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Determining geographic accessibility of family physician and nurse practitioner services in relation to the distribution of seniors within two Canadian Prairie Provinces

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ABSTRACT

Equitable access and distribution of health care services for rural and remote populations is a substantial challenge for health workforce planners and policy makers. Geospatial examination of access to health care considers both need and supply dimensions together to determine spatial access scores which contribute to a greater understanding of potential inequity in accessibility. This geospatial investigation explores geographic variation in accessibility to primary health care services utilizing combined access scores for family physicians and nurse practitioner services in urban and rural communities in the Canadian Prairie provinces of Saskatchewan and Alberta. An index of access scores was developed using a floating catchment area framework and a census subdivision geographic unit. Information about family physician and nurse practitioner practice locations and spatial population data were obtained from the Canadian Institute for Health Information and Statistics Canada respectively. Alberta has a better overall provincial access score than Saskatchewan for family physicians and nurse practitioners combined (11.37 vs. 9.77). The results demonstrate that nurse practitioner services are likely addressing primary care access gaps due to reduced numbers of family physician services in certain geographical areas. Combined access scores reveal inequalities in the distribution of primary health care services relative to the proportion of population aged 65 + across both provinces, particularly in rural and remote communities. This study contributes to health services research by exploration of combined access scores for family physician and nurse practitioner services in relation to the distribution of seniors. These findings provide insight into which areas may be in need of increased primary health care services with a focus on both of these health professional groups. The findings of this research will serve as a foundational model for future expansion of the methods to other health care provider groups and to other population health need indicators provincially and nationally.

1. Introduction

Equitable access and distribution of health care services for rural and remote communities is a substantial challenge for health workforce planners, managers and policy makers. Similar to other developed countries, Canada is continually updating health care strategies in an attempt to ensure that healthcare resources, particularly primary health care (PHC) services, are distributed and accessible according to population need across the full rural-urban spectrum – including urban areas and rural and remote communities (Government of Alberta, 2010; Government of Ontario, 2012). PHC is a term used to refer to the part of a health system that people interact with most of the time when they need health care (V. A. Crooks and Andrews, 2009; Health Canada, 2006). Access to PHC services is a considerable health delivery concern for all provincial/territorial jurisdictions in Canada. However, for jurisdictions with dispersed and low population density, ensuring equitable access and distribution of PHC services irrespective of location is a major challenge (Fucile, 2009; Matthew Richard McGrail and Humphreys, 2015; Ministry of Health and Long-Term Care, 2011). Accessibility to health care is classically characterized by the relationship between availability of health care providers and community-based demand for health care services. While access has a number of different dimensions, identifying the geospatial features of health care accessibility is considered critical across several countries.

In Canada, the increasing interest in geographic access to health care services to determine under-served areas has focused almost exclusively on physician services (Bell et al., 2012, 2013; V. Crooks and Schuurman, 2012; Guagliardo et al., 2004; Ngui and Apparicio, 2011).

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PHC models can however, involve a diverse range of health care professionals (including physicians, nurses, nurse practitioners, dietitians, physical therapists, dentists and social workers) capable of providing direct provision of essential health care (Health Canada, 2006; Hutchison et al., 2011). Recently, researchers have shown some interest in geographic access to dental (Emami et al., 2016; Fisher-Owens et al., 2016; Jones et al., 2016) and physical therapy (Shah et al., 2015) services. Having access to PHC services other than family physicians (general practitioners) is likely to be beneficial in a number of ways to achieve the best population health outcomes.

Shortage of physicians is a common concern among developed nations fuelling debate about the need to strategize for the implementation of alternative health care providers such as nurse practitioners or physician assistants (Martinez-Gonzalez et al., 2014). In 2009, Buske estimated future supply needs of Canadian physicians (for both family physicians and specialists) based on maximum work hours scenarios and identified that physician shortfall would likely be an issue in coming years (Buske, 2009). Shortage of physicians is not only an issue limited to Canada, but is identified as a problem in several countries (Aluttis et al., 2014; Carter et al., 2015; Petterson et al., 2012). The shortage of family physicians (FPs) is also illustrated by the 2014 Statistics Canada report where 14.9 percent of Canadians aged 12 and older reported not having a regular doctor, a proportion relatively unchanged over a 10 year period (i.e., 14.4 percent in 2005) (Gladu, 2007; Statcan, 2015a). Based on the 2014 Canadian Community Health Survey, in three out of ten provinces, the proportion of residents who were without a regular doctor was higher than the national average of 14.9 (i.e., Quebec: 25.1%; Alberta: 20.1%; Saskatchewan: 19.9%) (Statcan, 2015a). In response to a shortage of family physicians, particularly in rural and remote communities, various strategies are being implemented in the delivery of PHC services to optimize use of existing resources and by introducing/enhancing the role of other health care providers. The Canadian health system allows residents to freely choose where, and from whom they access PHC services within or, in some cases, across provincial limits. Health services in Canada are guided by The (1984) Canada Health Act, but provincially funded, managed and delivered (Health Canada, 2012). Across provincial PHC models, nurse practitioners have been introduced to fill the primary care gap due to the shortage of primary care physicians (A. DiCenso et al., 2010; Maier et al., 2016; Wong and Farrally, 2013). Nurse practitioners (NPs) are able to deliver a wide range of preventative and acute health care services both independently and within collaborative relationships with physicians and other health care providers (Canadian Nurse Practitioner Initiative (CNPI), 2006). Furthermore, NP practice in certain settings may be deemed to be equivalent to that of GPs (For a systemic review examining the effectiveness of NPs to GP service provise, see Alba DiCenso et al., 2007; Maier et al., 2016; Wong and Farrally, 2013). Based on this potential shortfall and/or inequity of PHC services, this study is focused on the geographic distribution of family physician and nurse practitioner services in two neighbouring prairie provinces having similar geographical areas but with different population sizes: Alberta and Saskatchewan (Siemer, 2017).

