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Geographic Equity in Hospital Utilization: Canadian Evidence Using a Concentration-Index Approach

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Abstract

Distance-related geographic barriers challenge the ability of health systems to allocate health care resources equitably according to need. The paper adapts the concentration-index approach, commonly used for measuring income-related equity, to assess distance-related equity in hospital utilization in the province of Ontario, Canada. The analysis is based on individual-level data from the Canadian Community Health Survey, which provides information on respondents' hospital utilization, health status, demographic, socio-economic status and location, merged with data on Ontario hospitals, and a geo-coded measure of each respondent's distance to the nearest general acute-care hospital. We find no evidence of a relationship between distance to the nearest hospital and either the probability of hospitalization or the annual number of hospital nights. Supplementary analyses provide insight into hypothesized pathways between distance and hospitalization. Although having a regular medical doctor is positively associated with distance to the nearest hospital, controlling for this does not affect the estimated distance-hospitalization relationship. Both the size and occupancy rate of the nearest hospital are correlated with distance and are strongly related to the probability of hospitalization, but again controlling for these factors did not affect the estimated relationship between hospital use and distance to the nearest hospital. We do, however, find a strong positive gradient between the probability of hospitalization and distance to the nearest large hospital. This gradient is driven by the fact that, for most of those far from a large hospital, the nearest hospital is small with a low occupancy rate. Calculation of the distance-related horizontal inequity index confirms no distance-related inequity in hospital utilization when distance is measured to the nearest hospital of any size; however, when distance is instead measured to the nearest large hospital, we observe large, pro-distance inequity. These distance-use relationships are not captured by traditional geographic measures based on measures of urbanization/ruralness.

Introduction

Health care systems around the world strive to allocate resources according to need (van Doorslaer et. al. 1993). Policies to achieve this objective emphasize public financing to reduce or remove financial barriers at the point of service. A critical test of the success of such policies is the extent to which, after controlling for need, health care utilization is systematically related to socio-economic status. Income-related equity in the utilization of health care is now well documented internationally and especially among OECD countries (van Doorslaer et. al. 2004a; van Doorslaer et. al. 2004b; Wagstaff and van Doorslaer 2000).

In many countries, however, the geographic dispersion of the population creates additional challenges to ensuring allocation according to need. Barriers facing those living in rural and remote settings can be substantial and do not yield simply to funding. Countries with large rural and remote populations have consequently implemented a variety of policies designed to reduce geographic barriers, including policies that offer financial incentives for providers to locate in rural and remote areas, locate training facilities in rural and remote areas and offer preferential admission to medical school to candidates from such settings, create alternative delivery models, employ tele-medicine technologies to link rural and remote areas to major medical centres, provide air-ambulance and related programs, and so forth (see, for example, Simoens and Hurst (2006) for a discussion of such policies among OECD countries with respect to medical services). Despite the considerable effort and resources committed to overcoming geographic barriers to access, the literature on quantifying geographic (in)equity in use is notably smaller and less-developed than the corresponding literature documenting income-related inequity.

This paper combines data from the Ontario component of the 2005 Canadian Community Health Survey and Ontario's hospital sector to examine a number of issues related to geographic equity in the use of hospital services in the province of Ontario, Canada. The core analysis investigates the extent to which individuals with the same need for hospital care, but who live at varying distances from the nearest hospital facility, utilize the same amount of hospital care. To do this, we adapt the well-established concentration-index approach developed to measure income-related equity in health and health care. This to our knowledge is the first application of the concentration-index approach to measure distance-related equity in health care utilization. In addition to this core analysis, to gain better insight into possible pathways between distance to the nearest hospital and hospital utilization we conduct a series of supplementary analyses: (1) we analyze the relationship between distance to the nearest hospital and access to community-based physician care and the impact that controlling for such access has on the estimated distance-use gradient for hospital care; (2) we examine how controlling for selected characteristics of the hospitals themselves — a heretofore neglected issue in the distance-use literature — influences the estimated distance-use gradient; (3) we compare distance-related equity when measured in reference to the nearest hospital of any size with equity when measured in relation to the nearest large hospital (a policy concern sometimes associated with regionalization of services); and (4) we compare geographic equity when measured by distance to the nearest-hospital with two non-distance-based measures of geographic barriers: a six-category classification of geographic areas – Urban Influence Zones – designed by Statistics Canada to reflect the extent to which an area is influenced by an urban centre; and the traditional, commonly used dichotomous classification urban vs. rural, also defined using Statistics Canada conventions. Measures based on urban/rural classifications are much more readily available in household surveys, making it important to identify how conclusions based on such measures differ from those obtained using distance itself.

Our analyses reveal a shallow, non-significant positive gradient between distance to the nearest hospital and hospital utilization, a gradient that does not appear to be generated by distance-related differences in access to primary physician care. Although characteristics of the nearest hospital exert an important influence on the probability of hospitalization, control for such characteristics does not modify the distance-use relationship. A much stronger (positive) relationship exists between hospital use and distance to a large hospital. In general, geographic measures that represent degrees of urbanization/ruralness fail to capture these relationships.

2.0 Relationship between Geographic Isolation and Health Care Utilization

Although it is commonly hypothesized that greater distance reduces access to and use of hospital care, a number of counteracting factors renders the direction of the relationship ambiguous a priori. Greater distance to a hospital increases the overall cost to an individual of obtaining hospital care. These distance-related costs include non-monetary costs, such as time costs, and non-insured monetary costs such as transportation costs and, in some situations, accommodation and related costs for the individual, relatives or friends. Consequently, other things equal, those more distant would be expected to demand less hospital care. Rural and remote areas most distant from hospitals also often have less access to community-based physician care. Reduced access to community-based physician care can affect demand for hospital care in two ways. Reduced access to such care reduces physician utilization and referrals to hospital. But such impeded access also reduces the likelihood of early detection and treatment which, for some conditions, ultimately requires more in-patient hospital care than otherwise would have been the case. On the supply-side, greater distance to a hospital can also affect providers' choices regarding the mix of treatment inputs toward a substitution of hospital care for physician care or informal care at home. Although in some situations greater distance to a hospital may prompt a physician to substitute community-based care for in-patient care, it is more commonly hypothesized that on balance greater distance will lead to a substitution of hospital care for community-based care (Goodman et. al. 1997). A patient living further from the hospital, for example, may be admitted for monitoring overnight rather than sent home with instructions to "return if their condition worsens." Similarly, once admitted, a patient living further from the hospital may stay a day or two longer to allow fuller recuperation before discharge home so as to reduce the chance of post-discharge complications and the need for readmission.

The relationship between distance and hospital use therefore reflects direct effects of distance on patient and physician decision-making regarding treatment and indirect effects mediated through barriers to complementary and substitute care that are correlated with distance to hospital. Although Goodman et al. (1997) posit that, other things equal, those more distant from a hospital will use more in-patient services, current evidence leaves unresolved both the sign of the overall effect and the relative importance of these separate pathways by which distance might influence hospital use.

2.1 Evidence on the Distance-use Relationship

The literature examining the determinants of hospital utilization is vast, most of it focusing on determinants other than geography (e.g., health status, income, gender, education) that commonly include region fixed effects or simple dichotomous urban/rural indicators as control variables. The literature that explicitly examines the relationship between distance and patterns of hospital utilization addresses a number of questions, including the relationship between distance and rates of hospital use and the relationship between distance and choice of hospital (e.g., Adams and Wright (1991)). Given the focus of this research, we confine our discussion below to the literature intended to document the relationship between distance and rates of hospital use.

Early studies of the distance-use relationship tended to focus only on users of care, and often on their use of specific facilities (Connor et. al. 1994). Not surprising, most studies found that use decreases with distance. Evidence from these early studies in part begat the common perception of a strong, widespread "distance-decay" relationship, whereby rates of use decay with distance (Connor et. al. 1994; Lin et. al. 2002). It has long been recognized that studies should adopt a population approach that includes both users and non-users of care. But because individual-level data on non-users is seldom available, population-based studies have often relied on ecological approaches in which utilization is measured by small-area rates of hospitalization and the denominator (including non-users) is based on census population estimates. Lin et al. (2002) and Goodman et al. (1997) typify this approach. Lin et al. examined the impact of travel distance on in-patient hospital use within three health regions of British Columbia, Canada. Individual-level data on users – utilization, age, sex and location – were drawn from the administrative data files of the universal public insurer; population size and socio-economic characteristics beyond age and sex were imputed from census information measured at the level of a census enumeration area. The study found an inverse distance-use relationship: those living in an enumeration area more distant from a hospital had lower rates of hospitalization. Goodman et al. (1997) examined the distance-use relationship in 72 hospital service areas located in northern New England states. Distance was measured by travel time to the nearest hospital facility. Individual data on users were drawn from the relevant state hospital commissions; population characteristics were measured at the level of postal codes. Separate analyses were conducted for "discretionary" medical conditions (characterized by large variation in practice) and "non-discretionary" procedures for which there is greater medical consensus on indications of need and less variation in practice. The study found that rates of hospitalization for discretionary medical conditions declined with distance to a hospital facility but that rates for "non-discretionary" conditions did not decline significantly with distance. While such ecological studies represent a notable improvement on the early user-only studies, their ecological design and limited ability to control for need potentially compromises their validity (Schwartz et. al. 2005).

A small number of recent survey-based studies take a population approach using individual-level data for both users and non-users. Iverson and Kopperd (2005) examine the self-reported use of hospital-based out-patient care and specialist care in Norway. The analysis measured accessibility using a municipal-level index that included measures of local capacity, distance as measured by travel time, and a discount factor for travel time, and controlled for individual characteristics including age, sex, self-assessed health status (SAHS), chronic conditions, education, and income. The study found no relationship between hospital out-patient visits and distance but a negative relationship between distance and visits to private specialists. Buchmueller et al. (2006) examine how increased distance to the nearest hospital following a series of hospital closures in Los Angeles County affected access to care and health status.

They found that the increased distance associated with hospital closures led to shift from reliance on emergency department visits as a regular source of care to community-based physician clinics (especially for the insured).1 The increased distance had little effect overall on perceived access to care, but it was associated with a decrease in perceived access among the elderly and low-income populations. Increased distance had no impact on utilization of an array of preventive services commonly available in both community and hospital clinics (pap smear, mammogram, flu shot, HIV tests), but some specifications suggested decreased utilization of colon cancer screenings, particularly for the uninsured. Finally, the closures and the consequent increase in distance was associated with an increase in mortality from acute myocardial infarction and unintentional injuries in the home but no increase for conditions (chronic heath disease, cancer) for which no effect would be expected.

Finally, Manga et al. (1987) examined in-patient hospital utilization in Canada using data from a national health survey. Although the study did not include a measure of distance to the nearest hospital — it instead used three-category classification of community size — it is notable because it identified a positive gradient between the measure of geographic isolation and hospital use: those living in the smallest communities were most likely to report an in-patient hospital stay. The supply of physicians was also found to be negatively associated with hospitalization, consistent with the hypothesis that increased access to physician care avoids some types of hospitalizations. The study could provide no insight into why those living in smaller communities had higher rates of hospital utilization.

In summary, research into the relationship between distance and use of hospital care documents a general, though not universal, pattern of a negative gradient between distance and use. The conclusion of a negative gradient remains tentative, however, because of important methodological limitations to many of the studies. The research has also largely left undocumented the relative importance of the hypothesized pathways between distance and hospital utilization. More recent work based on individual-level data documents the complex relationship between distance, use of hospital care, and access to and use of community care.

3.0 Methods

3.1 Measuring Equity using the Concentration Index

We assess distance-related equity in the utilization of hospital care using the concentration-index approach, which is suitable for assessing equity with respect to any variable that can be

[1] The authors note that the hospital closures may have been associated with increased investment in community-based clinics, though they were not able to document the extent to which this may have happened.

quantitatively ranked from lowest to highest, such as distance to a facility. The concentration index has the advantage of integrating information on both the gradient between use and distance and the geographic distribution of the population; the concentration index can also be decomposed to measure the contributions of various factors to observed levels of distance-related inequality in use.

The concentration index is defined in reference to the concentration curve. In our context, the horizontal axis of the concentration curve depicts the cumulative proportion of the population rank-ordered by distance to the nearest general, acute hospital; the vertical axis depicts the cumulative proportion of hospital nights. Negative values of the concentration index represent pro-closeness inequality (i.e., those living closer to a hospital use a disproportionately large share of hospital care) and positive values represent pro-distance inequality.

The concentration index is simply a measure of inequality; to assess inequity we must measure inequality in the relevant distribution of utilization. The concentration index approach to equity assessment therefore proceeds in five basic steps: (1) estimate a fully specified econometric model of utilization of the service under examination; (2) generate needs-adjusted predicted utilization for each observation in the sample; (3) indirectly need-standardize the distribution of utilization; (4) calculate the concentration index and the concentration curve for the need-standardized distribution; (5) decompose the concentration index into the contributions of each of the determinants of utilization. The concentration index for the need-standardized distribution of hospitalization (step 4 above) is a measure of horizontal inequity index because it measures the level of distance-related inequality in health care utilization between individuals with the same level of need.

Using the individual-level data from the Canadian Community Health Survey (CCHS), we estimate a two-part utilization model of hospital services. Part 1 models the incidence of hospitalization using a logistic regression where the dependent variable is 0 for those with no in-patient hospitalization in the year preceding the survey interview and 1 for those with at least one hospitalization. Part 2 models the number of hospital nights among those who had at least one in-patient stay. Because the number of nights is a count variable, part 2 is estimated using a zero-truncated negative binomial model. Both models include a set of independent variables representing an individual's distance to the nearest hospital, household income, health status, demographic and socio-economic characteristics, and health-related behaviours as described below:

$$util_i = G(\alpha_1 + \Sigma_k \beta_k x_{ki} + \Sigma_m \gamma_m z_{mi}) + \varepsilon_i \quad (1)$$

where G is the general functional form of the logit or negative binomial model, i indexes individuals, util is a measure of hospital utilization, *x* are need-related variables (e.g., health status), *z* are non-need-related variables (e.g., distance), and ε is a random term.

