HIGH COST NEIGHBOURHOODS: A PERSPECTIVE ON THE HEALTH CARE COST OF UNINTENTIONAL INJURIES

by

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Author's Declaration

I hereby declare than I am the sole author of this Research Paper.

I authorize Ryerson University to lend this Research Paper to other institutions or individuals for purposes of scholarly research.

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Abstract

This research analyzed the direct health care costs of traumatic unintentional injuries at St. Michael's Hospital from 2001 to 2003 for neighbourhoods in the City of Toronto. Trauma patients included those over the age of 19 years with an Injury Severity Score (ISS) greater than 12, where the injury was not self-inflicted. Geographic Information System (GIS) analysis allowed for the trauma dataset to be spatially aggregated to the corresponding Toronto neighbourhood using the patient's residential location. The various neighbourhood costs were then calculated and it was determined that they showed no geographic correlation. However, using multiple-linear regression models, predictive variables for these costs were determined. Some neighbourhoods in Toronto have higher costs than expected while other neighbourhoods have lower costs than expected. The neighbourhood with the highest costs was Moss Park while the lowest costs were found in Bayview Woods-Steeles.

Acknowledgements

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List of Acronyms

# of Injuries	Number of Injuries
ACF	Patients discharge disposition to an Acute Care Facility
Administrative	Patients occupation
AIS	Abbreviated Injury Scale
Alive	Patients discharged alive
CCF	Patients discharge disposition to a Chronic Care Facility
City of Toronto	The new amalgamated City of Toronto
Dead	Patients discharged deceased
Falls	Injuries from unintentional falls
Female	Patients female gender
GGH	The Greater Golden Horseshoe
GRC	Patients discharge disposition to a General Rehabilitation
Health	Patients occupation in health and medicine
Hom/Assult	Injuries inflicted by another person with intent to injure or kill,
Home	Patients discharge disposition to a Home
Home Support	Patients discharge disposition to a Home with Support
Injured at work	Patients injured while participating during employment activity
ISS	Injury Severity Score
LOG10	Logarithmic transformation of 10 or common log transformation
LOS	Length of Stay
Male	Patients male gender
Manufacturing	Patients occupation in the manufacturing industry
MV Traffic	Injuries from motor vehicle traffic incidents
NA	Patients did not get discharged from the hospital
NH	Neighbourhood
NHM	Patients discharge disposition to a Nursing Home
Other	Injuries from all other incidents including water transport, air
Other	Patients discharge disposition to another place
Other Jobs	Patients in all other occupations including homemaking,
Other Services	Patients occupation in other services
OTR CDS	Ontario Trauma Registry Comprehensive Dataset
OTR MDS	Ontario Trauma Registry Minimal Dataset
Pedal	Injuries from pedal vehicle incidents (cycling)
Professional Jobs	Patients occupation as professionals
Retired	Patients retired
Sales	Patients occupation in sales
SMH	St. Michael’s Hospital
Special Rehab	Patients discharge disposition to a Special Rehabilitation Facility
Student	Patients occupation as students
Unemployed	Patients unemployed
Unknown	Patients occupation is unknown
Zscore	Suffix to variables that have been standardized

CHAPTER 1: INTRODUCTION

The economic burden of unintentional and intentional injuries combined is estimated to be greater than $12.7 billion per year or 8% of the total direct and indirect costs of illness in Canada. Injuries rank fourth after cardiovascular disease, musculo-skeletal conditions and cancer in overall illness costs (Lane and Desjardins, 2002). Angus et al. (1998) estimate that unintentional injuries alone cost Canada more than $8.7 billion annually. These costs are incurred by individuals, family, the community, employers, insurers, government agencies and society (Workplace Health, Safety and Compensation Commission, 1999). Unintentional injuries in Canada can be viewed as a silent epidemic that is infecting our nation, costing billions of dollars a year (Angus et al., 1998). Unintentional injuries are preventable, they are not an inevitable consequence, studying these injuries and adopting prevention programs can save Canadians billions of dollars a year.