The continuous challenge of unequal health care provider distribution and increasing service needs of an aging population and those with chronic conditions can result in poorer health, shorter life expectancy and higher rates of disability (Chapman et al., 2003; Glazier et al., 1996; Mitton et al., 2011; Romanow, 2002). In Canada, the proportion of seniors (aged 65 years and over) increased (Statcan, 2013) to 4.9 million – 14.8% of the total population in 2011 - with large differences in the age structure of provincial populations (Statcan, 2015b). Based on the 2011 figures, Alberta had the lowest proportion of seniors among all provinces (i.e., 11.1%) whereas the proportion of seniors in Saskatchewan is close to national average (i.e., 14.9%) (Statcan, 2015b).

In order to administer and provide health care services, Alberta is divided into five large health services zones, and these five zones are further subdivided into 132 Local Geographic Areas (LGAs). In Saskatchewan, there are twelve Regional Health Authorities (RHAs), governed by Saskatchewan Health, that are responsible for providing health services. Although health care is provincially managed, the primary health care systems in both provinces operate within the same national legislative framework of the Canada Health Act (1984) (Canada, 1985). In order to examine the geographic distribution of primary care services within provincial health regions, a census based local geographic unit (i.e., Census Consolidated Subdivisions (CCSs)) will be used.

This geospatial research examines and compares the geographic accessibility to two front line PHC services in the two Canadian provinces of Saskatchewan and Alberta focusing on how nurse practitioners are distributed in comparison with family physicians at the municipal level. We hypothesize that PHC services would be distributed equitably when considering both family physicians and nursing practitioners instead of just family physicians across and within these two neighbouring Canadian provinces.

Table 1
Unit of analysis – Consolidated Census subdivision (CCS) Area.

Consolidated census subdivision	Alberta (n = 77)	Saskatchewan (n = 300)
CCS Area Mean (sq. km)	8313	1961
Std. Deviation of Area	12,865	15,553
Maximum Area (sq. km)	81,161	269,996
95 percentile of Area (sq. km)	33,226	2337
# of CCSs having an area greater than 8000 sqr. km	16 (7.80% of AB population)	2 (3.99% of SK population)
Average catchment 'radius' (assuming a circle) in km	51.4	25
Catchment size applied in 3SFCA method (km)	50	50

'n' indicates the number of CCS units existed in 2011 census.

Table 2
Summary of access scores for family physician (FP) and nurse practitioner (NP) across Alberta and Saskatchewan provinces.

Access Score (per-10,000 people)	Alberta (pop: 3,645,257)		Saskatchewan (pop: 1,033,381)	
	Count	Mean 3SFCA	Count	Mean 3SFCA
Family physician services	3986	10.80	1039	9.29
Nurse practitioner services	280	0.70	143	1.42
Combined (family physician + nurse practitioner) services	4266	11.37	1182	9.77

2. Methods and material

This exploratory geospatial research has examined access to family physician and nurse practitioner services across Saskatchewan and Alberta census consolidated subdivisions (CCSs) using a GIS-based accessibility approach. Generally, the input data required for such measures can be classified into two categories. The first category is related to supply data location such as hospital locations, or practice location of different health care providers. In our case, family physician and nurse practitioner health workforce information obtained from the Canadian Institute for Health Information (CIHI) is used. This information is based on the 2014 CIHI's Health Workforce Database. CIHI regularly gathers such data from national professional societies and associations, provincial/territorial regulatory bodies and governments, and educational intuitions, provides information for different professions at various geographic/administrative levels in a standardized format for researchers, health care planners and decision makers (https://www.cihi.