The distribution of needs-predicted utilization is obtained by predicting each respondent's hospital utilization using their individual-specific values of needs-related determinants of utilization while setting the value of non-need variables fixed at their sample means.

$$util_i^N = G(\hat{\alpha}_1 + \sum_k \hat{\beta}_k x_{k,i} + \sum_m \hat{\gamma}_m \bar{z}_m) \qquad (2)$$

Because non-need variables (z) are constant across the sample, variations in predicted utilization arise only from differences among individuals in need. Hence, the resulting distribution represents what utilization would be if only need determined utilization and all individuals received care according to empirical norms embodied in provincial utilization patterns.[2]

We obtain the need-standardized distribution by taking the difference between actual use and needs-predicted use and, as a normalization procedure, adding the mean of the need-predicted utilization:

$$util_i^{IS} = util_i - util_i^N + \frac{1}{n}\sum_i util_i^N \qquad (3)$$

Variation in the need-standardized distribution reflects variation in actual use unrelated to need. The concentration index associated with this distribution provides a measure of the extent to which this variation is related to a person's distance to the nearest hospital. Consequently, distance-related horizontal inequity (HI) is measured as the concentration index calculated on this need-standardized distribution. We calculate the concentration index and its standard error using the convenient regression approach (O'Donnell et. al. 2008).

The decomposition analysis identifies the contribution of each explanatory variable to distance-related inequality in the distribution unadjusted hospital utilization. To contribute to distance-related inequality a variable must be both correlated with distance and associated with hospital care utilization. The overall distance-related concentration index for unadjusted utilization is decomposed as follows:

$$CI_u = \sum_k (\beta_k \bar{d}_k / \mu) \bullet CI_k + GC_\varepsilon / \mu \qquad (4)$$

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[2] Unlike the case for linear models, the intrinsic non-linearity of the logit and negative binomial models means that the effect of non-need variables is not completely neutralized. In setting the value of non-need variables at their mean we follow convention in this literature (O'Donnell et. al. 2008).

where μ is the mean of util, $\overline{d}_k$ is the mean of d_k, CI_k are the individual concentration indices, and GC_ε is the generalized concentration index for ε. This decomposition is exact for linear models; for non-linear models the decomposition can be performed using a linear approximation based on estimated marginal effects (van Doorslaer et. al. 2004a).

3.2 Empirical Strategy

We conduct a sequential set of analyses to explore different dimensions of distance-related equity of hospital utilization.

1. Estimate a model that includes distance to the nearest hospital of any size plus socioeconomic, demographic, health controls. This model serves as a baseline estimate of the distance-use gradient, but provides little insight into factors that may contribute to the gradient.
2. We conduct two sets of analyses designed to provide insight into the possible role of access to community-based physician care in generating the distance-use relationship.
    a. Examine the relationship between distance to the nearest hospital and each of: having a regular medical doctor, reporting an unmet health need, visits to a general practitioner, and visits to a specialist (most of who are community-based).
    b. Add to the model of hospital utilization a variable indicating whether an individual has a regular medical doctor. If the addition of this variable modifies the estimated relationship between distance and hospital use, it suggests that access to physician care contributes to the distance gradient. If, in contrast, it has little or no impact on the distance gradient, access to physician care is not a factor driving the observed distance-use relationship.
3. To test a potential role of hospital characteristics, we consider two features of a respondent's nearest hospital: size, as measured by number of acute-care beds, and the occupancy rate.
4. We next examine the relationship between hospital utilization (at any hospital) and distance to the nearest large hospital, where "large" is defined alternately as a hospital with at least 100 beds and a hospital with at least 200 beds (mean hospital size).
5. Finally, we examine the relationship between hospital use and non-distance-based measures of geographic barriers, the six-category urban influence zone and the dichotomous urban/rural classification.

In our models we tested for region-level fixed effects (37 health regions), for non-linear relationships by specifying variables in log form or including higher-order polynomials, for interactions between focal variables such as distance and income, distance and hospital characteristics, and distance and urban-rural status (Ai and Norton 2003; Brambor et. al. 2005). All analyses are weighted using the survey sample weights and all standard errors are robust.

4.0 Data

The study data come from the Canadian Community Health Survey (CCHS) 2005/06 Master File, cycle 3.1, supplemented with data on hospital locations, sizes and occupancy rates. The CCHS is a cross-sectional survey of Canadians 12 years and older who reside in a private dwelling (approximately 98% of the Canadian population) (Statistics Canada 2005). The survey collects information on health status, health care utilization, health determinants, and demographic and socioeconomic characteristics. The sample for the province of Ontario is 41,758; 4039 observations were dropped because of incomplete records, leaving an analysis sample of 37,719.[3]

4.1 Variables

Dependent Variable. We analyze two self-reported measures of in-patient hospital utilization: (1) whether the respondent had an in-patient hospital stay in the 12 months prior to the survey interview; and (2) conditional on an in-patient stay, the number of in-patient hospital nights in the 12 months prior to the survey interview.

Independent Variables. The analysis examines three alternative ways to measure geographic access: (1) the straight-line continuous distance between an individual's residence and the nearest hospital;[4] (2) a six-category classification according to urban influence zones; and (3) a traditional dichotomous urban/rural classification. The measure of linear distance was created using information on each respondent's postal code, the postal codes of Ontario hospitals and a GeoCoder mapping program. Postal codes in Ontario represent small geographic areas: the median size of a postal code is 0.04km^2 ; often a single large building, such as a hospital, has a unique postal code. The GeoCoder program calculated the distance between the centroids of all pairs of postal codes in Ontario. This information, in conjunction with information on each hospital's postal code, enabled us to calculate distance to the nearest hospital for each postal

[3] 2342 observations were dropped because they included no information on income; 772 were dropped because of missing information on injuries; 319 because of missing information on education; 101 because of missing information on chronic conditions; and the remaining observations were dropped because of missing values for one or more of a number of variables, with no single variable accounting for more than 100 observations.

[4] Linear distance is an imperfect measure of the physical barriers where geographic features that must be circumvented (a lake) or traversed (a mountain; congested city traffic) lie between the two points of interest. More sophisticated functional distance measures can be created, but they make substantially greater data demands and in general, there is a high degree of correlation between linear distance measures and more sophisticated measures (Phibbs and Luft 1995).

code in the province. We then assigned distance to the nearest hospital for each survey respondent based on the respondent's postal code.[5]

The second set of geographic indicators, urban influence zones, is defined in reference to census metropolitan areas and census agglomerations (Statistics Canada 2008). Census metropolitan areas (CMAs) consist of one or more adjacent municipalities situated around a major urban core with a population of at least 100,000. Census agglomerations are defined similarly to CMAs except that the size of the urban core is smaller -- at least 10,000. The six categories of urban influence zones are as follows (see Appendix B for a visual depiction of these categories):

(1) *urban core*: large urban core around which a census metropolitan area (CMA) or census agglomeration (CA) is defined
(2) *secondary urban core*: the urban core of a CA that has been merged with an adjacent CMA or large CA
(3) *urban fringe w/in a CMA*: small urban areas (population > 1000) within a CMA or CA
(4) *urban area outside a CMA*: urban areas (population > 1000) outside CMAs or CAs
(5) *rural fringe w/in a CMA*: non-urban areas within a CMA or CA
(6) *rural*: non-urban areas outside a CMA or CA

Although these categories are designed to represent a location's relation to an urban centre, they do not represent a monotonic measure of physical proximity to a major urban centre; nor do they necessarily represent a monotonic classification from greater to lesser population density. Someone living in the rural area within a CMA, for instance, can be closer to a large urban area than someone living in an urban area outside a CMA.[6]

The final geographic indicator is the Statistics Canada's dichotomous urban/rural classification is based on an aggregation of urban influence zones: urban is defined as the aggregation of (1) – (4) above and rural is defined as the aggregation of (5) and (6).

Income is measured as the respondent's household income from all sources adjusted for household composition using the modified OECD equivalency scale.[7]

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[5] The analysis focuses on general, acute hospitals. In 2005 Ontario had a total of 252 hospitals. We excluded 77 rehabilitation, psychiatric, and other non-general, non-acute hospitals, leaving a sample of 175 general, acute hospitals included in analysis for geo-coding.

[6] In our sample, for example, nearly half of observations classified as urban (1-4 above) live more than 60 kilometers from the nearest hospital, while over 11.3% of those classified as rural (5-6) live fewer than 30 kilometers from the nearest hospital.

[7] The modified OECD equivalency scale assigns a weight of 1.0 to the first adult, 0.5 to the second adult, and 0.3 to each child.

The analysis controls for health status, demographic, socioeconomic, and lifestyle factors that affect hospital care utilization (see Table 1). A respondent's health status is measured by a 5-category self-assessed health status (excellent, very good, good, fair, poor), the number of self-reported chronic conditions, disability days in the previous two weeks, activity limitations, and an indicator of whether the respondent has suffered an injury in the previous twelve months. Demographic variables include age, sex, marital status and immigrant status. The socioeconomic measures beyond income include the respondent's highest level of education attained, current work status.[8] The health-related lifestyle variable is smoking behaviour (alcohol consumption was entered in early specification but was not significant). Table 1 lists the categories specified for each variable.

Our auxiliary analyses use four CCHS-derived indicators of access to or use of physician care. The first is a dichotomous indicator of whether the respondent has a regular medical doctor (based on their response to a direct question regarding this). The second is a dichotomous indicator of whether the respondent reported an unmet health need (again, based on a direct probe of this issue). The third is the number of self-reported visits to a general practitioner in the 12 months preceding the survey interview; and the fourth is the number of visits to a specialist physician in the 12 months preceding the survey interview.

Finally, we include two characteristics of the nearest hospital: the number of acute-care beds and the occupancy rate. Data on the number of beds is taken from two sources (Canadian Healthcare Association 2006; Ontario Ministry of Health and Long-term Care 2008a); the hospital occupancy rates were obtained from the Ontario Ministry of Health and Long-term Care (Ontario Ministry of Health and Long-term Care 2008b)

Assessing horizontal inequity requires that each variable be classified as either a need-related, legitimate determinant of hospital service use or a non-need-related determinant whose influence is a policy concern. Need-related factors in our model are: age, sex, all health status measures and smoking status.[9] Non-need factors are: income, education, immigrant status,

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[8] The survey includes information on whether a respondent has private supplemental health insurance. We exclude it for three reasons: (1) hospital care in Canada is free at the point of use; supplemental private insurance covers only non-medical amenities such as a semi-private room; (2) it was non-significant in preliminary hospital regressions; (3) 2253 observations had no information on private insurance, so including the variable meant dropping these observations.

[9] The effect of smoking status may represent need – smokers have more health problems – or non-need related preferences and attitudes. If the former dominate the impact of smoking on hospitalization will be positive and it would be appropriate to classify it as a need variable; if the latter dominate, the impact of smoking will be negative and it would be appropriate to classify it as a non-need variable. In our case, its impact is positive on the incidence of hospitalization and negative for the conditional number of nights. We chose to treat it as need-related in both. Our results are insensitive to how we classify it.

work status, marital status, regular medical doctor, hospital size, hospital occupancy rate, and most importantly, distance to the nearest hospital.

5.0 Results

5.1 Descriptive Statistics

Just under 7% of Ontarians had an in-patient hospital stay in the year prior to their survey interview (Table 1). Those who had an in-patient stay reported an average of 8.1 nights in hospital during the year preceding the survey. The unadjusted rates of hospitalization vary modestly both by distance (0.07 for those less than 30k from a hospital; 0.09 for those more than 30k) and by urban influence zones (Table 2).

A large majority of Ontarians live close to an acute, general hospital. Approximately 92% of individuals live fewer than 30 kilometers from the nearest hospital. When classified according to urban influence zones, 75% of the population is classified as living in an urban core, 3.3% in the urban fringe, and 7.8% in a secondary urban core, so that overall 85.3% of the population is classified as living in an urban area and 14.7% in a rural area (Table 2).

As expected, demographic and socio-economics characteristics of the sample accord with the Ontario population. Mean adjusted household income is $36,640, 50% are female, 61% are married, over half have a university education, nearly 20% are immigrants, over 60% work, 98% can speak English or French, approximately 90% rate their health as good or better, and a small minority suffer health limitations, activity restrictions, more than 3 chronic diseases, or experienced an injury in the previous year. The vast majority (91%) of the population has a regular medical doctor, approximately 4.7% reported an unmet health need, and there were an average of 3.20 GP visits and 0.94 specialist visits in the year preceding the survey.

Not surprisingly, the characteristics differ by distance and geographic category. Unadjusted data indicate, for example, that those further from a hospital have lower incomes and suffer from more chronic conditions, though there is little difference in the proportion having a regular medical doctor.

General, acute hospitals have an average of 200 beds, but there is substantial variation in hospital size, with nearly a quarter of the hospitals having fewer than 50 beds and just over half having more than 200 beds. The average occupancy rate is 84%, with again, substantial variation. Small hospitals with fewer than 50 beds have an average occupancy rate of 71% while hospitals with 200 or more beds had an average occupancy rate of 87%. Characteristics of the respondents' nearest hospitals also differ systematically with distance: among respondents within 10k of a hospital less than one-quarter of these hospitals have fewer than 100 beds; among respondents more than 30k from a hospital nearly two-thirds of these hospitals have fewer than 100 beds. Mean hospital size and occupancy rates also vary across geographic categories.

5.2 Equity Results

5.2.1 Incidence of Hospitalization

Table 3 presents estimates of the average marginal effects for selected variables based on a logistic regression of hospital use on demographic, socio-economic, health-related, and geographic variables. The results for the variables not presented are consistent with expectations and stable across specifications. Health-related variables exert the strongest influence on hospitalization, with the expected gradient for self-assessed health status, number of chronic conditions, heath limitations, disability status, and injury. The probability of hospitalization varies as expected by age and sex: other things equal, females of child-bearing age have the highest probability of hospitalization. The probability of hospitalization is higher among those who are (or were) married, those who do (or did) smoke more heavily, for aboriginals, and those who do not work and who are not students. Hospitalization is unrelated to education, immigrant status or language. Full results are available in Appendix A. Hereafter we focus on the distance measures.

Column 1 of table 3 presents the results for the baseline model that includes a measure of the distance to each respondent's nearest hospital. The estimated effect is positive but not significant at conventional levels.[10] The magnitude of the estimate is also modest: a 10k increase in distance is estimated to increase the probability of hospitalization by 0.2% points (about 3% on the baseline probability of 6.7%).

This estimate of the impact of distance reflects the net effect of the multiple pathways by which distance might affect the probability of being hospitalized. To identify the possible impact of differential access to community-based physician care by those who are more distant from a hospital we do two things: (a) examine the relationship between distance to the nearest hospital and indicators of access to physician care; and (b) add a measure of access to community-based physician care —having a regular medical doctor — to the model of hospital utilization. Table 4 summarizes the results of our analysis of the relationship between distance to the

[10] Higher order polynomials in distance (quadratic, cubic) as well as interaction terms distance with income, ruralness and nearest hospital size proved non-significant.

nearest hospital and indicators of access to physician care. (Full results are available in the appendix.)