Research studies from all over the world have documented unintentional injuries (Ricketts and Sheps, 2002; Nucklos et al., 2004; Klob, 2001). Some broad topics include preventative measures, societal issues, economic costs and data requirements. However, only a small number of these have included the geographic perspective of such injuries. These studies examine large scale geographic spaces such as provincial and state wide areas or urban and rural geographic areas. The lack of small geographic area spatial analysis, such as examining neighbourhoods, has been singled out by the Injury Prevention Research Office at St. Michael's Hospital (SMH) in Toronto. Ryerson University's Department of Geography and the Centre for the Study of Commercial Activity (CSCA) are working together with St. Michael's Hospital to research small scale spatial analysis studies of injuries. This paper is one of the many projects made possible through the cooperation between these research facilities.

1.1 Background

Unintentional injuries kill and disable people everyday. These injuries have both and economic and social cost. For the first time in Canadian history a study was produced that examined how much it costs to treat unintentional injuries. This study called "The Economic Burden of Unintentional Injury in Canada," was produced for Smart Risk by Angus et al. (1998), examined costs across the country for preventable injuries including falls, motor vehicle crashes, railway and pedestrian injuries, drowning and suffocation, poisoning and fires. The study examined the available data at a large geographic scale by investigating provincial and national data. A study of a different nature reported by Jennifer Gonnerman (2004) entitled "Neighbourhood Costs of America's Prison Boom: Million Dollar Blocks" used small scale geographic data to show city blocks that had high numbers of convicts. This research report combines the theory of the costs of unintentional injury and the theory of the million dollar blocks to understand the spatial relationships of the cost of unintentional injury at the neighbourhood level.

1.2 Research Need

Prevention is more often than not better than the cure. This philosophy is no different for unintentional injuries. The economic impacts of injury can be measured in terms of losses in time, money and well-being. Prevention is the best means to reduce the numbers of persons injured. An examination of the location of those injured with the associated costs may reveal a correlation with between the two.

Data for small scale spatial analysis are available for facilitating precise spatial analysis. Data of such precision are highly sensitive for privacy reasons and typically is never released. Through negotiations and contract agreements the data were released in confidence for this research to help facilitate solutions for the unintentional injury epidemic. These data opportunities are advantageous for the research community as well as for society since this may help prevent future unintentional injuries from occurring. Data at such precision can identify specific locations of high risk areas. These high risk areas can be explicitly targeted by prevention programs. This study examines the direct health care costs of St. Michael's Hospital's patients, from different Toronto neighbourhoods, that are reported to the Ontario Trauma Registry Comprehensive Dataset (OTRCD). The results of this research indicate areas where prevention programs may be established or better directed. Preventing injuries saves lives, improves the quality of life, as well as improves the bottom line.

1.3 Goals

The goal of this research is to combine the Ontario Trauma Registry database from St. Michael's Hospital with the St. Michael's Hospital decision support dataset to examine the neighbourhood costs of unintentional injuries and find reasons for these costs.

1.4 Hypothesis

The null hypothesis for this research is that there is no difference between neighbourhood injury costs. The second hypothesis for this research is that a bias for the differences between neighbourhoods exists.

1.5 Study Area

The study area for this research is limited to the City of Toronto, see Figure 1.1. The area of Toronto is further refined to the 140 various neighbourhood boundaries, defined by the city, for analysis. Refer to Figure 1.2 for the map of all Toronto's neighbourhoods.