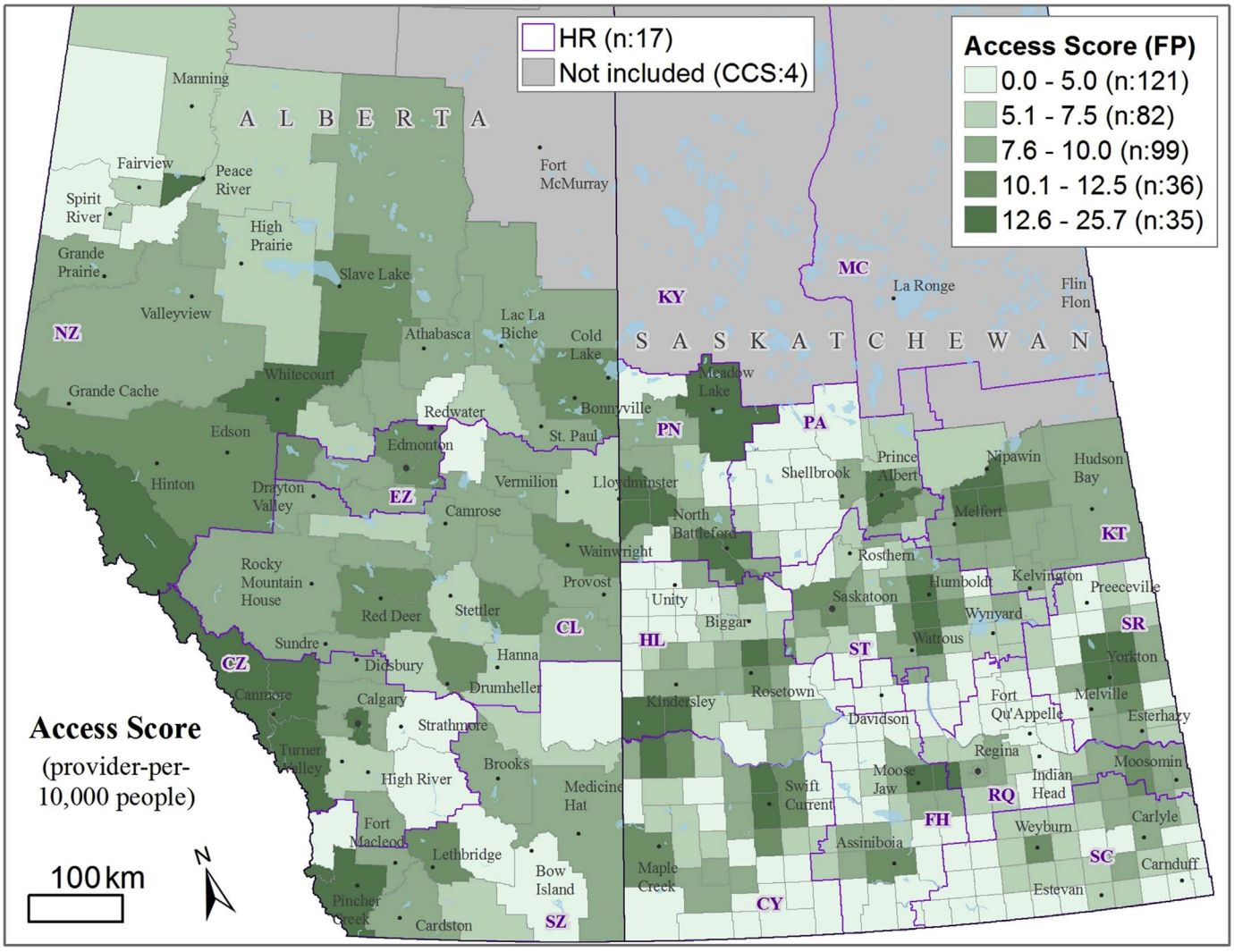

Fig. 1. Access score for family physician (FP) services across Census Consolidated Subdivisions (CCSs). Alberta health zones (CL = Central Zone; CZ = Calgary Zone; EZ = Edmonton Zone; NZ = North Zone; SZ = South Zone) and Saskatchewan health regional authorities (CY = Cypress; FH = Five Hills; HL = Heartland; KT = Kelsey Trail; KY = Keewatin Yatthé; MC = Mamawetan Churchill River; PA = Prince Albert Parkland; PN = Prairie North; RQ = Regina Qu'Appelle; SC = Sun Country; SR = Sunrise; ST = Saskatoon).

ca/en/spending-and-health-workforce/health-workforce). Only community-based family physician and nurse practitioners, providing direct patient care services outside of solely acute care settings (i.e., hospital) were included in the analysis. In order to convert postal code information into a set of geographic coordinates (latitude and longitude), an address locator in ArcGIS using MEP layer as reference data (DMTI Spatial, 2014) was used (Shah, Bell, and Wilson 2014; Bell et al., 2012). The second category deals with the demand data such as population sites that are generally represented by centroids of census geographic units, patient's place of residence. In our case, dissemination areas (DAs), the smallest Canadian census geographic unit for which all census data area disseminated in Canada, were incorporated in GIS-based accessibility measures.

To estimate the geographic accessibility (access score) for both services separately and in combined form, a GIS-based three-step floating catchment area (3SFCA) method with distance decay effects was applied (Luo, 2004; Bell et al., 2012, 2013; Bissonnette et al., 2012). The 3SFCA method is among GIS-methods that were developed using a well-known floating catchment area approach (Fahui Wang, 2012; Yang et al., 2006). This method has been previously applied to health care services, food availability, and access to physical therapy and dental services (Bell et al., 2012, 2013; Bissonnette et al., 2012; Shah et al., 2015) to calculate measures of geographic accessibility at rural and intra-urban levels by applying a single method. The first two steps of the 3SFCA method are similar to the two-step floating catchment area (2SFCA) method (Luo, 2004; F. Wang and Luo, 2005). In the first step of this 3SFCA method, a provider-to-population ratio is calculated at the location of health care services (supply or practice level). This is done by placing a buffer around each point of healthcare practice to select the population sites (i.e., healthcare demand) within its service catchment. Secondly, the ratios from all supply points that are within a buffer around each point of population demand (i.e., population catchment) are summated. In the first two steps of the 3SFCA method, it is assumed that access does not diminish with travel time/distance within a catchment area - a region where utilization of PHC services occurs. Thirdly, access scores are calculated by averaging the ratios from all population demand locations (i.e., a result of the second step) falling within a unit of analysis. We applied the 3SFCA method with distance decay effect by introducing weights for different distance zones within a 50 km service catchment to calculate access scores for family physicians and nurse practitioners for Alberta and Saskatchewan separately.

In the 3SFCA method, the 50-km distance was used as a cut-off/threshold to define the overall service catchment and population catchment areas. The selection of 50 km catchment area is based on the premise that catchment area should be greater than or at least equal to