Distance to the nearest hospital is positively and significantly associated with the likelihood of having a regular medical doctor, though the size of the effect is small (Table 4, col 1): each 10k increment in distance increases the probability of having a regular medical doctor by 0.03%. Distance to the nearest hospital is unrelated to either the probability of a GP visit during the year or the conditional number of GP visits. Distance to the nearest hospital, however, is negatively associated with both the probability of having at least one specialist visit in the previous year and the conditional number of specialist visits. (Again we obtain the common finding that those with higher incomes have higher rates of specialist utilization.) Finally, distance is negatively related to reporting an unmet health need, though the size of the effect is small.[11]

Having a regular medical doctor has a positive impact on the probability of being hospitalized (Column (2), Table 3): those with a regular medical doctor are approximately 23% more likely to be hospitalized than those without a regular medical doctor (marginal effect of 0.0157 on baseline risk of 0.067). Adding “regular medical doctor” to the model has no impact on the magnitude or statistical significance of the distance-use relationship.

These findings imply that those more distant from a hospital do not suffer impaired access to primary care (though they appear to have reduced access to specialist care); this is contrary to the common hypothesis, those with reduced access to a physician are less likely (rather than more likely) to be hospitalized; hence, other pathways must be responsible for the observed distance-use gradient since controlling for access to physician care has no impact on the estimated distance-use relationship,.

The next set of analyses explores one such possibility: that the gradient derives in part from characteristics of hospitals that are correlated with distance. As noted above, the sizes and occupancy rates of hospitals vary notably in ways correlated with distance: small hospitals have lower average occupancy rates and nearest hospital size is negatively correlated with distance. Specification (3) adds a measure of hospital size to the regression, revealing a small, negative relationship between the size of the nearest hospital and the probability of being hospitalized: other things equal, on average across the sample, a person whose nearest hospital has 50 beds is 6% more likely to be hospitalized (0.4% on baseline of 6.7%) than a person whose nearest hospital has 100 beds. Specification (4) adds instead the occupancy rate, which is also negatively associated with being hospitalized and has a sizable effect: on

[11] The unmet need could originate in any aspect of care, not just community-based physician care.

average, those whose nearest hospital has an occupancy rate of 0.60 are 17% more likely to be hospitalized than is someone whose nearest hospital has an occupancy rate of 0.90. In neither case does adding these variables appreciably affect the estimated distance-use relationship. Interaction terms between distance and either beds or occupancy rates are not significant. Hence, although these hospital characteristics affect the likelihood of being hospitalized, they do not modify the estimated distance-use relationship.

The next two specifications (6 and 7) examine the relationship between being hospitalized (in any hospital) and distance to a large hospital, where large is interpreted alternately as a hospital with more than 100 beds and a hospital with more than 200 beds. A statistically significant positive relationship between distance and use emerges as the hospital size cut-off used in the distance calculation increases: the distance coefficient is significant at just above conventional levels for the 100-bed threshold and is significant at the 5% level for the 200 bed threshold. The effect size is small, but more precisely estimated.

The last two specifications change the geographic measure from distance to the two systems of urban/rural classification, the six-category measure of urban influence zones and the dichotomous urban/rural measure. We find no significant difference in the probability of being hospitalized across individuals living in the different urban-influence zones. Although the individual estimates are not significant, the set of geographic dummies is significant as a group. The estimates suggest a pattern whereby those living in areas included within census metropolitan areas (larger urban centres) are less likely to be hospitalized. In specification 9, urban is not significant, but again the trend suggests that those living in an urban area have a lower probability of being hospitalized. Given that larger hospitals are far more likely to be located in urban areas, these patterns are consistent with the above finding that those who live more distant from a large hospital are more likely to be hospitalized.

5.2.2 Conditional Number of Hospital Nights

Table 5 presents the results of zero-truncated negative binomial models estimated over the conditional number of hospital nights. The specifications of independent variables are identical to those used to analyze the incidence of hospitalization. The relationships between number of nights and income, distance, and hospital characteristics are weaker than for incidence: none of these variables is statistically significant in any of the specifications. The only variable of interest that is consistently significant is having a regular medical doctor, which is positively associated with the conditional number of hospital nights. Those with a regular medical doctor who are hospitalized are predicted on average to have 2.1 additional nights (per year) compared to those who are hospitalized and who do not have a regular medical doctor.

5.2.3 Equity in Hospital Utilization

The concentration index for the raw, unstandardized distance-related distribution of the incidence of hospitalization (-0.0138) indicates a non-significant, modest pro-closeness bias (Table 6). After standardizing for population needs, the value of the HI is effectively zero (0.0015), indicating no distance-related inequity in the standardized distribution of hospitalizations. To the best of our ability to standardize for needs, there is no distance-related inequity in hospitalizations. However, as we modify the distance measure from distance to the nearest hospital of any size to the distance to a large hospital, a strong and statistically significant pro-distance bias emerges in both the raw and standardized distributions of hospitalizations. When we measure distance from the nearest hospital with more than 200 beds, for instance, the CI is 0.0574 and the HI is 0.0510 and both are statistically significant. This change is driven solely by the re-ranking of individuals as we change the distance measure, and in particular the increase in the average ranking of those who live close to a small hospital but far from a large hospital.[12] Such individuals not only have above-average rates of hospitalization, their rates of hospitalization are above the provincial norm given their need-related characteristics. This is a reflection of the "small hospital" effect we observed in the multi-variate results above whereby the likelihood of hospitalization decreases with size and occupancy rate of the nearest hospital.

There is no evidence of distance-related inequity in the distribution of the conditional number of hospital nights.

5.2.4 Decomposition Analysis

Table 7 presents decompositions of the distance-related concentration indices. The first column in the table lists the decomposition for the distance-related CI for the incidence of hospitalization when distance is measured to the nearest hospital. The decomposition has four notable features: non-need factors as a group contribute to a pro-distance bias while need factors contribute to a pro-closeness bias; the need and non-need factors are almost exactly off-

[12] The distance to the nearest hospital of 200 or more beds is equal to the distance to the nearest hospital of any size plus a non-negative increment (equal to zero for those whose nearest hospital is 200 or more beds and a positive number for all others). The distance-related CI when distance is measured with respect to the nearest 200-bed hospital equals the distance-related CI for any hospital plus the distance-related CI for the distance increment. The "increment-related" CI for the raw distribution is 0.0712 and the "increment-related HI" is 0.495: those for whom the distance increment between the two measures is large have unusually high rates of hospitalization.

setting; the most important non-need factors are distance itself and marital status while the most important need factors are age and self-assessed health status; and the error term is large and pro-closeness, indicating that unmeasured aspects of utilization are systematically biased toward pro-closeness. When we change the distance measure to be the nearest hospital of 200 or more beds (column 3), now both non-need and need factors contribute to a pro-distance bias. Among non-need factors once again distance and marital status stand out for their relatively large contributions; among need factors the age/sex contribution stands out. Once again the error term is relatively large, though it is now pro-distance. For the conditional number of nights when distance to the nearest hospital is used (column 2), the need and non-need factors are again almost perfectly off-setting and there is a relatively large pro-closeness error term. Among non-need factors, immigration status emerges as a relatively large contributor to pro-distance bias and, although marital status is again important, it now contributes toward a pro-closeness bias.

6.0 Discussion

Our main analysis, based on a person's distance to the nearest hospital of any size, indicates distance-related equity in the distribution of hospital care in Ontario, Canada. The estimated distance-use gradient — which suggest slightly higher rates of hospitalization among those more distant from a hospital — is small in magnitude, is not statistically significant and is robust to many model specifications.[13] This finding contrasts with most previous studies of the distance-use relationship, many of which were based on ecological analyses rather than individual-level data from a population-based survey.

Some analysts have previously argued that we should expect a positive gradient (e.g., Goodman et. al. 1997), but our supplemental analyses imply that the determinants of the gradient are different than has been hypothesized. It has been hypothesized, for instance, that impaired access to primary care among those more distance can contribute to a positive gradient because the conditions of those with impaired access go undetected longer, become more severe, and ultimately lead to more hospitalizations than among those with better access to primary physician care. Our results reveal that, in contrast, access to primary care physician services — as measured by having a regular medical doctor[14] — is positively (rather than

[13]If a respondent's location relative to a hospital is endogenous, determined in part by health status, we would expect those in poorer health to locate near a hospital. To the extent that we have failed to fully measure health status, unobserved heterogeneity in health could bias our estimate downward.

[14] In Canada, general and family practitioners act as gatekeepers to specialist services, so few individuals have a specialist as their regular medical doctor.

negatively) associated with distance to the nearest hospital, and the distributions of both GP use and unmet need suggest no distance-related problems of access to primary care.[15] Furthermore, having a regular medical doctor is positively (rather than negatively) associated with both the probability of being hospitalized and the conditional number of in-patient hospital nights. (These patterns may be in part spurious rather than causal: having a regular medical doctor may be correlated with lower unobserved health status.) We were not able to identify separately the effects of distance-related non-insured monetary costs and the impact of distance on treatment choices, but the lack of a net effect of the two suggests either that they are both unimportant or that they coincidentally perfectly offset each other. The former is more likely.

In contrast to these commonly discussed potential determinants of a distance-use gradient, our analysis reveals that characteristics of the hospital sector itself — a heretofore neglected factor — play a critical role in determining distance-related patterns of care. Both the size and the occupancy rate of the nearest hospital exert a large effect on the probability of being hospitalized and on the conditional number of hospital nights. Controlling for these characteristics had no impact on the distance-use relationship when distance is measured to the nearest hospital.[16] But these hospital characteristics play an important role in the substantial distance-use gradient our analysis did uncover: that between distance to the nearest large hospital (200 beds or more) and the probability of being hospitalized. Those whose nearest hospital of any size is small and who live far from a large hospital are substantially more likely to be hospitalized than are individuals whose nearest hospital is large. The acute-care hospital sector in Canada has one of the highest average occupancy rates among OECD countries (OECD 2005). Small hospitals, however, which are predominately located in small towns, have relatively low occupancy rates. Physicians in such settings have the option to hospitalize patients for conditions below the threshold for admission to large, capacity-constrained urban hospitals. In this sense, the large-hospital distance-gradient is caused by differences in treatment choices, but in this case the differences are driven not by considerations of distance, but by the fact that bed availability in small hospitals allows physician to lower the threshold for hospitalization. A (now-dated) study of differences in the practice patterns of rural and urban physicians in the Canadian province of Manitoba discovered differences in hospitalizations consistent with such behaviour (Roos et. al. 1986). To the extent that the policy concern is

[15] This is not to say that there are no problems of access to primary care in Ontario; such problems, however, are not correlated with distance to a hospital.
[16] A test for an interaction between distance and occupancy rate of the nearest hospital was not significant.

about access to hospital care for those living in small communities far from urban centres (as it is sometimes articulated), these results indicate that such individuals actually have higher rates of hospital utilization.

Analyses based on either distance to the nearest hospital of any size or urban/rural geo-codes miss this relationship. The former miss it because, as noted, distance *per se* exerts relatively little influence (whether the nearest hospital is small or large). The geographic variables, whether specified using the more detailed urban-influence zones or the dichotomous urban/rural classification, failed to detect any strong geographic utilization patterns. The point estimates for the urban influence zones are consistent with the large-hospital gradient, but there is too much heterogeneity within each geographic category for the effect to emerge clearly. The simple dichotomous classification is simply too aggregated to pick up such effects.

The concentration-index approach proved invaluable in identifying these relationships, demonstrating its value for equity analyses beyond that possible by estimating only regression-based marginal effects. In particular, comparison of the concentration indices when distance was measured to the nearest 200-bed hospital rather than any hospital focused attention on the impact of the group of individuals living close to a small hospital but far from a large hospital (whose rankings changed the most when the distance measure changed). Although the regression-based distance gradient became statistically significant when the distance measure changed, the much-smaller point still implied a shallow gradient. But because the CI-approach integrates information on both the gradient (between distance rank and use) and the underlying distribution of distances, it allowed us to quantify the distance inequality more clearly.

The wide availability of both geo-coding programs and survey data with detailed information on health, socio-economic and demographic status has expanded greatly the geographic analysis of health care utilization. Of particular value would be studies based on linked survey and administrative data that permit examination of questions such as how the mix of inputs, especially across the physician and hospital sectors, differs by distance; how the distance gradient may differ for differing types of services (e.g., services with much medical discretion vs. those without; ambulatory-care sensitive conditions vs. others, etc.); whether appropriateness of care differs by distance; whether those more distant from large regionalized facilities have less access to the regionalized services available only in these large centres (even if they have higher hospital utilization overall), and so forth. Our findings suggest a more complex pattern of hospital use than revealed by previous empirical analyses of the distance-use relationship, patterns that deserve further scrutiny now possible given increased access to population-based survey data and geo-coding technologies.