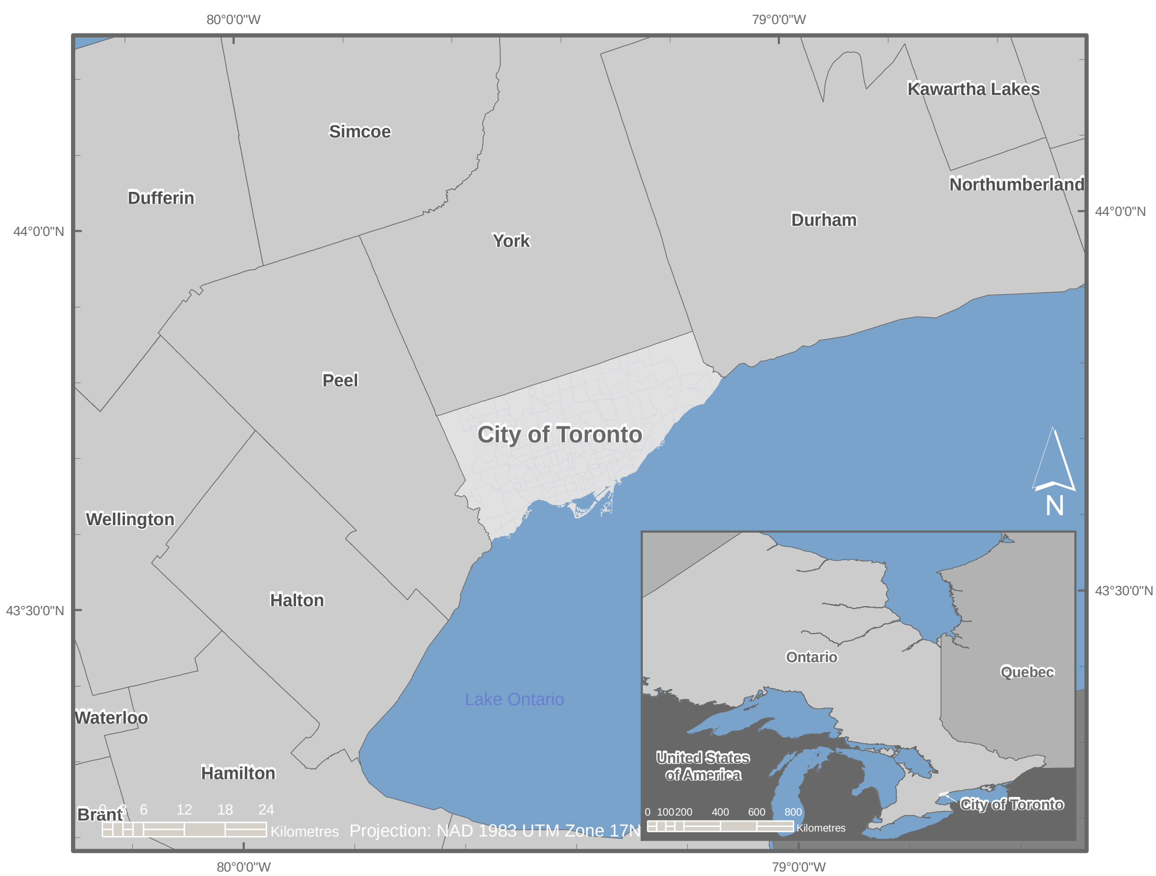

Figure 1.1 – City of Toronto

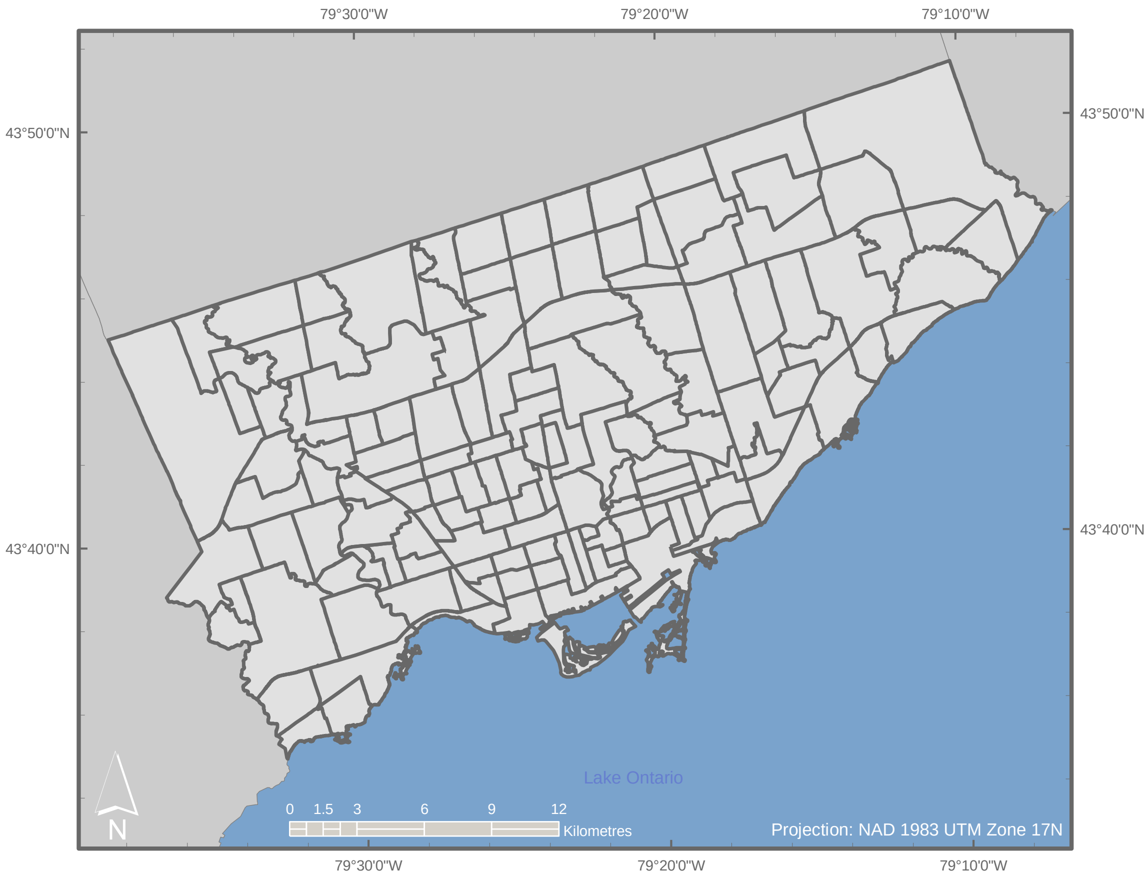

Figure 1.2 – City of Toronto Neighbourhoods

1.6 Organization of Paper

The remainder of the paper will be broken down into the following chapters. Chapter Two deals with the background research on the various components of this paper including injury, injury costs and analysis. Chapter Three outlines the methodological techniques conducted. Chapter Four outlines the results of the analysis. Chapter Five concludes this paper by discussing research limitations, conclusions and future avenues.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Canada is not the only country facing the problem of unintentional injuries. Countries throughout the world are facing the same epidemic (Australian Government, 2004; Miller et al., 1995; Brohi, 2005; Goodchild et al., 2002). A number of jurisdictions are approaching prevention as the best means to combat the increasing number of injured. This study will add to the body of research that relates to the phenomena of unintentional injuries by specifically examining the residential location of the costs of those injured unintentionally.

This chapter provides the background information on the theories and techniques referred to in later chapters. The first section examines unintentional injuries with respect to Canada and the world. The second deals with the various costs associated with injury and how best to measure them. The final section examines the various mapping and analytical techniques.

2.2 Injury

2.2.1 Overview