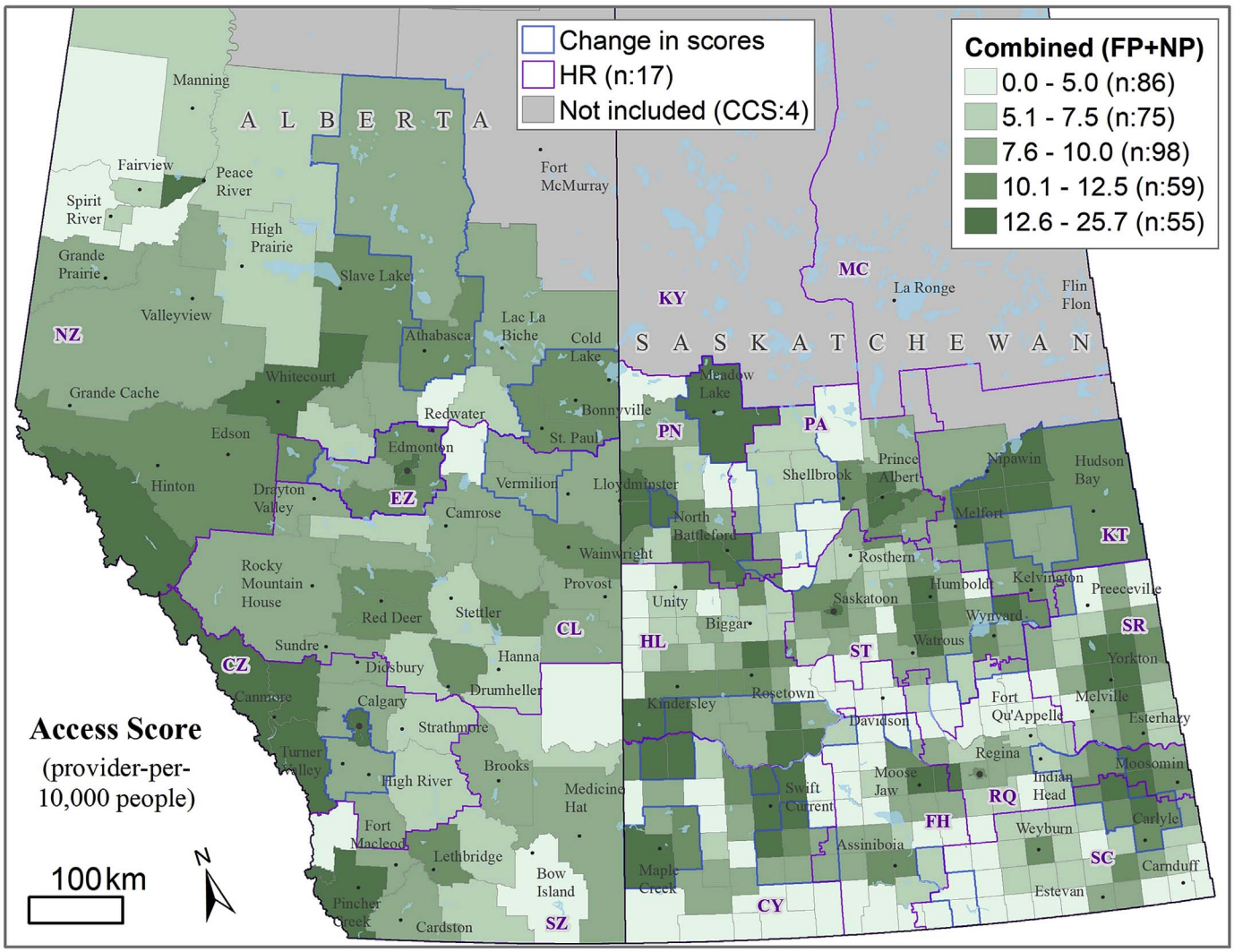

Fig. 2. Combined access score for family physician (FP) and nurse practitioner (NP) services across Census Consolidated Subdivisions (CCSs). Alberta health zones (CL = Central Zone; CZ = Calgary Zone; EZ = Edmonton Zone; NZ = North Zone; SZ = South Zone) and Saskatchewan health regional authorities (CY = Cypress; FH = Five Hills; HL = Heartland; KT = Kelsey Trail; KY = Keewatin Yatthé; MC = Mamawetan Churchill River; PA = Prince Albert Parkland; PN = Prairie North; RQ = Regina Qu'Appelle; SC = Sun Country; SR = Sunrise; ST = Saskatoon).

the average of the areal units of analysis (i.e., census consolidated subdivisions (CCSs, which should also take into account that individuals living in one municipality may travel to seek care in other or neighbouring municipalities. Table 1 presents a summary of CCS size (inlcuding number of CCSs having an area greater than 8000 sqr. km) for both provinces. According to Statistics Canada, a CCS, census geographic unit between census division (CD) and census subdivisions (CSDs; municipalities or areas treated as municipal equivalents for statistical purposes), is a combination of adjacent census subdivisions (CSD). Based on the 2011 Canadian Census, there were 77 and 300 CCSs in Alberta and Saskatchewan respectively. We used Euclidean methodology to calculate the distance between the health care locations and population sites for the sake of catchment areas (Cromley and McLafferty, 2012).

To account for the distance decay effects within catchment areas, each catchment area is further divided into five zones: 1–10 km; 11–20 km; 21–30 km; 31–40 km; 41–50 km. We assigned weights to five distance zones using the following criteria (Fahui Wang, 2012): No weight within the first 10 km, and a zero weight beyond 50 km. An exponential function ($e^{-x/5}$) was applied to assign the weights to the rest of the four distance zones: 0.82 (11–20 km), 0.67 (21–30 km), 0.55 (31–40 km), 0.45 (41–50 km). Using MS Access™ for this research, population and health care supply data (i.e., dissemination Areas (DAs) and family physicians/nurse practitioner by postal code respectively) with geographic coordinates information (Canada Lambert Conformal Conic projection and metric coordinates) were imported into a database and a series of queries were applied to calculate the Access Score in the form of providers-per-10,000 population. A point in a plane has two coordinates (x, y). In two dimensions, the x-coordinate usually directs to the “east” and the y-coordinate points “north.” The Euclidean distance functions were applied to measure a straight-line distance (in meters) between two point layers.

To analyze how nurse practitioners are distributed in comparison with family physicians in two provinces, the Pearson correlation test was conducted separately using the Statistical software Statistical Package for the Social Sciences (SPSS) IBM version 24. Next, to analyze variation across the access scores for family physician and nurse practitioner services for both provinces, comparative analyses were performed in association with a population subgroup (i.e., population 65 years and over) that have much higher health care utilization. Information about this variable was extracted from the 2011 Population Census (Statcan, 2011). The 2011 CSD census data were used to prepare the CCS variable for the population 65 years and over. Both variables (combined access score and percentage of seniors) were dichotomized

Table 3
Differences between access score categories for family physician (FP) services and combined access scores for family physician and nurse practitioner (FP + NP) services for: a) Alberta, b) Saskatchewan, and c) Both (Alberta and Saskatchewan).