Table 1: Descriptive Statistics, Canadian Community Health Survey and Ontario Hospitals

CCHS (N = 37,856)	**Mean**	**s.d.**		**Mean**	**s.d.**		**Mean**	**s.d.**
Hospital Utilization:			Work status			Current Smoking		
In-patient Hospital Stay (Yes/No)	0.07	0.25	Currently working	0.63	0.48	Current - Heavy	0.42	0.49
Unconditional number of nights	0.54	5.40	Student	0.16	0.36	Current - Occasional	0.16	0.37
Conditional number of nights	8.09	19.43	*Not working (ref.)*	0.21	0.41	Former	0.05	0.22
			Language: Eng/Frch	0.98	0.14	*Never (ref.)*	0.37	0.48
Non-need variables:			Aboriginal	0.02	0.13	Number of Chronic Conditions		
Measures of Geographic Barriers			Regular Medical Doctor	0.91	0.28	*0 (ref.)*	0.30	0.46
Linear Distance – nearest hosp	6.14	7.10	Unmet Need	0.05	0.22	1	0.26	0.44
Urban Influence Zones			GP Visits	3.20	5.00	2-3	0.28	0.45
Urban Core	0.75	0.43	Specialist Visits	0.94	3.37	> 3	0.16	0.36
Urban Fringe w/in CMA/CA	0.03	0.18				Number of Disability days		
Secondary urban core	0.02	0.14	**Need variables:**			*0 (ref.)*	0.83	0.38
Rural Fringe Inside CMA/CA	0.08	0.26	Age			1 -2	0.07	0.26
Urban Area outside CMA/CA	0.05	0.22	*<30 (ref.)*	0.27	0.45	≥ 3	0.10	0.30
Rural Area outsde CMA/CA (ref.)	0.07	0.25	30-39	0.17	0.38	Injury (1 = yes)	0.14	0.35
Dichotomous Urban/Rural			40-49	0.21	0.41	Activity Restrictions		
Urban	0.86	0.35	50-59	0.15	0.36	Some	0.13	0.34
Adjusted Household Income	36045	29949	60-69	0.10	0.30	Often	0.11	0.31
Marital status			70+	0.09	0.29	*Never(ref.)*	0.76	0.43
Married	0.60	0.49	Sex (Female)	0.50	0.50			
Widowed/Divorced/Separated	0.11	0.31	Health Status			**Ontario Hospitals**	N = 175	
Never Married (ref.)	0.29	0.45	*Excellent (ref.)*	0.2231	0.416	Number of Acute Beds	200.2	133.8
Education			Very good	0.3924	0.488	< 50 Beds	0.22	0.41
Less than secondary education (ref)	0.22	0.41	Good	0.2776	0.448	50-99 beds	0.06	0.24
Secondary education	0.16	0.37	Fairly	0.0790	0.270	100-200 beds	0.16	0.37
Some Post-secondary education	0.08	0.27	Poor	0.0280	0.165	> 200 beds	0.55	0.50
Post-secondary graduate	0.54	0.50	Health limitations			Occupancy Rate (percent)	83.63	10.57
Immigrant Status			Sometimes	0.13	0.34	< 50 Beds	71.47	18.61
Immigrant 0-10 years	0.09	0.28	Often	0.09	0.29	50-99 beds	76.74	15.06
Immigrant 10-30 years	0.10	0.30	*Rarely (ref.)*	0.77	0.42	100-200 beds	81.11	6.81
Canadian-born/ Immig>30 yrs (ref.)	0.81	0.39				> 200 beds	87.30	7.86

Table 2: Descriptive Statistics for Selected Variables, by Geographic Areas

Geographic Area	Proportion of Population	Incidence of Hosp	Mean Number of Hospital Nights	Adjusted Household Income	Proportion with two or more Chronic Conditions	Regular MD	Proportion of Hospitals with < 100 beds	Mean Occ Rate of Nearest Hosp
Distance to Nearest Hospital								
< 10k	0.76	0.07	0.53	36040	0.33	0.91	0.24	0.84
10 to 29k	0.16	0.07	0.60	36599	0.43	0.93	0.41	0.84
> 30k	0.08	0.09	0.65	31373	0.46	0.90	0.64	0.80
Urban Influence Zone								
Urban Core	0.75	0.06	0.52	35,971	0.43	0.91	234	0.85
Secondary Urban Core	0.02	0.07	0.36	38,620	0.44	0.94	95	0.80
Urban Fringe	0.03	0.06	0.81	39,429	0.45	0.93	140	0.82
Urban o/s CMA	0.05	0.09	0.69	33,629	0.50	0.88	40	0.76
Rural Fringe i/s CMA	0.08	0.06	0.64	37,465	0.45	0.94	154	0.84
Rural o/s CMA	0.07	0.08	0.53	33,732	0.48	0.91	65	0.79
Urban/Rural								
Urban	0.86	0.07	0.53	36,098	0.43	0.91	215	0.84
Rural	0.14	0.07	0.58	35,720	0.46	0.93	112	0.81

Table 3: Average Marginal Effects, Alternative Logistic Regression Models for Incidence of Hospitalization, Ontario Canada

	1	2	3	4	5	6	7	8
Summary Statistics								
N	37,719	37,719	37,719	37,719	37,719	37,719	37272	37272
Pseudo-R^2	0.105	0.105	0.105	0.105	0.105	0.105	0.106	0.106
Log-Likelihood	-8267.35	-8262.55	-8259.17	-8257.69	-8257.53	-8256.47	-8145.44	-8148.88
Variable								
Ln(Income)	-0.00036 (-0.15)	-0.00051 (-0.20)	-0.00050 (-0.20)	-0.00050 (-0.20)	-0.00049 (-0.19)	-0.00042 (-0.16)	-0.00024 (-0.05)	-0.0003 (-0.01)
Distance to Nearest Hosp	0.00022 (1.14)	0.00021 (1.07)	0.00015 (0.75)	0.00020 (1.05)				
Regular MD		0.0157*** (2.51)	0.0160*** (2.54)	0.0161*** (2.57)	0.0167*** (2.65)	0.0170*** (2.69)	0.0155**	0.015**
Ln (# Bed Nearest Hosp)			-0.0032** (-1.96)					
Ln (Occ Rate Nearest Hosp)				-0.0287*** (-2.89)	-0.0260** (-2.48)	-0.0247** (-2.36)		
Distance to Nearest Hosp > 100 beds					0.00004 (1.49)			
Distance to Nearest Hosp > 200 Beds						0.00005** (2.11)		
Urban Influence Zone								
Urban Core							-0.0062 (-1.24)	
Secondary Urban Core							-0.0040 (-0.36)	
Urban o/s CMA							0.008 (1.06)	
Urban Fringe w/in CMA							-0.0126 (-1.17)	
Rural Fringe w/in CMA							-0.0050 (-0.96)	
Rural o/s CMA							-	
Urban								-0.0025 (-0.49)

Note: all models include the following additional control variables not listed: age, sex, marital status, immigrant status, education, work status, language ability, aboriginal status, self-assessed health status, health limitations, number of chronic conditions, disability status, activity restrictions, injuries, and smoking status.
z-scores in parentheses : *sig ≤ 0.10; ** sig ≤ 0.05; ***sig ≤ 0.01

Table 4: Results of Auxiliary OLS Analyses of Relationship between Distance and Unmet Need, Regular MD, GP Use and Specialist Use

	Has Regular MD	GP Use (yes/no)	Specialist Use (yes/no)	Reported Unmet Need
Summary Statistics	(1)	(2)	(3)	(4)
N	37,534	37,534	37,534	37,534
R^2	0.047	0.075	0.126	0.042
F-stat	13.71 (0.00)	23.90 (0.00)	39.24 (0.00)	6.89 (0.00)
Variable				
Ln(Income)	0.0038 (1.24)	0.007* (1.88)	0.018*** (4.78)	0.0007 (0.38)
Distance to Nearest Hosp	0.0014*** (5.30)	-0.00035 (-0.94)	-0.0011*** (-3.23)	-0.00035** (-2.17)

Note: all models include the following additional control variables not listed: age, sex, marital status, immigrant status, education, work status, language ability, aboriginal status, self-assessed health status, health limitations, number of chronic conditions, disability status, activity restrictions, injures, and smoking status.
T-stats in parentheses; *sig ≤ 0.10; ** sig ≤ 0.05; ***sig ≤ 0.01

Table 5: Average Marginal Effects, Alternative Zero-Truncated Negative Binomial Models, Conditional Nights in Hospital, Ontario, Cda

	1	2	3	4	5	6	7	8
Summary Statistics								
N	3085	3085	3085	3085	3085	3085	3049	3049
R^2								
Pseudo-Likelihood	-8918.4	-8914.1	-8913.9	-8914.0	8914.2	8911.2		
Variable								
Ln(Income)	-0.1882 (-0.53)	-0.2325 (-0.66)	-0.2324 (-0.66)	-0.2331 (-0.66)	-0.2313 (-0.66)	-0.2317 (-0.66)	0.0322 (0.10)	-0.264 (0.20)
Distance to Nearest Hosp	0.0171 (0.45)	0.0142 (0.38)	0.0156 (0.40)	0.0142 (0.38)				
Regular MD		2.109*** (2.53)	2.102*** (2.52)	2.104*** (2.51)	2.117*** (2.53)	2.135*** (2.54)	2.182** (2.52)	2.168** (2.51)
Ln (# Bed Nearest Hosp)			0.0784 (0.27)					
Ln (Occ Rate Nearest Hosp)				0.179 (0.11)	0.182 (0.11)	0.289 (0.18)		
Distance to Nearest Hosp > 100 beds					0.00013 (0.03)			
Distance to Nearest Hosp > 200 Beds						0.0013 (0.26)		
Urban Influence Zone								
Urban Core							0.888 (1.48)	
Secondary Urban Core							-1.807 (-1.03)	
Urban o/s CMA							3.041**	
Urban Fringe							6.498* (1.80)	
Rural w/in CMA							3.354 (1.40)	
Rural o/s CMA							-	
Urban								-0.288 (-0.06)

Note: all models include the following additional control variables not listed: age, sex, marital status, immigrant status, education, work status, language ability, aboriginal status, self-assessed health status, health limitations, number of chronic conditions, disability status, activity restrictions, injuries, and smoking status.
z-scores in parentheses; *sig ≤ 0.10; ** sig ≤ 0.05; ***sig ≤ 0.01

Table 6: Concentration Indices (CI) and Horizontal Inequity Indices (HI) for Hospital Utilization in Ontario

Utilization Measure	Distance Measure	Distance-related Indices	
		$CI_{unadjusted}$	HI
Incidence of Hosptialization	Nearest hosp (all hosp)	-0.0138	0.0015
	Nearest hosp > 100 beds	0.0105	0.0203
	Nearest hosp > 200 beds	0.0574***	0.0510***
Conditional Nights	Nearest hosp (all hosp)	-0.0185	-0.0065
	Nearest hosp > 100 beds	0.0102	0.0143
	Nearest hosp > 200 beds	0.0262	0.0117

*** $p \leq 0.01$

Table 7: Decomposition of Distance and Income-Related Concentration Indices

	Distance-related CIs			
	Incidence of Hospitalization: $Distance_{all}$	*Conditional Nights: $Distance_{all}$*	*Incidence of Hospitalization: $Distance_{200}$*	*Conditional Nights: $Distance_{200}$*
	(1)	(2)	(3)	(4)
CI	-0.0138	-0.0185	0.0574	0.0262
HI	0.0015	-0.0065	0.051	0.0117
Non-Need	***0.0129***	***0.0086***	***0.0315***	***-0.0138***
Income	-0.0001	-0.0008	-0.00003	-0.0137
Distance	0.0086	0.0059	0.0129	-0.0002
Regular MD	0.0021	0.0012	0.0010	0.0027
Occupancy rate	-0.0029	0.0001	0.0058	-0.0000
Marital status	0.0059	-0.0038	0.0128	-0.0047
Education	0.0000	0.0009	-0.0057	0.0056
Immigration	-0.0003	0.0039	-0.0011	0.0068
Work status	-0.0003	0.0007	0.0045	-0.0106
Language	0.0000	0.0014	0.0001	0.0032
Aboriginal	-0.0002	-0.0010	0.0012	-0.0028
Need	***-0.0115***	***-0.0087***	***0.0051***	***-0.0711***
Age and Sex	-0.0053	0.0058	-0.0074	-0.0027
SAH	-0.0044	-0.0109	0.0012	-0.0407
Health limitation	-0.0009	0.0003	0.0039	-0.0180
Smoking	-0.0001	-0.0004	0.0008	-0.0018
Chronic Condition	-0.0012	-0.0006	0.0052	-0.0038
Disability days	-0.0015	-0.0026	0.0002	-0.0047
Injury	0.0019	-0.0001	0.0014	0.0000
Activity restrictions	0.0001	-0.0003	-0.0001	0.0005
Error(CI)	-0.0152	-0.0184	0.0208	0.1111

$Distance_{all}$ signifies that the distance measure used was distance to the nearest hospital of any size;
$Distance_{200}$ signifies that the distance measure used was distance to the nearest hospital with 200 or more beds.

Appendix A: Full Results of Models

(For Review Purposes only. Not intended for publication.)

- **Table A.1: Logistic Regression for Incidence of Hospitalization, Distance to Nearest Hospital of Any Size**

Observation	37719	Log pseudolikelihood	-8267.35
Wald chi2(41)	1164.52	Pseduo R2	0.105
Prob >chi^2	0		

	Coef.	Std.Err.	Z-score
$Distance_{any}$	0.0034	0.0030	1.14
Ln(income)	-0.0059	0.0396	-0.15
Married	0.6893	0.0971	7.10
Widow/Div	0.6414	0.1219	5.26
Secondary	-0.0827	0.1027	-0.81
Some post-second	0.0425	0.1294	0.33
Post secondary	-0.0149	0.0786	-0.19
Immigrant≤10yrs	0.0212	0.1542	0.14
Immigrant 10-30yrs	-0.0361	0.1288	-0.28
Currently working	-0.1573	0.0960	-1.64
Students	-0.5140	0.1538	-3.34
Speak Eng/Frch	0.0261	0.3138	0.08
Aboriginal	0.3158	0.1571	2.01
Age 30-39	-0.9124	0.2062	-4.42
Age 40-49	-0.8902	0.1798	-4.95
Age 50-59	-0.5362	0.1676	-3.20
Age 60-69	-0.1869	0.1749	-1.07
Age 70+	0.0734	0.1815	0.40
Female	0.6458	0.1507	4.29
Female 30-39	0.8686	0.2331	3.73
Female 40-49	-0.2547	0.2446	-1.04
Female 50-59	-0.8530	0.2193	-3.89
Female 60-69	-0.9996	0.2090	-4.78
Female 70+	-0.9312	0.1862	-5.00
SAHS- Very good	-0.2411	0.1027	-2.35
SAHS -Good	0.0088	0.1007	0.09
SAHS-Fair	0.5181	0.1191	4.35
SAHS-Poor	0.9528	0.1517	6.28
Health limit-some	0.3305	0.0907	3.64
Health limit-often	0.5512	0.1049	5.26
Smoke: Current Heavy	0.0099	0.0865	0.11
Smoke: Current Occasional	0.4539	0.2065	2.20
Smoke: Former	0.2843	0.0712	4.00
1 chronic cond.	0.0298	0.1077	0.28
2-3 chronic cond.	0.2444	0.1066	2.29
> 3 chronic cond.	0.5219	0.1216	4.29
1-2 disability days	-0.0995	0.1063	-0.94
≥ 3 disability days	0.5029	0.0872	5.77
Injury	0.3874	0.0788	4.92
Act Restrict-some	-0.0414	0.0884	-0.47
Act Restrict-often	0.0106	0.1017	0.10
Constant	-3.4605	0.5166	-6.70

Table A.2: Logistic Regression for Incidence of Hospitalization, Distance to Nearest Hospital of Any Size

Observation	37719	Log pseudolikelihood	-8262.55
Wald chi2(41)	1161.92	Pseduo R2	0.105
Prob >chi^2	0		