In 1998, the World Health Organization (WHO) stated that sixteen percent of global burden of disease was attributed to injuries (Figure 2.1). Globally, more than five million people die from injuries every year. Injuries kill more people than HIV/AIDS and malaria combined (WHO, 2000). An injury is defined simply as physical damage to the body. Public health professionals divide injuries into two categories: “unintentional injuries,” that include most injuries resulting from traffic collisions, burns, falls, and poisonings; or “intentional injuries” that are injuries resulting from deliberate acts of violence against oneself or others (WHO, 2000). An unintentional injury is not an accident because the term “accident” suggests that those events are random and an unavoidable part of living. Public health officials view injuries as preventable and needing to be studied scientifically.

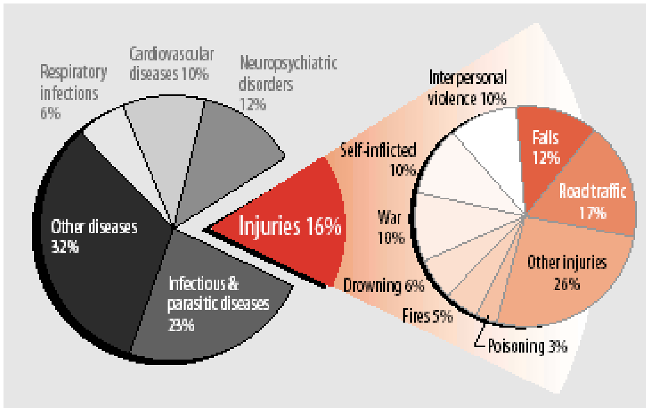

Figure 2.1 – Global burden of disease attributable to injuries, 1998 estimates
Source: WHO, 2000

To date, most injury prevention strategies are concentrated in developed countries (WHO, 2000). These countries have estimated these various strategies at the national, community, family, and individual level. Strategies include laws requiring the use of seat belts, child car seats, and fencing around outdoor pools help prevent injuries. Also, programs such as designated drivers and indoor smoke detectors have proven to help prevent injuries (WHO, 2000). These strategies and programs all focus on the safety and well-being of people and are the results of large amounts of research studying personal injuries.