Proportion of population and count of CCS units across five access categories % of total population [unit count]						
a) Alberta (2011 Population: 3,556,693; Number of CCSs: 74)						
FP → (FP + NP) ↓	< 5	5–7.5	7.5–10	10–12.5	> 12.5	Total
< 5	0.78 [8]					0.78 [8]
5–7.5	1.36 [3]	3.3 [12]				4.66 [15]
7.5–10		2.7 [2]	17.41 [24]			20.11 [26]
10–12.5			2.5 [3]	16.33 [12]		18.82 [15]
> 12.5				22.84 [1]	32.79 [9]	55.63 [10]
AB	2.14 [11]	6 [14]	19.91 [27]	39.16 [13]	32.79 [9]	100 [74]
b) Saskatchewan (2011 Population: 996,824; Number of CCSs: 299)						
FP → (FP + NP) ↓	< 5	5–7.5	7.5–10	10–12.5	> 12.5	Total
< 5	6.4 [78]					6.4 [78]
5–7.5	4.42 [29]	3.61 [31]				8.04 [60]
7.5–10	0.22 [3]	4.56 [32]	6.25 [37]			11.03 [72]
10–12.5		0.44 [4]	24.93 [29]	5.34 [11]		30.7 [44]
> 12.5		0.04 [1]	0.79 [6]	24.32 [12]	18.68 [26]	43.82 [45]
SK	11.05 [110]	8.65 [68]	31.97 [72]	29.65 [23]	18.68 [26]	100 [299]
c) Alberta and Saskatchewan (2011 Population: 4,553,517; Number of CCSs: 373)						
FP → (FP + NP) ↓	< 5	5–7.5	7.5–10	10–12.5	> 12.5	Total
< 5	2.01 [86]					2.01 [86]
5–7.5	2.03 [32]	3.37 [43]				5.4 [75]
7.5–10	0.05 [3]	3.11 [34]	14.97 [61]			18.12 [98]
10–12.5		0.1 [4]	7.41 [32]	13.92 [23]		21.43 [59]
> 12.5		0.01 [1]	0.17 [6]	23.16 [13]	29.7 [35]	53.04 [55]
Both	4.09 [121]	6.58 [82]	22.55 [99]	37.08 [36]	29.7 [35]	100 [373]

into two categories: below and above. In the case of combined access score, a score of 7.5 providers-per-10, 000 population was used as a cut-off value in order to classify CCS into categories below and above categories. We selected 7.5 as the cut-off value to classify areas into poor and good geographic accessibility after reviewing the provincal and national physician-to-population ratios (i.e., close to 10 (or greater) physicians per 10, 000 population, see Table 2). There is no hard and fast rule regarding the cut-off value, however, such kind of values can be accessed after considering the overall distribution of the data. In the case of percentage of seniors, the national average value was considered to classify CCS into below and above categories. For spatial comparisons, a set of four classes based on the below and above categories from both variables were used: below category for combined access score versus below category for the seniors variable; similarly, below-above, above-below, and above-above. The distribution of below-above class indicates that a considerable number of municipalities with poor access scores and a higher percentage of seniors are located in rural and remote areas. ArcGIS Map 10.5 (ESRI, Redlands, U.S.) and Microsoft Office 2016 (MS Access and Microsoft Excel) were software tools used for mapping and data analysis (spatial and nonspatial).

3. Results

There were 3986 and 1039 family physicians, and 280 and 143 nurse practitioners in Alberta and Saskatchewan respectively that were included in this analysis. The provincial summary of the access scores for family physician and nurse practitioner services that were estimated separately for both provinces using a 3SFCA method with distance decay effects are given in Table 2. The mean family physician access score for Alberta is comparatively higher than Saskatchewan (10.80 and 9.29 respectively) whereas the mean nurse practitioner access score for Saskatchewan is higher (0.70 vs. 1.42). Overall, the combined score (family physician and nurse practitioner services together) for Alberta is comparatively higher (11.37 vs. 9.77). There is no significant correlation between the family physician access score and nurse practitioner access scores in both provinces (for Alberta, Pearson correlation = −0.014; p = 0.903; 2-tailed and for Saskatchewan: Pearson correlation = 0.110; p = 0.057; 2-tailed).

The spatial distribution of 3SFCA access score for family physician and combined access score for both services at community (CCS) level that were estimated separately for Alberta and Saskatchewan are shown in Figs. 1 and 2 respectively. Access scores refer to health care providers-per-10, 000 people. In both cases, higher scores indicate better geographic accessibility to PHC (primary health care) services whereas low (that includes 'no scores') scores indicate communities with poor access to PHC services. The access scores for both FP and combined services (family physician + nurse practitioner) are categorized into five manually-defined classes: < 5.0; 5.1–7.5; 7.6–10.0; 10.1–12.5; > 12.5. The first two classes (< 5.0 and 5.1–7.5) indicate CCSs with the poor access scores also called poorly-served municipalities. Table 3 compares the differences in distribution of combined versus FP access scores where the cross-tabulation view of the percentage of total population and number of CCS units between the categories of these two access scores are given. In both Figures, higher access scores tend to be associated with urban areas with decreasing accessibility in more rural areas. However, combined scores for family physician and nurse practitioner services indicate that improvement in the geographic accessibility to PHC services can be seen in rural areas with poor family physician access scores. Comparative results also demonstrate nurse practitioner services may be addressing gaps in family physician access, particularly in poorly-served categories (see Table 3a and b). For example, municipalities that fall within the Prince Albert (PA) and Kelsey Trail (KT) RHAs in central Saskatchewan and within the Central Zone close to the High River township in Alberta demonstrate increased access primarily due to nurse practitioner services. However, there are still some municipalities that fall within the poor