	Coef.	Std.Err.	Z-score
Distance_{any}	0.0032	0.0030	1.07
Ln(income)	-0.0079	0.0395	-0.20
Regular MD	0.2669	0.1163	2.30
Married	0.6923	0.0979	7.07
Widow/Div	0.6496	0.1227	5.29
Secondary	-0.0809	0.1028	-0.79
Some post-second	0.0432	0.1294	0.33
Post secondary	-0.0105	0.0786	-0.13
Immigrant≤10yrs	0.0343	0.1545	0.22
Immigrant 10-30yrs	-0.0392	0.1289	-0.30
Currently working	-0.1607	0.0960	-1.67
Students	-0.5192	0.1536	-3.38
Speak Eng/Frch	0.0334	0.3132	0.11
Aboriginal	0.3332	0.1571	2.12
Age 30-39	-0.9152	0.2067	-4.43
Age 40-49	-0.9074	0.1798	-5.05
Age 50-59	-0.5594	0.1677	-3.34
Age 60-69	-0.2113	0.1749	-1.21
Age 70+	0.0443	0.1810	0.24
Female	0.6363	0.1505	4.23
Female 30-39	0.8605	0.2332	3.69
Female 40-49	-0.2537	0.2446	-1.04
Female 50-59	-0.8428	0.2192	-3.84
Female 60-69	-0.9922	0.2088	-4.75
Female 70+	-0.9215	0.1860	-4.95
SAHS- Very good	-0.2409	0.1026	-2.35
SAHS -Good	0.0098	0.1007	0.10
SAHS-Fair	0.5201	0.1192	4.36
SAHS-Poor	0.9533	0.1517	6.28
Health limit-some	0.3321	0.0907	3.66
Health limit-often	0.5550	0.1049	5.29
Smoke: Current Heavy	0.0225	0.0870	0.26
Smoke: Current Occasional	0.4613	0.2068	2.23
Smoke: Former	0.2903	0.0714	4.07
1 chronic cond.	0.0244	0.1080	0.23
2-3 chronic cond.	0.2350	0.1069	2.20
> 3 chronic cond.	0.5097	0.1221	4.18
1-2 disability days	-0.0989	0.1062	-0.93
≥ 3 disability days	0.5057	0.0872	5.80
Injury	0.3894	0.0789	4.94
Act Restrict-some	-0.0419	0.0883	-0.47
Act Restrict-often	0.0083	0.1017	0.08
Constant	-3.6789	0.5345	-6.88

Table A. 3: Logistic Regression for Incidence of Hospitalization, Distance to Nearest Hospital of Any Size

Observation	37719	Log pseudolikelihood	-8259.17
Wald chi2(41)	1179.16	Pseduo R2	0.106
Prob >chi^2	0		

	Coef.	Std.Err.	Z-score
$Distance_{any}$	0.0023	0.0030	0.75
Ln(income)	-0.0078	0.0396	-0.20
Regular MD	0.2706	0.1164	2.33
Ln(Acute beds)	-0.0493	0.0252	-1.96
Married	0.6868	0.0977	7.03
Widow/Div	0.6484	0.1225	5.29
Secondary	-0.0763	0.1027	-0.74
Some post-second	0.0512	0.1300	0.39
Post secondary	-0.0012	0.0784	-0.02
Immigrant≤10yrs	0.0530	0.1550	0.34
Immigrant 10-30yrs	-0.0281	0.1293	-0.22
Currently working	-0.1587	0.0961	-1.65
Students	-0.5158	0.1536	-3.36
Speak Eng/Frch	0.0321	0.3148	0.10
Aboriginal	0.3284	0.1573	2.09
Age 30-39	-0.9192	0.2064	-4.45
Age 40-49	-0.9129	0.1794	-5.09
Age 50-59	-0.5617	0.1676	-3.35
Age 60-69	-0.2110	0.1749	-1.21
Age 70+	0.0468	0.1810	0.26
Female	0.6339	0.1503	4.22
Female 30-39	0.8650	0.2328	3.72
Female 40-49	-0.2458	0.2438	-1.01
Female 50-59	-0.8409	0.2192	-3.84
Female 60-69	-0.9928	0.2089	-4.75
Female 70+	-0.9199	0.1859	-4.95
SAHS- Very good	-0.2401	0.1028	-2.34
SAHS -Good	0.0090	0.1007	0.09
SAHS-Fair	0.5194	0.1192	4.36
SAHS-Poor	0.9551	0.1519	6.29
Health limit-some	0.3316	0.0909	3.65
Health limit-often	0.5520	0.1050	5.26
Smoke: Current Heavy	0.0189	0.0871	0.22
Smoke: Current Occasional	0.4576	0.2079	2.20
Smoke: Former	0.2890	0.0714	4.05
1 chronic cond.	0.0247	0.1081	0.23
2-3 chronic cond.	0.2373	0.1071	2.22
> 3 chronic cond.	0.5122	0.1223	4.19
1-2 disability days	-0.0989	0.1061	-0.93
≥ 3 disability days	0.5094	0.0875	5.82
Injury	0.3900	0.0789	4.94
Act Restrict-some	-0.0434	0.0884	-0.49
Act Restrict-often	0.0083	0.1017	0.08
Constant	-3.4432	0.5374	-6.41

Table A. 4: Logistic Regression for Incidence of Hospitalization, Distance to Nearest Hospital of Any Size

Observation	37719	Log pseudolikelihood	-8257.69
Wald chi2(41)	1178.64	Pseduo R2	0.106
Prob >chi^2	0		

	Coef.	Std. Err.	Z-score
$Distance_{any}$	0.0031	0.0030	1.05
Ln(income)	-0.0077	0.0396	-0.20
Regular MD	0.2736	0.1165	2.35
Ln(Occupancy Rate)	-0.4471	0.1540	-2.90
Married	0.6887	0.0977	7.05
Widow/Div	0.6468	0.1225	5.28
Secondary	-0.0769	0.1027	-0.75
Some post-second	0.0497	0.1296	0.38
Post secondary	-0.0030	0.0785	-0.04
Immigrant≤10yrs	0.0491	0.1546	0.32
Immigrant 10-30yrs	-0.0321	0.1289	-0.25
Currently working	-0.1588	0.0961	-1.65
Students	-0.5136	0.1535	-3.35
Speak Eng/Frch	0.0308	0.3141	0.10
Aboriginal	0.3236	0.1572	2.06
Age 30-39	-0.9189	0.2067	-4.45
Age 40-49	-0.9088	0.1797	-5.06
Age 50-59	-0.5578	0.1676	-3.33
Age 60-69	-0.2077	0.1747	-1.19
Age 70+	0.0506	0.1810	0.28
Female	0.6363	0.1504	4.23
Female 30-39	0.8645	0.2332	3.71
Female 40-49	-0.2533	0.2445	-1.04
Female 50-59	-0.8447	0.2195	-3.85
Female 60-69	-0.9898	0.2088	-4.74
Female 70+	-0.9218	0.1859	-4.96
SAHS- Very good	-0.2397	0.1027	-2.33
SAHS -Good	0.0096	0.1007	0.10
SAHS-Fair	0.5202	0.1192	4.36
SAHS-Poor	0.9560	0.1518	6.30
Health limit-some	0.3331	0.0908	3.67
Health limit-often	0.5540	0.1049	5.28
Smoke: Current Heavy	0.0204	0.0870	0.23
Smoke: Current Occasional	0.4576	0.2067	2.21
Smoke: Former	0.2889	0.0714	4.05
1 chronic cond.	0.0237	0.1080	0.22
2-3 chronic cond.	0.2352	0.1069	2.20
> 3 chronic cond.	0.5130	0.1220	4.21
1-2 disability days	-0.1007	0.1062	-0.95
≥ 3 disability days	0.5082	0.0873	5.82
Injury	0.3909	0.0789	4.95
Act Restrict-some	-0.0432	0.0884	-0.49
Act Restrict-often	0.0074	0.1018	0.07
Constant	-1.7180	0.8468	-2.03

Table A.5: Logistic Regression for Incidence of Hospitalization, Distance to Hospital ≥100 beds

Observation	37719	Log pseudolikelihood	-8257.53
Wald chi2(41)	1182.08	Pseduo R2	0.106
Prob >chi^2	0		

	Coef.	Std.Err.	Z-score
$Distance_{100}$	0.0007	0.0005	1.49
Ln(income)	-0.0076	0.0396	-0.19
Regular MD	0.2822	0.1168	2.42
Ln(Occupancy Rate)	-0.4041	0.1622	-2.49
Married	0.6883	0.0976	7.05
Widow/Div	0.6448	0.1225	5.26
Secondary	-0.0765	0.1027	-0.74
Some post-second	0.0507	0.1296	0.39
Post secondary	-0.0030	0.0785	-0.04
Immigrant≤10yrs	0.0487	0.1547	0.31
Immigrant 10-30yrs	-0.0316	0.1287	-0.25
Currently working	-0.1582	0.0961	-1.65
Students	-0.5136	0.1536	-3.34
Speak Eng/Frch	0.0301	0.3140	0.1
Aboriginal	0.3132	0.1579	1.98
Age 30-39	-0.9171	0.2066	-4.44
Age 40-49	-0.9076	0.1798	-5.05
Age 50-59	-0.5566	0.1676	-3.32
Age 60-69	-0.2069	0.1747	-1.18
Age 70+	0.0498	0.1809	0.28
Female	0.6364	0.1505	4.23
Female 30-39	0.8625	0.2332	3.7
Female 40-49	-0.2530	0.2447	-1.03
Female 50-59	-0.8454	0.2196	-3.85
Female 60-69	-0.9912	0.2090	-4.74
Female 70+	-0.9210	0.1860	-4.95
SAHS- Very good	-0.2404	0.1026	-2.34
SAHS -Good	0.0090	0.1007	0.09
SAHS-Fair	0.5184	0.1192	4.35
SAHS-Poor	0.9546	0.1518	6.29
Health limit-some	0.3340	0.0908	3.68
Health limit-often	0.5551	0.1049	5.29
Smoke: Current Heavy	0.0186	0.0870	0.21
Smoke: Current Occasional	0.4572	0.2068	2.21
Smoke: Former	0.2887	0.0714	4.05
1 chronic cond.	0.0232	0.1079	0.21
2-3 chronic cond.	0.2346	0.1069	2.19
> 3 chronic cond.	0.5122	0.1220	4.2
1-2 disability days	-0.1009	0.1062	-0.95
≥ 3 disability days	0.5076	0.0873	5.81
Injury	0.3913	0.0789	4.96
Act Restrict-some	-0.0448	0.0883	-0.51
Act Restrict-often	0.0070	0.1018	0.07
Constant	-1.9067	0.8822	-2.16

Table A.6: Logistic Regression for Incidence of Hospitalization, Distance to Hospital ≥200 beds

Observation	37719	Log pseudolikelihood	-8256.47
Wald chi2(41)	1183.42	Pseduo R2	0.106
Prob >chi^2	0		

	Coef.	Std. Err.	Z-score
$Distance_{200}$	0.0008	0.0004	2.1
Ln(income)	-0.0066	0.0398	-0.16
Regular MD	0.2862	0.1167	2.45
Ln(Occupancy Rate)	-0.3817	0.1614	-2.37
Married	0.6845	0.0977	7.01
Widow/Div	0.6420	0.1225	5.24
Secondary	-0.0757	0.1027	-0.74
Some post-second	0.0524	0.1295	0.4
Post secondary	-0.0006	0.0784	-0.01
Immigrant≤10yrs	0.0577	0.1553	0.37
Immigrant 10-30yrs	-0.0234	0.1292	-0.18
Currently working	-0.1547	0.0961	-1.61
Students	-0.5106	0.1536	-3.32
Speak Eng/Frch	0.0262	0.3139	0.08
Aboriginal	0.3044	0.1580	1.93
Age 30-39	-0.9145	0.2067	-4.43
Age 40-49	-0.9068	0.1798	-5.04
Age 50-59	-0.5563	0.1677	-3.32
Age 60-69	-0.2042	0.1748	-1.17
Age 70+	0.0538	0.1810	0.3
Female	0.6364	0.1506	4.23
Female 30-39	0.8610	0.2333	3.69
Female 40-49	-0.2533	0.2447	-1.03
Female 50-59	-0.8438	0.2196	-3.84
Female 60-69	-0.9897	0.2089	-4.74
Female 70+	-0.9207	0.1860	-4.95
SAHS- Very good	-0.2407	0.1026	-2.35
SAHS -Good	0.0086	0.1007	0.09
SAHS-Fair	0.5182	0.1192	4.35
SAHS-Poor	0.9545	0.1518	6.29
Health limit-some	0.3352	0.0908	3.69
Health limit-often	0.5552	0.1049	5.29
Smoke: Current Heavy	0.0167	0.0870	0.19
Smoke: Current Occasional	0.4577	0.2069	2.21
Smoke: Former	0.2881	0.0714	4.04
1 chronic cond.	0.0227	0.1079	0.21
2-3 chronic cond.	0.2340	0.1069	2.19
> 3 chronic cond.	0.5109	0.1220	4.19
1-2 disability days	-0.1006	0.1062	-0.95
≥ 3 disability days	0.5065	0.0873	5.8
Injury	0.3928	0.0789	4.98
Act Restrict-some	-0.0451	0.0883	-0.51
Act Restrict-often	0.0060	0.1018	0.06
Constant	-2.0295	0.8849	-2.29

Table A.7: Logistic Regression of Incidence of Hospitalization , 6-Category Urban Influence Zones

Observation	37272	Log pseudolikelihood	-8140.88
Wald chi2(76)	1177.78	Pseduo R2	0.11
Prob >chi^2	0		

	Coef.	Std. Err.	Z-score
Ln(income)	-0.0038	0.0395	-0.1
Urban Core	-0.0955	0.0826	-1.16
Urban Fringe	-0.2109	0.1749	-1.21
Secondary Urban Core	-0.0675	0.1680	-0.4
rural Finge	-0.0845	0.1160	-0.73
Urban o/s CMA	0.1209	0.1057	1.14
Regular MD	0.2615	0.1172	2.23
Married	0.6889	0.0984	7.00
Widow/Div	0.6363	0.1229	5.18
Secondary	-0.0942	0.1027	-0.92
Some post-second	0.0535	0.1303	0.41
Post secondary	0.0112	0.0789	0.14
Immigrant≤10yrs	0.0373	0.1573	0.24
Immigrant>10yrs	-0.0597	0.1330	-0.45
Currently working	-0.1762	0.0967	-1.82
Students	-0.5028	0.1550	-3.24
Speak Eng/Frch	-0.0037	0.3128	-0.01
Aboriginal	0.3117	0.1589	1.96
Age 30-39	-0.8895	0.2091	-4.25
Age 40-49	-0.8893	0.1817	-4.89
Age 50-59	-0.5262	0.1692	-3.11
Age 60-69	-0.1853	0.1769	-1.05
Age 70+	0.0542	0.1832	0.3
Female	0.6475	0.1519	4.26
Female 30-39	0.8475	0.2359	3.59
Female 40-49	-0.2862	0.2481	-1.15
Female 50-59	-0.8570	0.2207	-3.88
Female 60-69	-1.0094	0.2103	-4.8
Female 70+	-0.9115	0.1873	-4.87
SAHS- Very good	-0.2384	0.1035	-2.3
SAHS -Good	0.0284	0.1015	0.28
SAHS-Fair	0.5524	0.1201	4.6
SAHS-Poor	0.9748	0.1533	6.36
Health limit-some	0.3171	0.0919	3.45
Health limit-often	0.5431	0.1055	5.15
Heavy	0.0237	0.0872	0.27
Occasional	0.4401	0.2102	2.09
Former	0.2956	0.0722	4.1
1 chronic cond.	0.0160	0.1088	0.15
2-3 chronic cond.	0.2381	0.1082	2.2
> chronic cond.	0.5122	0.1231	4.16
2 disability days	-0.0839	0.1070	-0.78
>3 disability days	0.5138	0.0881	5.83
Injury	0.3991	0.0794	5.02
Act Restrict-some	-0.0534	0.0890	-0.6
Act Restrict-often	-0.0108	0.1027	-0.11
Constant	-3.6078	0.5336	-6.76