2.2.2 Injuries in Canada

The occurrence rate of injuries in Canada can be viewed as an epidemic (Angus et al., 1998). Injuries are the leading cause of death for Canadians between the ages of one and forty-four (Lane and Desjardins, 2002). Each year, more than 13,000 Canadians die and over 200,000 are admitted to hospital due to injuries. This accounts for an estimated two million hospital days (Lane and Desjardins, 2002). Tables 2.1 and 2.2 show the unintentional injuries resulting in death and hospitalization, distributed by major unintentional injury category, 1995-1996.

Table 2.1 – Deaths Resulting From Unintentional Injury, Distributed by Major Category, Canada, 1994

Major Cause of Hospitalization	**Number**	**% Distribution**
Falls	2,567	38.3
Motor Vehicle Crashes	2,047	30.5
Poisoning	581	8.7
Drowning and Suffocation	353	5.3
Fires	274	4.1
Other	888	13.2
Total	6,710	100

Source: Angus et al., 1998

Table 2.2 – Unintentional Injuries Resulting in Hospitalization, Distributed by Major Category, Canada, 1995-96

Major Cause of Hospitalization	**Number**	**% Distribution**
Falls	54,520	56.1
Motor Vehicle Crashes	8,031	8.3
Poisoning	3,980	4.1
Drowning and Suffocation	2,425	2.5
Fires	2,304	2.4
Other	25,885	26.6
Total	97,145	100

Source: Angus et al., 1998

2.2.3 Injuries in Ontario

Across all age groups, unintentional injury ranks fourth among the leading causes of death, after cancer, circulatory system and respiratory diseases. According to Albert and Eden (1999) it is also the fourth leading cause of hospitalization. In 1996, 3138 Ontarians died of intentional and unintentional injuries. That is more than eight people per day. Two-thirds were males. The largest percentage of injury deaths (39 per cent) was among persons aged 65 years and older (Angus et al., 1998). Figure 2.2 shows the breakdown of unintentional injury in Ontario.

Figure 2.2 – Breakdown of unintentional injuries in Ontario
Source: Angus et al., 1998

2.2.4 Injury Types and Classifications

An important aspect of injury prevention analysis is how injuries are documented. In Canada, there are a different classification systems that document how the injury occurred and the nature of the injury. The extent of the injury is documented using the International Classification of Disease (ICD), Abbreviated Injury Scale (AIS) and Injury Severity Score (ISS).

ICD codes are used to classify diseases and other health problems recorded on many types of health and vital records including death certificates and hospital records

(WHO, 2005). In 1948, the WHO took over the responsibility for the ICD classifications and its completion (WHO, 2005). Currently in Canada, ICD-9 and ICD-10 codes are used to conduct research and classify cases. Updating the ICD-9 codes to ICD-10 codes is ongoing across various medical specialties. The International Classification of Disease codes are broken down into different types of injuries, outlined in table 2.3.

Table 2.3 – Nature of Injury, Description and ICD9-CM Codes (N-Codes)

Nature of Injury Description	Description	ICD9-CM Codes
Fractured skull	Fractured skull or face bones	800-804
Fractured spine	Fracture of vertebral column, ribs, sternum, pelvis, or other trunk area	805-809
Fractured limb	Fracture of parts of upper or lower limbs	810-829
Dislocation	Dislocation of jaw, elbow, knee, shoulder etc.	830-839
Sprains	Sprains and strains of shoulder, arms, hips, thighs etc.	840-848
Other cranial	Concussion, cerebral lacerations, hemorrhages	850-854
Internal	Internal injury to chest, abdomen and pelvis	860-869
Open wound	Any open wound to head, neck & trunk of body	870-899
Blood vessel	Injury to blood vessels	900-904
Late effects	Late effects of injuries, poisonings or other external causes	905-909
Superficial	Superficial injuries to face, trunk, limbs etc.	910-919
Contusion	Bruise & hematoma of face, neck, trunk, limbs etc.	920-924
Crushing	Crushing of face, neck, trunk, limbs etc.	925-929
In orifice	Effects of foreign bodies entering through orifice (eye, nose, respiratory tract etc.)	930-939
Burns	Burns to face, neck, trunk, limbs, internal	940-949
Nerves & spinal cord	Injury to nerves (optic, cranial, trunk etc.) & spinal cord (without evidence of bone injury)	950-957
Poison	Poisonings by drugs, medicaments, toxic Non-medical substances	960-989
Other	Other & unspecified effects of external causes & non-injury-related primary diagnoses	990-995, 958, 59 & all ICD0 less than 800
Medical/surgical complications	Complications of surgical & medical care not elsewhere classified	996-999