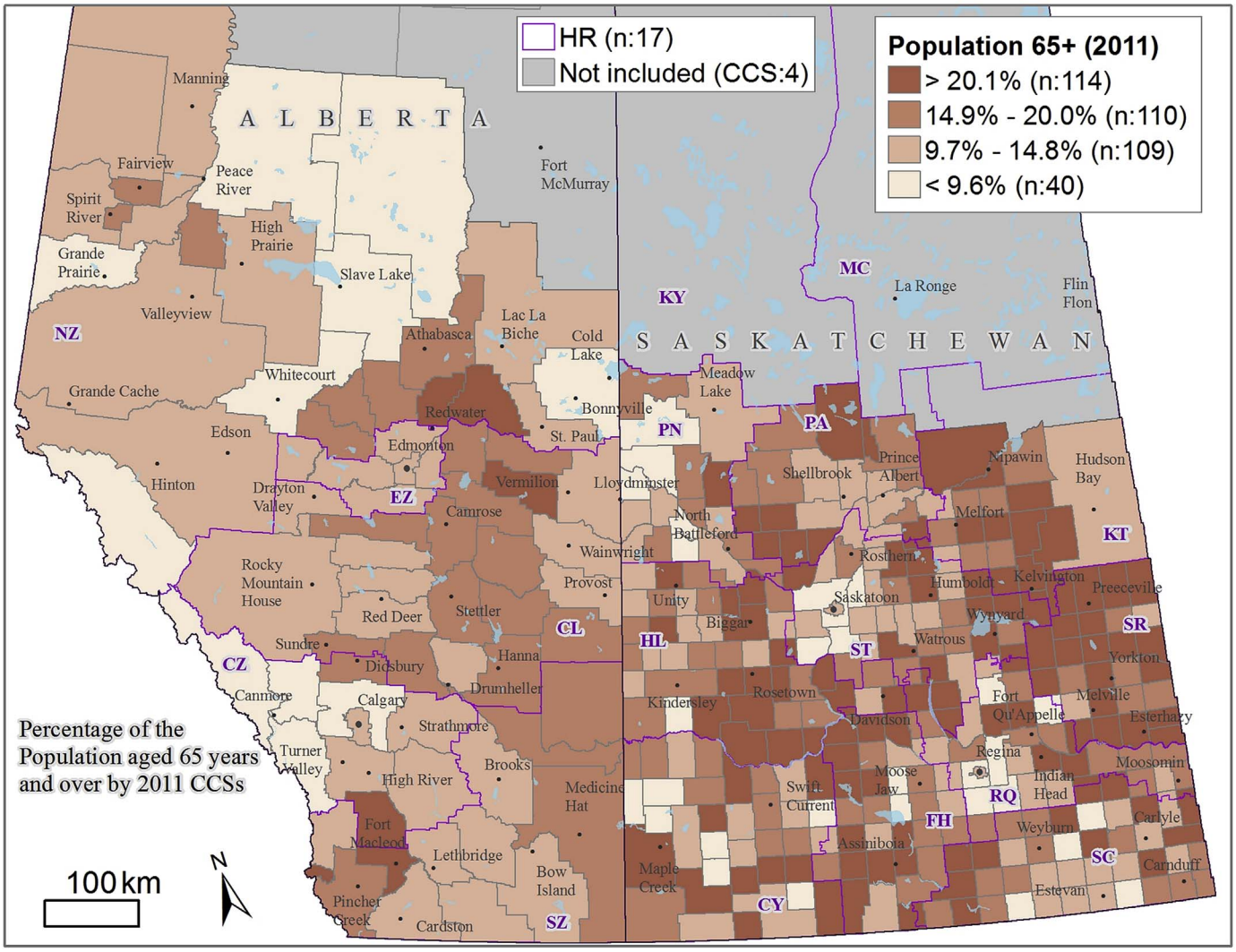

Fig. 3. Percentage of the population aged 65 years and over in 2011 Census Consolidated Subdivisions (CCSs). Alberta health zones (CL = Central Zone; CZ = Calgary Zone; EZ = Edmonton Zone; NZ = North Zone; SZ = South Zone) and Saskatchewan health regional authorities (CY = Cypress; FH = Five Hills; HL = Heartland; KT = Kelsey Trail; KY = Keewatin Yatthé; MC = Mamawetan Churchill River; PA = Prince Albert Parkland; PN = Prairie North; RQ = Regina Qu'Appelle; SC = Sun Country; SR = Sunrise; ST = Saskatoon).

access categories based on combined access score (86 and 75 CCSs in the first two access categories) as shown in Fig. 2 and Table 3.

Fig. 3 presents the distribution of the percentage of population 65 years and over (senior's population) at CCS level. For mapping, percent of senior population was classified into four manually defined categories: < 9.6%, 9.7%–14.8%, 14.9%–20.0%, and > 20.1%. The national average of senior's population (i.e., 14.8%) was used as a cut-off to classify the range (i.e., 0.0–34.6) with an equal interval of 5% for second and third categories. There are a large number of CCSs above the national average (110 CCSs and 114 CCSs). The spatial distribution of the percentage of the senior population (age 65 and over) at CCS levels is shown in Fig. 3. Fig. 4 displays the cross-tabulation view of the combined access score for family physician and nurse practitioner services with the percentage of seniors (age 65 years and over) at CCS level.

4. Discussion

This study investigated the patterns of geographic accessibility for family physician and nurse practitioner services in two neighbouring Canadian prairie provinces (Alberta and Saskatchewan) that have similar geographical areas but with different population sizes (Siemer, 2017). The resultant combined access scores for family physician and nurse practitioner services that were estimated using a 3SFCA method with distance decay effects reveal inequities in the distribution of PHC services across these two provinces, particularly within more rural and remote municipalities or regions of the provinces.

