Experimental study -** Each subject is assigned to a treated group or a control group before the start of the treatment • **Control trial -** an experimental study in which people are allocated to intervention groups and evaluated for outcomes • **Quasi-experiment -** An experiment in which subjects are not randomly assigned to groups. Often this is the method of choice in field trials where the samples of the outcome

		are taken from the same individuals before and after the experiment/intervention **Mixed methods -** Tackles a research question using different research methodologies. Please specify the research methodologies used
What is the year of publication?	☐ [Textbox]	
When was the study conducted?/Wha	☐ Provide year/year range ☐ Not reported	
Did the study provide definition of "medically uninsured"	[Textbox]	
How was the data collected?	○ Database ○ Questionnaire/Survey (Postal) ○ Questionnaire/Survey (Web-based) ○ Questionnaire/Survey (Phone) ○ Other, specify: ____	
Study Participants		
Where was the study population-of-interest from? (Select all that apply)	○ New Brunswick ○ PEI ○ Nova Scotia ○ Newfoundland and Laborador ○ Quebec ○ Ontario ○ Manitoba ○ Saskatchewan ○ Alberta ○ British Colombia ○ Northwest Territories ○ Yukon ○ Nunavut	
Did the study include a control/comparison group?	○ Yes ☐ Concurrent comparison: Textbox ☐ Pre and post comparison: Textbox ○ No	
How were the participants selected?	[Textbox]	**Specify database used**
What medically uninsured groups were studied? (Select all that apply)	○ Recent immigrants without provincial insurance ○ Undocumented residents ○ Students on student-visa	

(Add options as they occur)	○ Individuals on working-visa ○ Individuals who have lost health-card ○ Foreign visitor ○ Other: _____	
Did the medically uninsured populations studied have private insurance?	○ Yes, specify: ____ ○ No ○ Not reported	
What is the sample size (n) of the study?	○ Total N: ____ ○ Number of individuals in comparison group: _____ ○ Number of individuals who are medically insured: _____	
Was the response/participation rate captured?	○ Yes, please specify : [text] ○ No [text] ○ Not applicable	
Indicate the number of men and women in the study:	☐ Men in medically uninsured group : _____ ☐ Women in medically uninsured group: _____ ☐ Men in comparison group: _____ ☐ Women in comarison group: _____ ☐ ○ Not stated	
Indicate the age of population investigated:	Medically uninsured group: ☐ Children, specify range: ☐ Middle age, specify range: ☐ Elderly, specify range: ☐ Not reported Comparison group: ☐ Children, specify range: ☐ Middle age, specify range: ☐ Elderly, specify range: ☐ Not reported	
Indicate the ethnicity of population investigated:	Medically uninsured group: ☐ South-asian, country of origin: ☐ Asian, country of origin: ☐ Latino, country of origin: ☐ African: ☐ Not reported Comparison group: ☐ South-asian, country of origin: ☐ Asian, country of origin: ☐ Latino, country of origin:	

	☐ African: ☐ Not reported	
Was any additional demographic information captured in the study results? If so, please specify.	☐ Socioeconomic status [text] ☐ Education level [text] ☐ Work status [text] ○ Other, please specify: [text]	Capture all of the details provided
Data Extraction (DCU)		
What category does the result fall under?	○ Clinical outcomes ○ Healthcare utilization ○ Cost of care	
Cost of Care		
Were cost-estimates provided for the patient population/individual studied?	○ Yes, cost to individual patient ▪ Specific cost estimates/numbers: _____ ▪ Descriptive: ____ ○ Yes, cost to healthcare system ▪ Specific cost estimates/numbers: _____ ▪ Descriptive: ____ ○ No	
Clinical Outcomes		
Was being medically uninsured studied as a risk factor for negative health outcomes?	○ Yes ▪ Results showed it to be a statistically significant risk factor ▪ Results showed it not to be a statistically significant risk factor ○ Not reported	
If poor outcomes were reported, what demographic characteristics were studied as risk factors?	○ Age ▪ Statistically significant, protective ▪ Statistically significant, increased risk ▪ Not statistically significant ▪ Significance not tested ○ Sex ▪ Statistically significant, protective ▪ Statistically significant, increased risk ▪ Not statistically significant ▪ Significance not tested ○ Household income	

	▪ Statistically significant, protective ▪ Statistically significant, increased risk ▪ Not statistically significant ▪ Significance not tested	
What health outcomes were investigated in the medically uninsured population? (Add options as they occur)	○ Cardiovascular-related ○ Accident ○ Maternal care ○ Hypertension ○ T2D ○ HIV	
What health outcomes were reported in the medically uninsured population? (Add options as they occur)	○ Cardiovascular-related, specify: _____ ○ Accident, specify: _____ ○ Maternal care, specify: _____ ○	
Healthcare Utilization		
What healthcare service was accessed by medically uninsured population/individual? (Add options as they occur)	○ Acute emergency care ○ Out-patient services ○ In-patient care/hospitalization	
Was the number/amount of times that the service was accessed reported? (Add options as they occur)	○ Yes, specify: ____ ○ No, not reported	
Was the duration of healthcare utilization reported? (Add options as they occur)	○ Yes, specify: ____ ○ No, not reported	
Was the severity of healthcare utilization reported? (Add options as they occur)	○ Yes, specify: ○ No, not reported	
Final Questions		
What are the reported limitations of the study? (Add options as they occur)	○ Limited by data source ○ Lack of knowledge on underdiagnosed/under treated ○ Small sample size ○ Limited matching	

Was there sufficient quantitative data to do meta-analysis?	○ Yes ○ No	

Appendix 5: Risk of bias form

Was the research question or objective in this paper clearly stated?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Was the study population clearly specified and defined?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Were the study participants (samples) selected randomly so the sample reflects outcomes and exposure in the population of interest?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Was a sample size justification, power description, or variance and effect estimates provided?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Was measurement of the exposure variables valid and reliable?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Was measurement of the outcome variables valid and reliable?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Was the timeframe sufficient so that one could reasonably expect to see an association between	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]

exposure and outcome if it existed?	
If a questionnaire was used to measure outcomes, was it appropriately validated and reliably tested?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Can we be confident that the outcome of interest was not present at start of study?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Were outcome data available for all, or nearly all, participants?	○ Yes [text] ○ No [text] ○ Unsure[text] ○ N/A [text]
Overall score:	○ Poor ○ Fair ○ Good ○ Cannot be determined