Source: Arbor, 1989

The AIS was originally introduced in 1971 and is a specialized trauma classification of injuries that is based mainly on anatomical descriptors of the tissue damage caused by the injury (Champion, 2004). The AIS has two components; the injury descriptor and the severity score. The injury descriptor divides the body into six regions (head, chest, face, extremity, abdomen and external). The severity score ranges from 1 (relatively minor) to 6 (currently untreatable), and is assigned to each injury descriptor.

The ISS is an "anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an AIS score and is allocated to one of six body regions (head, face, chest, abdomen, extremities [including Pelvis], and external). Only the highest AIS score in each body region is used. The three most severely injured body regions have their score squared and added together to produce the ISS score" (Brohi, 2005). This system was developed in 1974 by Baker. The injury severity score ratings are outlined below.

- When ISS is below 25, the mortality risk is minimal; above 25; it is an almost linear increase
- When ISS is 50, the mortality is 50%
- When ISS is above 70, mortality close to 100%
- If an injury is assigned an AIS of 6 (unsurvivable injury), the ISS score is automatically assigned to 75
- Highest ISS score obtainable is 75 (Baker et al., 1974).

2.2.5 Cause of Injury Classifications

The cause of the injury is documented using the External Cause of Injury codes (E codes). The WHO created these codes as a supplemental code for use with the ICD codes. E codes have four digits, providing a systematic way to classify diagnostic information. Table 2.4 defines the different categories of E codes. They are standardized internationally; allow consistent comparisons of data among communities and countries. They are easily used in computerized data systems. E codes provide information about both the event during which the injury took place and the individuals who were injured. For example, E codes can record whether the individual injured was a passenger in a motor vehicle that collided with another motor vehicle (E813.1) or the driver of a motor vehicle that collided with a train (E810.0).

Table 2.4 – Categories for External Cause of Injury Codes (E-Codes)

E-Code	Definition
E810 - E819	Motor Vehicle traffic
E820 - E825	Motor Vehicle non-traffic
E826	Pedal cycles (e.g., bicycles)
E800 - E807, E827 - E829, E831, E833 - E838, E840 - E848	Other vehicle or transport (including railway, water & air)
E850.1, 854.1, E860 - E869	Unintentional poisonings
E880 - E888	Falls
E890 - E899	Fire & flame
E900 - E909	Incidents due to natural & environmental factors
E830, E832, E910	Drowning & Submersion
E911 - E913	Suffocation
E914 - E915	Foreign body (excludes choking)
E920	Cutting & piercing
E922	Firearms
E929, E959, E969, E977, E989, E999	Late effects of injury
E950 - E958	Self inflicted injury
E960 - E968	Assaults
E916 - E919, E921, E923 - E928, E970 - E976, E978, E980 - E988, E990 - E998	Other incidents
E849	Place of Occurrence
E849.0	Home
E849.1	Farm
E849.2	Mine & quarry
E849.3	Industrial place & premises
E849.4	Place for recreation & sport
E849.5	Street & highway
E849.6	Public building
E849.7	Residential institution
E849.8	Other, specified
E849.9	Other, unspecified

Source: Arbor, 1989

2.2.6 Intent of Injury

The cause, nature and the symptoms of an injury describe the factors of the injury event. However, these classifications do not describe the reason for the injury; that it is either intentional or unintentional. An intentional injury can have the same symptoms and nature as an unintentional injury. There are three types of classifications to describe the intent of an injury. Self inflicted injuries are categorized as intentional injuries and unintentional injuries are recorded as so. The third classification, assault or homicide, can be viewed as either intentional or unintentional. For this study, assaults and homicides are viewed as unintentional injuries.