This study adds new information to health services research by introducing combined access scores for two PHC services and comparing it with the population of seniors who may have higher potential PHC service needs. Given nurse practitioners' potential role in addressing reduced access to family physicians, the combined access scores (family physician and nurse practitioner) indicate considerable potential improvements in the geographic accessibility to PHC services in rural areas. For example, municipalities that fall within the Prince Albert Parkland (PA) and Kelsey Trail (KT) RHAs in Saskatchewan and within Central Zone (CZ) close to the town of High River in Alberta as shown in Fig. 2 demonstrate increased access primarily due to increased availability and usage of nurse practitioner services. However, there are some municipalities that fall within the poor access categories based on combined access scores (i.e., 86 and 75 CCSs in the first two access categories) as shown in Fig. 2 and Table 3. It is also evident from the cross-tabulations of combined scores with senior populations that a substantial number of municipalities with poor or low access scores (i.e., below 7.5 providers-per-10,000 population) and who have a higher percentage of resident seniors, are found in rural and remote municipalities in both provinces.

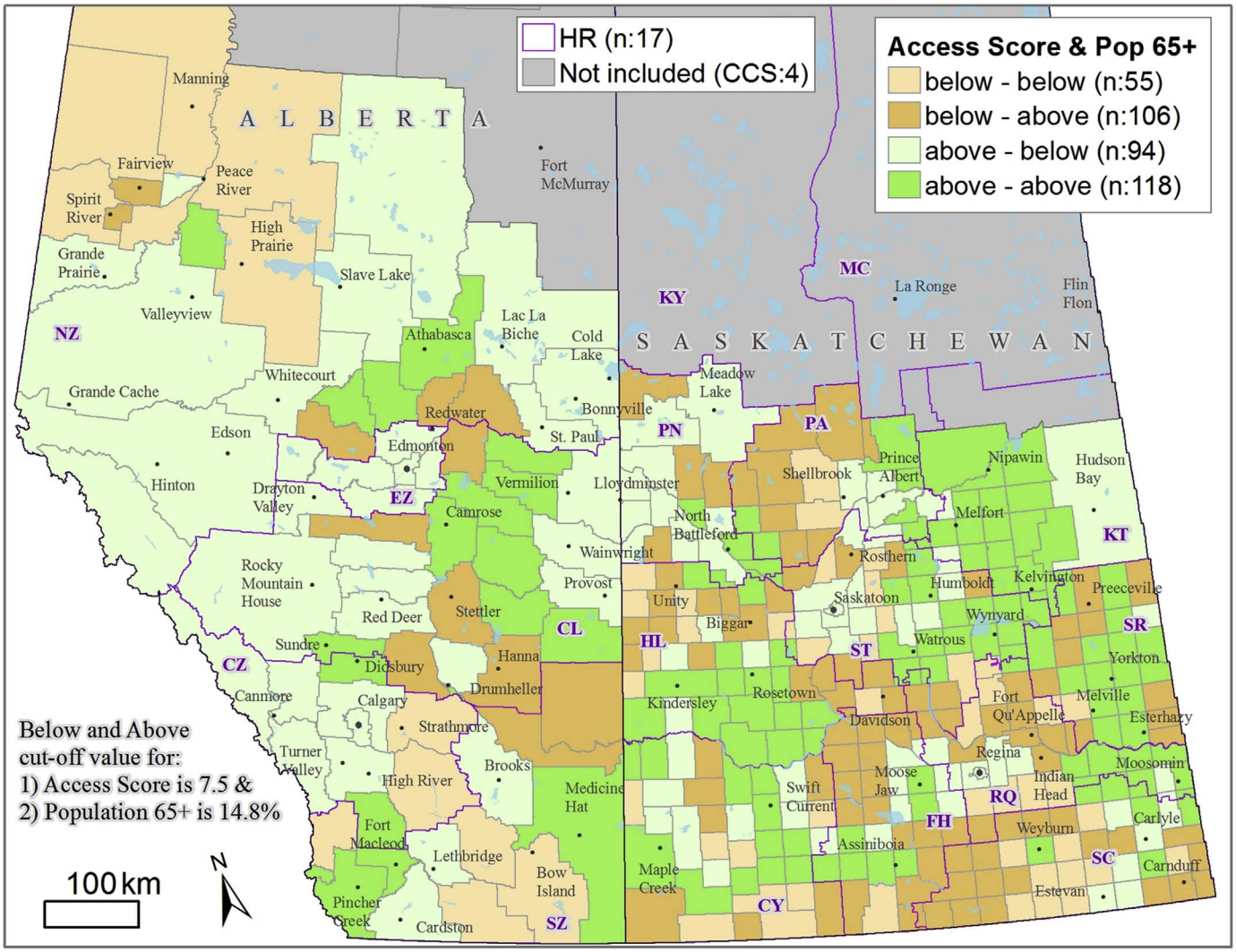

Fig. 4. Access score for (FP + NP) services and percentage of the population aged 65 years and over across 2011 Census Consolidated Subdivisions (CCSs). Alberta health zones (CL = Central Zone; CZ = Calgary Zone; EZ = Edmonton Zone; NZ = North Zone; SZ = South Zone) and Saskatchewan health regional authorities (CY = Cypress; FH = Five Hills; HL = Heartland; KT = Kelsey Trail; KY = Keewatin Yatthé; MC = Mamawetan Churchill River; PA = Prince Albert Parkland; PN = Prairie North; RQ = Regina Qu'Appelle; SC = Sun Country; SR = Sunrise; ST = Saskatoon).