Table A.8: Logistic Regression of Incidence of Hospitalization – Dichotomous Urban/Rural

Observation	37272	Log pseudolikelihood	-8144.63
Wald chi2(76)	1157.34	Pseduo R2	0.11
Prob >chi^2	0		

	Coef.	Std. Err.	Z-score
Ln(income)	-0.0048	0.0394	-0.12
Urban Core	-0.0383	0.0676	-0.57
Regular MD	0.2524	0.1168	2.16
Married	0.6933	0.0986	7.03
Widow/Div	0.6393	0.1231	5.19
Secondary	-0.0969	0.1027	-0.94
Some post-second	0.0519	0.1303	0.4
Post secondary	0.0052	0.0788	0.07
Immigrant≤10yrs	0.0250	0.1564	0.16
Immigrant>10yrs	-0.0712	0.1319	-0.54
Currently working	-0.1782	0.0966	-1.85
Students	-0.5073	0.1550	-3.27
Speak Eng/Frch	0.0029	0.3130	0.01
Aboriginal	0.3218	0.1587	2.03
Age 30-39	-0.8904	0.2089	-4.26
Age 40-49	-0.8897	0.1814	-4.9
Age 50-59	-0.5249	0.1691	-3.1
Age 60-69	-0.1873	0.1769	-1.06
Age 70+	0.0521	0.1831	0.28
Female	0.6488	0.1519	4.27
Female 30-39	0.8465	0.2359	3.59
Female 40-49	-0.2882	0.2481	-1.16
Female 50-59	-0.8590	0.2207	-3.89
Female 60-69	-1.0078	0.2103	-4.79
Female 70+	-0.9113	0.1873	-4.86
SAHS- Very good	-0.2377	0.1035	-2.3
SAHS -Good	0.0289	0.1014	0.29
SAHS-Fair	0.5505	0.1201	4.58
SAHS-Poor	0.9726	0.1531	6.35
Health limit-some	0.3169	0.0918	3.45
Health limit-often	0.5426	0.1054	5.15
Heavy	0.0268	0.0872	0.31
Occasional	0.4381	0.2099	2.09
Former	0.2971	0.0722	4.11
1 chronic cond.	0.0175	0.1088	0.16
2-3 chronic cond.	0.2397	0.1081	2.22
> chronic cond.	0.5138	0.1230	4.18
2 disability days	-0.0861	0.1071	-0.8
>3 disability days	0.5131	0.0880	5.83
Injury	0.3987	0.0794	5.02
Act Restrict-some	-0.0516	0.0890	-0.58
Act Restrict-often	-0.0079	0.1026	-0.08
Constant	-3.6389	0.5292	-6.88

Table A.9: ZTNB Regression for conditional # of Hospitalization, Distance to Nearest Hospital of Any Size

Observation	3085	Log likelihood	-8918.41
Wald chi2(41)	737.24	Prob >chi^2	0

	Coef.	Std. Err.	Z-score
$Distance_{any}$	0.0019	0.0041	0.45
Ln(income)	-0.0204	0.0386	-0.53
Married	-0.1756	0.1052	-1.67
Widow/Div	-0.0740	0.1336	-0.55
Secondary	0.1999	0.1144	1.75
Some post-second	-0.1532	0.1295	-1.18
Post secondary	0.0703	0.0864	0.81
Immigrant≤10yrs	-0.4326	0.1232	-3.51
Immigrant 10-30yrs	-0.0071	0.1607	-0.04
Currently working	-0.0982	0.0985	-1
Students	-0.4797	0.1447	-3.32
Speak Eng/Frch	0.4283	0.2737	1.56
Aboriginal	0.1826	0.1653	1.11
Age 30-39	-0.2550	0.2175	-1.17
Age 40-49	0.2367	0.2664	0.89
Age 50-59	0.4091	0.2889	1.42
Age 60-69	0.3095	0.2382	1.3
Age 70+	0.5491	0.2431	2.26
Female	-0.1852	0.1914	-0.97
Female 30-39	0.3151	0.2454	1.28
Female 40-49	0.0505	0.3056	0.17
Female 50-59	0.1421	0.3339	0.43
Female 60-69	-0.2080	0.2449	-0.85
Female 70+	-0.1044	0.2331	-0.45
SAHS- Very good	0.1123	0.1007	1.11
SAHS -Good	0.3404	0.1095	3.11
SAHS-Fair	0.6840	0.1614	4.24
SAHS-Poor	0.7237	0.1643	4.41
Health limit-some	0.2301	0.1187	1.94
Health limit-often	0.5151	0.1546	3.33
Smoke: Current Heavy	-0.2629	0.1277	-2.06
Smoke: Current Occasional	-0.5036	0.1489	-3.38
Smoke: Former	-0.1236	0.0878	-1.41
1 chronic cond.	0.1861	0.1084	1.72
2-3 chronic cond.	0.3708	0.1060	3.5
> 3 chronic cond.	0.2841	0.1299	2.19
1-2 disability days	0.1280	0.1725	0.74
≥ 3 disability days	0.3075	0.1136	2.71
Injury	-0.0079	0.0895	-0.09
Act Restrict-some	-0.2191	0.1214	-1.81
Act Restrict-often	0.0470	0.1525	0.31
Constant	0.9890	0.5310	1.86

Table A.10: ZTNB Regression for conditional # of Hospital Nights, Distance to Nearest Hospital of Any Size

Observation	3085	Log likelihood	-8914.07
Wald chi2(41)	739.21	Prob >chi^2	0

	Coef.	Std. Err.	Z-score
$Distance_{any}$	0.0015	0.0041	0.38
Ln(income)	-0.0253	0.0385	-0.66
Regular MD	0.2560	0.1108	2.31
Married	-0.1707	0.1042	-1.64
Widow/Div	-0.0614	0.1323	-0.46
Secondary	0.1989	0.1138	1.75
Some post-second	-0.1424	0.1298	-1.1
Post secondary	0.0716	0.0857	0.84
Immigrant≤10yrs	-0.4338	0.1217	-3.56
Immigrant 10-30yrs	-0.0084	0.1602	-0.05
Currently working	-0.1036	0.0978	-1.06
Students	-0.4946	0.1432	-3.45
Speak Eng/Frch	0.4361	0.2730	1.6
Aboriginal	0.2137	0.1657	1.29
Age 30-39	-0.2632	0.2133	-1.23
Age 40-49	0.2254	0.2636	0.86
Age 50-59	0.3963	0.2867	1.38
Age 60-69	0.2906	0.2349	1.24
Age 70+	0.5297	0.2418	2.19
Female	-0.1928	0.1882	-1.02
Female 30-39	0.3134	0.2406	1.3
Female 40-49	0.0482	0.3023	0.16
Female 50-59	0.1421	0.3312	0.43
Female 60-69	-0.2097	0.2415	-0.87
Female 70+	-0.0989	0.2316	-0.43
SAHS- Very good	0.1163	0.1001	1.16
SAHS -Good	0.3424	0.1086	3.15
SAHS-Fair	0.6791	0.1604	4.23
SAHS-Poor	0.7253	0.1635	4.44
Health limit-some	0.2252	0.1180	1.91
Health limit-often	0.5056	0.1544	3.27
Smoke: Current Heavy	-0.2526	0.1272	-1.99
Smoke: Current Occasional	-0.4987	0.1478	-3.37
Smoke: Former	-0.1223	0.0872	-1.4
1 chronic cond.	0.1726	0.1081	1.6
2-3 chronic cond.	0.3604	0.1055	3.42
> 3 chronic cond.	0.2674	0.1295	2.07
1-2 disability days	0.1417	0.1726	0.82
≥ 3 disability days	0.3153	0.1132	2.79
Injury	-0.0092	0.0889	-0.1
Act Restrict-some	-0.2135	0.1205	-1.77
Act Restrict-often	0.0555	0.1522	0.36
Constant	0.8087	0.5304	1.52

Table A.11: ZTNB Regression for conditional # of Hospital Nights, Distance to Nearest Hospital of Any Size

Observation	3085	Log likelihood	-8913.95
Wald chi2(41)	741.51	Prob >chi^2	0

	Coef.	Std. Err.	Z-score
$Distance_{any}$	0.0017	0.0042	0.4
Ln(income)	-0.0253	0.0385	-0.66
Regular MD	0.2557	0.1108	2.31
Ln(Acute beds)	0.0085	0.0312	0.27
Married	-0.1682	0.1049	-1.6
Widow/Div	-0.0582	0.1328	-0.44
Secondary	0.1986	0.1140	1.74
Some post-second	-0.1434	0.1296	-1.11
Post secondary	0.0699	0.0857	0.82
Immigrant≤10yrs	-0.4379	0.1230	-3.56
Immigrant 10-30yrs	-0.0090	0.1611	-0.06
Currently working	-0.1025	0.0973	-1.05
Students	-0.4957	0.1430	-3.47
Speak Eng/Frch	0.4406	0.2729	1.61
Aboriginal	0.2140	0.1659	1.29
Age 30-39	-0.2643	0.2136	-1.24
Age 40-49	0.2274	0.2642	0.86
Age 50-59	0.3909	0.2838	1.38
Age 60-69	0.2853	0.2353	1.21
Age 70+	0.5256	0.2417	2.17
Female	-0.1938	0.1884	-1.03
Female 30-39	0.3127	0.2409	1.3
Female 40-49	0.0429	0.3020	0.14
Female 50-59	0.1481	0.3260	0.45
Female 60-69	-0.2067	0.2411	-0.86
Female 70+	-0.0973	0.2312	-0.42
SAHS- Very good	0.1168	0.1000	1.17
SAHS -Good	0.3435	0.1085	3.17
SAHS-Fair	0.6804	0.1605	4.24
SAHS-Poor	0.7257	0.1633	4.44
Health limit-some	0.2266	0.1171	1.93
Health limit-often	0.5039	0.1532	3.29
Smoke: Current Heavy	-0.2513	0.1271	-1.98
Smoke: Current Occasional	-0.4996	0.1477	-3.38
Smoke: Former	-0.1222	0.0871	-1.4
1 chronic cond.	0.1720	0.1078	1.6
2-3 chronic cond.	0.3607	0.1054	3.42
> 3 chronic cond.	0.2663	0.1290	2.06
1-2 disability days	0.1385	0.1698	0.82
≥ 3 disability days	0.3153	0.1132	2.79
Injury	-0.0089	0.0889	-0.1
Act Restrict-some	-0.2130	0.1203	-1.77
Act Restrict-often	0.0580	0.1494	0.39
Constant	0.7634	0.5533	1.38

Table A.12: ZTNB Regression for conditional # of Hospital Nights, Distance to Nearest Hospital of Any Size

Observation	3085	Log likelihood	-8914.05
Wald chi2(41)	739.29	Prob >chi^2	0

	Coef.	Std. Err.	Z-score
$Distance_{any}$	0.0015	0.0041	0.38
Ln(income)	-0.0254	0.0385	-0.66
Regular MD	0.2555	0.1113	2.3
Ln(Occupancy rate)	0.0195	0.1713	0.11
Married	-0.1700	0.1044	-1.63
Widow/Div	-0.0602	0.1316	-0.46
Secondary	0.1985	0.1141	1.74
Some post-second	-0.1428	0.1300	-1.1
Post secondary	0.0710	0.0855	0.83
Immigrant≤10yrs	-0.4343	0.1217	-3.57
Immigrant 10-30yrs	-0.0088	0.1600	-0.06
Currently working	-0.1033	0.0980	-1.05
Students	-0.4945	0.1432	-3.45
Speak Eng/Frch	0.4369	0.2733	1.6
Aboriginal	0.2149	0.1647	1.3
Age 30-39	-0.2631	0.2133	-1.23
Age 40-49	0.2252	0.2636	0.85
Age 50-59	0.3960	0.2870	1.38
Age 60-69	0.2905	0.2349	1.24
Age 70+	0.5294	0.2417	2.19
Female	-0.1926	0.1882	-1.02
Female 30-39	0.3124	0.2399	1.3
Female 40-49	0.0487	0.3023	0.16
Female 50-59	0.1423	0.3314	0.43
Female 60-69	-0.2104	0.2415	-0.87
Female 70+	-0.0991	0.2315	-0.43
SAHS- Very good	0.1163	0.1001	1.16
SAHS -Good	0.3426	0.1084	3.16
SAHS-Fair	0.6793	0.1604	4.24
SAHS-Poor	0.7253	0.1635	4.44
Health limit-some	0.2250	0.1179	1.91
Health limit-often	0.5059	0.1543	3.28
Smoke: Current Heavy	-0.2527	0.1269	-1.99
Smoke: Current Occasional	-0.4987	0.1479	-3.37
Smoke: Former	-0.1226	0.0869	-1.41
1 chronic cond.	0.1727	0.1078	1.6
2-3 chronic cond.	0.3603	0.1054	3.42
> 3 chronic cond.	0.2669	0.1288	2.07
1-2 disability days	0.1412	0.1722	0.82
≥ 3 disability days	0.3150	0.1136	2.77
Injury	-0.0091	0.0889	-0.1
Act Restrict-some	-0.2135	0.1205	-1.77
Act Restrict-often	0.0550	0.1522	0.36
Constant	0.7235	0.9409	0.77

Table A.13: ZTNB Regression for conditional # of Hospital Nights, Distance to Nearest Hospital ≥ 100 beds