Including the distance decay parameter helps to improve the validity of the 3SFCA method. There are different ways to create catchment areas (including the buffer zone, road catchment area, origin-destination cost matrix analysis, etc. …), however there is no consensus on the catchment size for health care services (Allan, 2014; Matthew R. McGrail and Humphreys, 2014). In geographic research, different procedures have been applied to define the service catchment area including variable catchment sizes (Bauer and Groneberg, 2016; Luo and Whippo, 2012), commuter-based proximity (Fransen et al., 2015) and distance decay within the catchment area (Delamater, 2013). In health services research, it is well recognized that the utilization of health services decreases with increasing travel impedance (time or distance) from a regular source of health care –normally termed as distance decay effect (Aspen et al., 2012; Cromley and McLafferty, 2012, 305–306; M. McGrail, 2012; Nemet and Bailey, 2000; Thouez et al., 1988; Fahui Wang, 2012). As mentioned previously, under the Canadian health system, residents are allowed to freely choose where they access PHC services within or even in some cases across provincial limits. It is thus hard to predetermine how far someone is willing to travel to access PHC services. For example, M. McGrail et al. (2015) found that residents of sparsely-settled communities are prepared to travel significantly further to access a family physician for non-emergency utilization compared with residents of closely-settled rural communities within the states of Victoria and New South Wales in Australia. However, distance to health care services may influence consumer preferences and choice when seeking PHC in urban as well as in rural areas (Aspen et al., 2012; Ministry of Health and Long-Term Care, 2011). In the absence of distance decay within a catchment area, it could be interpreted that access to services for both nearby and close to the catchment residents are the same.

Comparison of two adjacent Canadian Prairie Provinces provides an opportunity to examine how differing demographics and provincial health care policies might influence access to PHC services. Although health care is provincially managed, the primary health care systems in both provinces are operating within the same national legislative framework, The Canada Health Act (1984). Alberta has proportionately more total population living in urban areas in comparison to Saskatchewan (82% and 65% respectively) (Friesen and Cardoso, 2017; Martel, 2015). In 2016, health expenditure per capita was comparatively higher in Alberta (In AB, 6995 dollars comprising 41% of the total province budget; than in SK 6838 dollars comprising 38% of the total province budget) (see table 11, CIHI, 2016). Out of total health expenditures, Alberta is spending proportionately more on health care professional reimbursement (AB: 26.0% versus SK: 22.8%) (IPAC

(Institute of Public Administration of Canada), 2013). Alberta Health Services (AHS), a single health authority in Alberta province established in 2008, is responsible for health services in the province (IPAC (Institute of Public Administration of Canada), 2013). To provide health care services, Alberta is divided into five large health services zones, and these five zones are further subdivided into 132 Local Geographic Areas (LGAs). In Saskatchewan, there are twelve Regional Health Authorities (RHAs) under Saskatchewan Health that are responsible for providing health services. However, the Saskatchewan government is in the process of amalgamating the twelve RHAs into one provincial health authority (Abrametz et al., 2016). This organizational shift may impact health resources and service delivery that should be further explored.

These findings should be interpreted in light of the following limitations. First, GIS-based accessibility measures are sensitive to the quality of input data and practice considerations that can influence the outcome access scores (Bath et al., 2015; Cromley and Albertsen, 1993; Guagliardo, 2004; Jacquez, 2012; McLafferty et al., 2012). Incomplete input data for generating geographic coordinates (Bell et al., 2012; Guagliardo, 2004), selection of health care professions working in multiple sites (primary, secondary, or and tertiary practice settings) either within or across health regions (Albert et al., 2005; Cromley and Albertsen, 1993), or working hours may influence the results. In the present study, we included only those health care providers whose primary practice information was provided (postal code) (Albert et al., 2005; Badley et al., 2015). The proportion of providers whose postal code was not provided/not suitable was very small (less than 1%) and will likely have minimal impact on the results. Secondly, while access scores for both provinces were calculated separately – geographic accessibility may extend beyond the provincial boundaries in some cases - under certain conditions it is possible that residents of one province living close to the border may utilize PHC services located across the border (V. Crooks and Schuurman, 2012). Further work needs to be carried out to investigate the relationship of geographic accessibility to health care services (exploring the use of full-time equivalent 'FTE' measurements) using other social-demographic factors (e.g., income, education, lone parents, households without car, etc.) and need indices (Kaltenthaler et al., 2004) such as the deprivation index (Pampalon et al., 2012) and the Canadian marginalization index (Matheson et al., 2012), amongst others. For example, provincial and local government/policy makers would likely be interested to know the extent to which low household income influences access to primary health care in both the rural and urban settings. The variability in geographical accessibility to GP and NP services both within and between these two neighbouring Canadian provinces suggests that population distribution and needs are not the only drivers for organization of health care services. Indeed, other research suggests that factors such as incentives, market, and providers' social ties determine where health care providers choose to practice. However, an in depth geospatial examination of PHC provision of services, as presented in this research, provides empirical evidence of potential inequities which can ultimately be used to inform policies aimed at health services re-organization and distribution. For example, communities identified as having 'poor' access, could be targeted for service and policy interventions such as: enhanced recruitment and retention efforts; PHC service provision by alternative health care providers; hub and spoke models of travelling care; and/or telehealth models of care delivery.

5. Conclusion

This study set out to examine the geographical accessibility to FP and NP services at the municipal level for the neighbouring Canadian provinces of Alberta and Saskatchewan with a focus on how nurse practitioners are distributed in comparison to family physicians and how nurse practitioners in combination with family physicians, may improve the geographic accessibility to PHC services. There is a discrepancy in these provinces between the distribution of PHC services, especially in rural settings and distribution of population 65 years and over. These findings provide insight into which regions/areas may be in need of increased PHC services with a focus on family physicians and nurse practitioners. Exploration of innovative recruitment/retention initiatives or alternative PHC delivery methods (e.g. Telehealth, greater use of other health care proessional team members [Bath et al., 2016; Keijser et al., 2016; Wakerman et al., 2008]) may help to address PHC access shortages in underserved areas. The results of this study support an argument that health care accessibility should be monitored on a regular basis to inform decision makers. The findings of this research will serve as a foundational model for future expansion of the methods to other health care provider groups, other provinces, and other countries.

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