Observation	3085	Log likelihood	-8914.23
Wald chi2(41)	706.81	Prob >chi^2	0

	Coef.	Std. Err.	Z-score
$Distance_{100}$	0.0000	0.0005	0.03
Ln(income)	-0.0252	0.0385	-0.65
Regular MD	0.2577	0.1116	2.31
Occupancy rate	0.0199	0.1735	0.11
Married	-0.1685	0.1045	-1.61
Widow/Div	-0.0609	0.1316	-0.46
Secondary	0.1949	0.1152	1.69
Some post-second	-0.1443	0.1305	-1.11
Post secondary	0.0687	0.0856	0.8
Immigrant≤10yrs	-0.4382	0.1211	-3.62
Immigrant 10-30yrs	-0.0110	0.1601	-0.07
Currently working	-0.1046	0.0980	-1.07
Students	-0.4956	0.1428	-3.47
Speak Eng/Frch	0.4331	0.2728	1.59
Aboriginal	0.2120	0.1649	1.29
Age 30-39	-0.2638	0.2134	-1.24
Age 40-49	0.2243	0.2633	0.85
Age 50-59	0.4007	0.2890	1.39
Age 60-69	0.2917	0.2346	1.24
Age 70+	0.5273	0.2416	2.18
Female	-0.1922	0.1885	-1.02
Female 30-39	0.3123	0.2399	1.3
Female 40-49	0.0501	0.3019	0.17
Female 50-59	0.1372	0.3328	0.41
Female 60-69	-0.2116	0.2411	-0.88
Female 70+	-0.0990	0.2318	-0.43
SAHS- Very good	0.1192	0.1014	1.18
SAHS -Good	0.3436	0.1085	3.17
SAHS-Fair	0.6787	0.1601	4.24
SAHS-Poor	0.7253	0.1632	4.44
Health limit-some	0.2249	0.1177	1.91
Health limit-often	0.5048	0.1548	3.26
Smoke: Current Heavy	-0.2513	0.1274	-1.97
Smoke: Current Occasional	-0.4988	0.1477	-3.38
Smoke: Former	-0.1229	0.0869	-1.42
1 chronic cond.	0.1731	0.1082	1.6
2-3 chronic cond.	0.3583	0.1075	3.33
> 3 chronic cond.	0.2661	0.1296	2.05
1-2 disability days	0.1426	0.1738	0.82
≥ 3 disability days	0.3145	0.1134	2.77
Injury	-0.0081	0.0891	-0.09
Act Restrict-some	-0.2134	0.1204	-1.77
Act Restrict-often	0.0564	0.1519	0.37
Constant	0.7333	0.9449	0.78

Table A.14: ZTNB Regression for conditional # of Hospital Nights, Distance to Nearest Hospital ≥ 200 beds

Observation	3085	Log likelihood	-8914.17
Wald chi2(41)	701.28	Prob >chi^2	0

	Coef.	Std. Err.	Z-score
$Distance_{100}$	0.0001	0.0006	0.26
Ln(income)	-0.0252	0.0385	-0.65
Regular MD	0.2595	0.1118	2.32
Ln(Occupancy rate)	0.0315	0.1758	0.18
Married	-0.1698	0.1045	-1.62
Widow/Div	-0.0615	0.1316	-0.47
Secondary	0.1966	0.1146	1.71
Some post-second	-0.1425	0.1300	-1.1
Post secondary	0.0705	0.0841	0.84
Immigrant≤10yrs	-0.4357	0.1215	-3.59
Immigrant 10-30yrs	-0.0087	0.1601	-0.05
Currently working	-0.1033	0.0981	-1.05
Students	-0.4945	0.1429	-3.46
Speak Eng/Frch	0.4335	0.2725	1.59
Aboriginal	0.2103	0.1654	1.27
Age 30-39	-0.2639	0.2132	-1.24
Age 40-49	0.2240	0.2634	0.85
Age 50-59	0.4013	0.2890	1.39
Age 60-69	0.2924	0.2346	1.25
Age 70+	0.5279	0.2416	2.18
Female	-0.1924	0.1884	-1.02
Female 30-39	0.3125	0.2397	1.3
Female 40-49	0.0511	0.3020	0.17
Female 50-59	0.1372	0.3330	0.41
Female 60-69	-0.2119	0.2413	-0.88
Female 70+	-0.0989	0.2319	-0.43
SAHS- Very good	0.1183	0.1015	1.17
SAHS -Good	0.3431	0.1086	3.16
SAHS-Fair	0.6788	0.1603	4.24
SAHS-Poor	0.7249	0.1633	4.44
Health limit-some	0.2242	0.1176	1.91
Health limit-often	0.5044	0.1550	3.25
Smoke: Current Heavy	-0.2531	0.1276	-1.98
Smoke: Current Occasional	-0.4987	0.1478	-3.37
Smoke: Former	-0.1233	0.0870	-1.42
1 chronic cond.	0.1726	0.1082	1.59
2-3 chronic cond.	0.3572	0.1078	3.31
> 3 chronic cond.	0.2658	0.1298	2.05
1-2 disability days	0.1431	0.1738	0.82
≥ 3 disability days	0.3138	0.1135	2.77
Injury	-0.0075	0.0893	-0.08
Act Restrict-some	-0.2127	0.1206	-1.76
Act Restrict-often	0.0566	0.1522	0.37
Constant	0.6760	0.9548	0.71

Table A.15: ZTNB Regression of conditional # of Hospital Nights, 6-Category Urban Influence Zones

Observation	3049	Log likelihood	-8819.65
Wald chi2(76)	738.97	Prob >chi^2	0

	Coef.	Std. Err.	Z-score
Ln(income)	-0.0347	0.0394	-0.88
Urban Core	0.0965	0.0945	1.02
Urban Fringe	0.5386	0.2418	2.23
Secondary Urban Core	-0.2161	0.1724	-1.25
rural Finge	0.3152	0.1650	1.91
Urban o/s CMA	0.2940	0.1280	2.3
Regular MD	0.2639	0.1136	2.32
Married	-0.2072	0.1061	-1.95
Widow/Div	-0.0777	0.1343	-0.58
Secondary	0.2158	0.1128	1.91
Some post-second	-0.1447	0.1293	-1.12
Post secondary	0.0815	0.0844	0.97
Immigrant≤10yrs	-0.4112	0.1235	-3.33
Immigrant>10yrs	0.0172	0.1661	0.1
Currently working	-0.0844	0.0979	-0.86
Students	-0.5069	0.1372	-3.69
Speak Eng/Frch	0.4097	0.2745	1.49
Aboriginal	0.1805	0.1598	1.13
Age 30-39	-0.2842	0.2115	-1.34
Age 40-49	0.1969	0.2525	0.78
Age 50-59	0.3584	0.2647	1.35
Age 60-69	0.3074	0.2319	1.33
Age 70+	0.5383	0.2390	2.25
Female	-0.2125	0.1837	-1.16
Female 30-39	0.3575	0.2397	1.49
Female 40-49	0.0797	0.2916	0.27
Female 50-59	0.1955	0.3069	0.64
Female 60-69	-0.2272	0.2385	-0.95
Female 70+	-0.0742	0.2281	-0.33
SAHS- Very good	0.1033	0.1016	1.02
SAHS -Good	0.3193	0.1080	2.96
SAHS-Fair	0.6305	0.1494	4.22
SAHS-Poor	0.6842	0.1660	4.12
Health limit-some	0.2561	0.1162	2.2
Health limit-often	0.5295	0.1550	3.42
Heavy	-0.2602	0.1239	-2.1
Occasional	-0.4893	0.1479	-3.31
Former	-0.1273	0.0833	-1.53
1 chronic cond.	0.1822	0.1048	1.74
2-3 chronic cond.	0.3713	0.1016	3.65
> chronic cond.	0.2864	0.1258	2.28
2 disability days	0.1278	0.1669	0.77
>3 disability days	0.3225	0.1101	2.93
Injury	-0.0448	0.0843	-0.53
Act Restrict-some	-0.2323	0.1222	-1.9
Act Restrict-often	0.0303	0.1544	0.2
Constant	0.8365	0.5403	1.55

Table A.16: ZTNB Regression of conditional # of Hospital Nights, Dichotomous Urban/Rural

Observation	3049	Log likelihood	-8838.03
Wald chi2(76)	673.31	Prob >chi^2	0.00

	Coef.	Std. Err.	Z-score
Ln(income)	-0.0286	0.0393	-0.73
Urban Core	-0.0309	0.0925	-0.33
Regular MD	0.2595	0.1118	2.32
Married	-0.1715	0.1056	-1.62
Widow/Div	-0.0562	0.1331	-0.42
Secondary	0.2078	0.1154	1.8
Some post-second	-0.1493	0.1324	-1.13
Post secondary	0.0649	0.0867	0.75
Immigrant≤10yrs	-0.4332	0.1220	-3.55
Immigrant>10yrs	0.0123	0.1650	0.07
Currently working	-0.0909	0.0978	-0.93
Students	-0.4915	0.1434	-3.43
Speak Eng/Frch	0.4418	0.2714	1.63
Aboriginal	0.1990	0.1707	1.17
Age 30-39	-0.2709	0.2161	-1.25
Age 40-49	0.2219	0.2634	0.84
Age 50-59	0.3773	0.2808	1.34
Age 60-69	0.2799	0.2349	1.19
Age 70+	0.5195	0.2422	2.15
Female	-0.2123	0.1902	-1.12
Female 30-39	0.3282	0.2434	1.35
Female 40-49	0.0585	0.3041	0.19
Female 50-59	0.1665	0.3227	0.52
Female 60-69	-0.2127	0.2418	-0.88
Female 70+	-0.0796	0.2333	-0.34
SAHS- Very good	0.1206	0.1032	1.17
SAHS -Good	0.3381	0.1095	3.09
SAHS-Fair	0.6699	0.1586	4.22
SAHS-Poor	0.7011	0.1653	4.24
Health limit-some	0.2371	0.1185	2
Health limit-often	0.5236	0.1551	3.38
Heavy	-0.2495	0.1282	-1.95
Occasional	-0.4758	0.1483	-3.21
Former	-0.1191	0.0867	-1.37
1 chronic cond.	0.1802	0.1095	1.65
2-3 chronic cond.	0.3547	0.1072	3.31
> chronic cond.	0.2630	0.1297	2.03
2 disability days	0.1457	0.1756	0.83
>3 disability days	0.3085	0.1134	2.72
Injury	-0.0165	0.0892	-0.18
Act Restrict-some	-0.2195	0.1215	-1.81
Act Restrict-often	0.0460	0.1529	0.3
Constant	0.8844	0.5379	1.64

Table A.17: Logistic Regression for Incidence of Unmet Need, Distance to Nearest Hospital of Any Size

Observation	37534	Log pseudolikelihood	-6329.86
Wald chi2(77)	834.65	Pseduo R2	0.109
Prob >chi^2	0		

	Coef.	Std. Err.	Z-score
$Distance_{anv}$	-0.0058	0.0040	-1.45
Ln(income)	0.0354	0.0477	0.74
Regular MD	-1.0141	0.1010	-10.04
Married	0.1262	0.1013	1.25
Widow/Div	-0.0326	0.1354	-0.24
Secondary	0.4602	0.1374	3.35
Some post-second	0.6385	0.1744	3.66
Post secondary	0.7146	0.1127	6.34
Immigrant≤10yrs	0.4278	0.1740	2.46
IImmigrant 10-30yrs	0.2267	0.1524	1.49
Currently working	-0.0553	0.1252	-0.44
Students	0.0531	0.1723	0.31
Speak Eng/Frch	-0.1403	0.3277	-0.43
Aboriginal	-0.0621	0.1892	-0.33
Age 30-39	-0.0577	0.1806	-0.32
Age 40-49	-0.1462	0.1870	-0.78
Age 50-59	-0.3373	0.2145	-1.57
Age 60-69	-0.4416	0.2204	-2
Age 70+	-0.5886	0.2410	-2.44
Female	0.2486	0.1677	1.48
Female 30-39	0.0317	0.2206	0.14
Female 40-49	0.3126	0.2342	1.33
Female 50-59	0.0320	0.2571	0.12
Female 60-69	0.1313	0.2604	0.5
Female 70+	-0.5290	0.2640	-2
SAHS- Very good	0.3336	0.1256	2.66
SAHS -Good	0.2817	0.1348	2.09
SAHS-Fair	0.5002	0.1601	3.12
SAHS-Poor	0.6161	0.2110	2.92
Health limit-some	0.2882	0.1129	2.55
Health limit-often	0.6813	0.1413	4.82
Smoke: Current Heavy	0.2570	0.1027	2.5
Smoke: Current Occasional	0.6144	0.1729	3.55
Smoke: Former	0.1173	0.0943	1.24
1 chronic cond.	0.6032	0.1352	4.46
2-3 chronic cond.	0.7903	0.1369	5.77
> 3 chronic cond.	0.9689	0.1595	6.07
1-2 disability days	0.4142	0.1221	3.39
≥ 3 disability days	0.7275	0.1079	6.75
Injury	0.3804	0.0985	3.86
Act Restrict-some	0.2951	0.1122	2.63
Act Restrict-often	0.1285	0.1323	0.97
Constant	-4.6971	0.6124	-7.67
Health Region	Controlled		

Table A.18: Logistic Regression for Having a Regular Medical Doctor, Distance to Nearest Hospital of Any Size

Observation	37534	Log pseudolikelihood	-10381.02
Wald chi2(76)	1156.70	Pseduo R2	0.08
Prob >chi^2	0		

	Coef.	Std. Err.	Z-score
$Distance_{any}$	0.0180	0.0042	4.27
Ln(income)	0.0428	0.0358	1.19
Married	0.1977	0.0863	2.29
Widow/Div	-0.1703	0.1115	-1.53
Secondary	-0.3162	0.0933	-3.39
Some post-second	-0.2299	0.1182	-1.95
Post secondary	-0.4451	0.0788	-5.65
Immigrant≤10yrs	-0.6036	0.1063	-5.68
Immigrant 10-30yrs	0.0846	0.1184	0.71
Currently working	0.1769	0.1019	1.73
Students	0.3464	0.1236	2.8
Speak Eng/Frch	0.1157	0.2873	0.4
Aboriginal	-0.4180	0.1435	-2.91
Age 30-39	-0.1421	0.1133	-1.25
Age 40-49	0.3559	0.1248	2.85
Age 50-59	0.8969	0.1486	6.04
Age 60-69	0.9641	0.1930	5
Age 70+	1.1847	0.2038	5.81
Female	0.3334	0.0952	3.5
Female 30-39	0.5862	0.1448	4.05
Female 40-49	0.2437	0.1627	1.5
Female 50-59	-0.3196	0.1925	-1.66
Female 60-69	-0.0697	0.2298	-0.3
Female 70+	-0.2081	0.2136	-0.97
SAHS- Very good	-0.0050	0.0723	-0.07
SAHS -Good	-0.0581	0.0803	-0.72
SAHS-Fair	-0.0142	0.1177	-0.12
SAHS-Poor	0.0097	0.2179	0.04
Health limit-some	-0.1214	0.1049	-1.16
Health limit-often	-0.1180	0.1300	-0.91
Smoke: Current Heavy	-0.6734	0.0768	-8.77
Smoke: Current Occasional	-0.3800	0.1275	-2.98
Smoke: Former	-0.2592	0.0735	-3.53
1 chronic cond.	0.2115	0.0711	2.97
2-3 chronic cond.	0.4830	0.0770	6.27
> 3 chronic cond.	0.5805	0.1240	4.68
1-2 disability days	0.1123	0.0984	1.14
≥ 3 disability days	-0.1378	0.0969	-1.42
Injury	-0.0229	0.0722	-0.32
Act Restrict-some	0.1681	0.0966	1.74
Act Restrict-often	0.1574	0.1235	1.27
Constant	1.3603	0.4631	2.94
Health Region		Controlled	

Table A.19: Logistic Regression for Incidence of GP Use, Distance to Nearest Hospital of Any Size

Observation	37534	Log pseudolikelihood	-17394.18
Wald chi2(76)	1354.51	Pseduo R2	0.08
Prob >chi^2	0		

	Coef.	Std. Err.	Z-score
$Distance_{any}$	-0.0023	0.0023	-0.98
Ln(income)	0.0451	0.0231	1.96
Married	0.2183	0.0578	3.77
Widow/Div	0.1168	0.0827	1.41
Secondary	0.1300	0.0660	1.97
Some post-second	0.0054	0.0884	0.06
Post secondary	0.2391	0.0588	4.06
Immigrant≤10yrs	-0.1129	0.0924	-1.22
Immigrant 10-30yrs	0.0262	0.0845	0.31
Currently working	-0.0296	0.0724	-0.41
Students	0.1094	0.0910	1.2
Speak Eng/Frch	0.0150	0.2238	0.07
Aboriginal	-0.2633	0.1270	-2.07
Age 30-39	-0.1839	0.0854	-2.15
Age 40-49	0.1360	0.0905	1.5
Age 50-59	0.3020	0.1060	2.85
Age 60-69	0.3230	0.1280	2.52
Age 70+	0.7626	0.1375	5.55
Female	0.6378	0.0731	8.73
Female 30-39	0.2857	0.1130	2.53
Female 40-49	-0.1849	0.1238	-1.49
Female 50-59	-0.3452	0.1378	-2.5
Female 60-69	-0.2537	0.1473	-1.72
Female 70+	-0.5613	0.1468	-3.82
SAHS- Very good	0.2157	0.0518	4.16
SAHS -Good	0.1689	0.0591	2.86
SAHS-Fair	0.3112	0.0989	3.15
SAHS-Poor	0.6401	0.1769	3.62
Health limit-some	0.0843	0.0776	1.09
Health limit-often	0.2235	0.1002	2.23
Smoke: Current Heavy	-0.3681	0.0578	-6.37
Smoke: Current Occasional	0.0728	0.0982	0.74
Smoke: Former	-0.0150	0.0502	-0.3
1 chronic cond.	0.3117	0.0516	6.05
2-3 chronic cond.	0.7275	0.0576	12.64
> 3 chronic cond.	1.0214	0.0894	11.42
1-2 disability days	0.1839	0.0813	2.26
≥ 3 disability days	0.5939	0.0878	6.77
Injury	0.4021	0.0597	6.74
Act Restrict-some	0.0573	0.0725	0.79
Act Restrict-often	0.1378	0.0911	1.51
Constant	-0.2033	0.3304	-0.62
Health Region		Controlled	

Table A.20: ZTNB Regression for Conditional # of GP Visits, Distance to Nearest Hospital of Any Size

Observation	29985	Log pseudolikelihood	-63360.60
Wald chi2(76)	3277.64	Prob >chi^2	0

	Coef.	Std. Err.	Z-score
Distance_{any}	0.0005	0.0015	0.3
Ln(income)	-0.0375	0.0156	-2.41
Married	0.0883	0.0386	2.29
Widow/Div	0.1816	0.0463	3.92
Secondary	0.0298	0.0362	0.82
Some post-second	-0.0122	0.0490	-0.25
Post secondary	0.0076	0.0296	0.26
Immigrant≤10yrs	0.1496	0.0576	2.6
Immigrant 10-30yrs	0.0448	0.0459	0.97
Currently working	-0.1567	0.0407	-3.85
Students	-0.2316	0.0538	-4.3
Speak Eng/Frch	-0.2714	0.0774	-3.51
Aboriginal	0.0898	0.0690	1.3
Age 30-39	0.0791	0.0691	1.14
Age 40-49	-0.0316	0.0637	-0.5
Age 50-59	0.0433	0.0646	0.67
Age 60-69	0.0691	0.0678	1.02
Age 70+	0.1767	0.0789	2.24
Female	0.5457	0.0497	10.98
Female 30-39	-0.1525	0.0811	-1.88
Female 40-49	-0.3144	0.0845	-3.72
Female 50-59	-0.5672	0.0735	-7.72
Female 60-69	-0.6036	0.0714	-8.46
Female 70+	-0.7313	0.0742	-9.85
SAHS- Very good	0.1840	0.0372	4.94
SAHS -Good	0.3726	0.0376	9.9
SAHS-Fair	0.5826	0.0471	12.36
SAHS-Poor	0.8273	0.0626	13.22
Health limit-some	0.1657	0.0370	4.48
Health limit-often	0.3338	0.0488	6.85
Smoke: Current Heavy	0.0203	0.0389	0.52
Smoke: Current Occasional	0.0191	0.0661	0.29
Smoke: Former	-0.0360	0.0295	-1.22
1 chronic cond.	0.3565	0.0385	9.27
2-3 chronic cond.	0.6516	0.0402	16.19
> 3 chronic cond.	0.8822	0.0451	19.55
1-2 disability days	0.0922	0.0375	2.46
≥ 3 disability days	0.3133	0.0343	9.13
Injury	0.1805	0.0317	5.7
Act Restrict-some	-0.0064	0.0372	-0.17
Act Restrict-often	0.0288	0.0461	0.62
Constant	0.6753	0.1831	3.69
Health Region		Controlled	

Table A.21: Logistic Regression for Incidence of Specialist Use, Distance of Nearest Hospital of Any Size

Observation	37534	Log pseudolikelihood	-19434.10
Wald chi2(76)	2094.86	Pseduo R2	0.11
Prob >chi^2	0		

	Coef.	Std. Err.	Z-score
$Distance_{any}$	-0.0069	0.0022	-3.16
Ln(income)	0.1142	0.0251	4.55
Married	0.2883	0.0543	5.31
Widow/Div	0.1179	0.0738	1.6
Secondary	0.2986	0.0625	4.78
Some post-second	0.5337	0.0802	6.65
Post secondary	0.4682	0.0520	9.01
Immigrant≤10yrs	-0.1029	0.0959	-1.07
Immigrant 10-30yrs	-0.1735	0.0776	-2.24
Currently working	-0.0469	0.0606	-0.77
Students	0.0043	0.0847	0.05
Speak Eng/Frch	0.0457	0.1952	0.23
Aboriginal	-0.2521	0.1152	-2.19
Age 30-39	-0.0292	0.0987	-0.3
Age 40-49	0.0965	0.0978	0.99
Age 50-59	0.2487	0.1022	2.43
Age 60-69	0.5121	0.1089	4.7
Age 70+	0.6600	0.1139	5.79
Female	0.6659	0.0800	8.33
Female 30-39	0.1835	0.1177	1.56
Female 40-49	-0.2659	0.1234	-2.16
Female 50-59	-0.3170	0.1237	-2.56
Female 60-69	-0.6577	0.1252	-5.25
Female 70+	-0.9619	0.1204	-7.99
SAHS- Very good	0.0879	0.0539	1.63
SAHS -Good	0.2486	0.0573	4.34
SAHS-Fair	0.5213	0.0781	6.68
SAHS-Poor	0.7644	0.1179	6.49
Health limit-some	0.3209	0.0606	5.3
Health limit-often	0.5119	0.0746	6.86
Smoke: Current Heavy	-0.2165	0.0559	-3.87
Smoke: Current Occasional	0.1676	0.1044	1.6
Smoke: Former	0.0497	0.0442	1.12
1 chronic cond.	0.3717	0.0584	6.36
2-3 chronic cond.	0.7174	0.0578	12.4
> 3 chronic cond.	1.0318	0.0696	14.82
1-2 disability days	0.2025	0.0726	2.79
≥ 3 disability days	0.3644	0.0613	5.94
Injury	0.3254	0.0521	6.24
Act Restrict-some	0.2146	0.0614	3.5
Act Restrict-often	0.2578	0.0700	3.68
Constant	-3.9110	0.3280	-11.92
Health Region		Controlled	

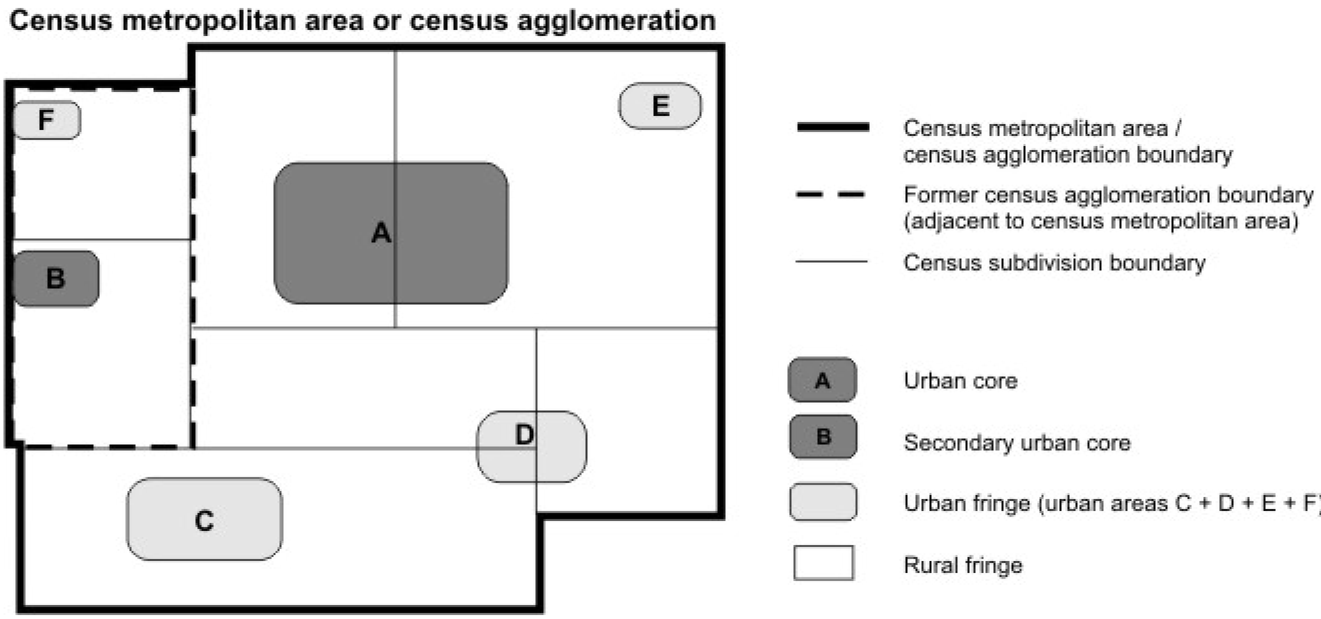
Table A.22: ZTNB Regression for Conditional # of Specialist Visits, Distance to Nearest Hospital of Any Size

Observation	10598	Log pseudolikelihood	-24307.54
Wald chi2(76)	631.57	Prob >chi^2	0

	Coef.	Std. Err.	Z-score
$Distance_{any}$	0.0003	0.0008	0.43
Ln(income)	0.0421	0.0258	1.63
Married	0.0390	0.0633	0.62
Widow/Div	0.1577	0.0727	2.17
Secondary	0.1395	0.0581	2.4
Some post-second	0.0872	0.0826	1.06
Post secondary	0.1645	0.0451	3.65
Immigrant≤10yrs	-0.0889	0.1442	-0.62
Immigrant 10-30yrs	-0.2169	0.0630	-3.44
Currently working	-0.2338	0.0544	-4.3
Students	-0.1074	0.1222	-0.88
Speak Eng/Frch	0.0651	0.1146	0.57
Aboriginal	0.1694	0.1114	1.52
Age 30-39	0.0430	0.1184	0.36
Age 40-49	0.1576	0.1555	1.01
Age 50-59	-0.1349	0.1213	-1.11
Age 60-69	-0.2856	0.1167	-2.45
Age 70+	-0.3761	0.1294	-2.91
Female	0.2712	0.1034	2.62
Female 30-39	0.0789	0.1340	0.59
Female 40-49	-0.4085	0.1603	-2.55
Female 50-59	-0.2608	0.1392	-1.87
Female 60-69	-0.3815	0.1241	-3.08
Female 70+	-0.5789	0.1270	-4.56
SAHS- Very good	-0.0055	0.0600	-0.09
SAHS -Good	0.0312	0.0584	0.53
SAHS-Fair	0.2220	0.0767	2.9
SAHS-Poor	0.5668	0.0982	5.77
Health limit-some	0.1324	0.0560	2.37
Health limit-often	0.3609	0.0602	5.99
Smoke: Current Heavy	-0.1335	0.0500	-2.67
Smoke: Current Occasional	-0.1759	0.0971	-1.81
Smoke: Former	-0.0052	0.0453	-0.11
1 chronic cond.	0.1924	0.0766	2.51
2-3 chronic cond.	0.1363	0.0620	2.2
> 3 chronic cond.	0.3604	0.0777	4.64
1-2 disability days	-0.0832	0.0645	-1.29
≥ 3 disability days	0.1089	0.0532	2.05
Injury	0.0343	0.0532	0.64
Act Restrict-some	-0.0548	0.0532	-1.03
Act Restrict-often	-0.0852	0.0583	-1.46
Constant	0.5539	0.3076	1.8
Health Region		Controlled	

Appendix B: Urban Influence Zones

Figure B.1: Depiction of Urban Influence Zones



Source: Statistics Canada

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