2.2.7 Health Canada Databases

There are a variety of databases in Canada and Ontario that provide information related to injuries. The document "Inventory of Injury Data Sources and Surveillance Activities" from Health Canada (2005) goes into great detail describing all the public datasets that relate to injury. Unfortunately, not all these datasets can be utilized to conduct research at a small scale for privacy reasons. Typically, information is withheld or aggregated to a level which is not satisfactory for small scale spatial analysis studies. Of the datasets in Canada, the ones available for use include the Office of the Chief Coroner for Ontario, Ontario Trauma Registry, Emergency Medical Service (EMS) and St. Michael's Hospital decision support dataset. Refer to Appendix 1 for the full breakdown of unintentional injury information for each of these datasets.

2.3 Injury Costs

2.3.1 Overview

In 1995, preventable injuries were estimated to amount to $300 for every Canadian citizen or $8.7 billion (Lane and Desjardins, 2002). There are a variety of paradigms used for the calculation of the costs of unintentional injury as well as different types of costs. The following sections examine the types of costs and the different paradigms that can be used to calculate these costs.

2.3.2 Types of Injury Costs

2.3.2.1 Direct Costs

The direct costs according to the "Economic Burden of Unintentional Injury in Canada" include all items related to diagnosis, treatment, continuing care, rehabilitation, and terminal care such as expenditures for hospitals, outpatient care, nursing home services, home care, health care professionals, drugs and appliances (Angus et al., 1998). Direct costs are the resources expended for prevention activities or health care (Haddix et al., 1996). These include hospitals and other health care institutions, physicians and other health care professionals, drugs and medical appliances, health science research, administration, and other related health care expenditures (Moore et al., 1997). Direct costs may include labour, such as that of health professionals and support staff, as well as capital, such as equipment, buildings, supplies, utilities and land (Chan et al., 1996).

Direct costs can be measured by using two separate approaches to account for the specific variables mentioned above. They include the prevalence-based method or the incidence-based method.

The prevalence-based model quantifies economic costs by measuring all costs due to illness that occur within a given time period (usually a single year), regardless of the time of disease onset (Moore et al., 1997). The resulting direct health care costs are the total expenditures considered to be relevant (Goodchild et al., 2002).

Moore et al. (1997) describe the incidence-based model as a model that quantifies the total lifetime costs of new cases of an illness with onset in the base year. It estimates the costs of new cases of illness in the base year from the beginning to the end of the illness (cure or death). The incidence approach is good for predicting the future effects of changes in current illness patterns (Choi and Pak, 2002). Goodchild et al. (2002) suggests that this method takes the "bottom up" approach to estimating costs. It allows researchers to compare patient costs at a fine level of aggregation, but requires detailed data.

2.3.2.2 Indirect Costs

Unlike the direct cost estimations, indirect costs are based on more assumptions that are much harder to measure. Indirect costs are the "resources forgone as the result of a health condition" (Haddix et al., 1996). They are related to lost productivity due to disability and premature mortality, causing absence from work or non-market activities (Chan et al., 1996). Depending on the point of view taken for the analysis, the indirect costs can range from narrow to broad, where the societal view is the broadest (Angus et al., 1998). There are two major estimation methods used to calculate the indirect cost of illness and injury. They include the human capital approach and the "willingness-to-pay approach". These two methods generate results that are not comparable (Moore et al., 1997). The assumptions underlying these economic cost estimates include similar ways to estimate direct costs, but differ in what to include in indirect costs. The "willingness to pay" approach (which yields much higher estimates) bases its indirect cost estimates on research findings about what people are willing to pay for safety and what society judges to be just financial settlements for things like pain and suffering.

- Human Capital Approach

The human capital approach, developed by Rice and colleagues, estimates indirect costs associated with illness and premature death in terms of productivity losses (foregone income). “This approach applies current average earnings by age and sex to lost market time and imputes the market value of time withdrawn” (Choi and Pak, 2002). The fundamental presumption of this approach is that people are valuable economic resources (Goodchild et al., 2003). The shortcomings of this approach are that some groups of people are undervalued relative to other groups. In short, the human capital approach is a more conservative approach than the “willingness-to pay” approach and bases its indirect cost estimates solely on lost productivity.

- Willingness-To-Pay

The willingness-to-pay approach considers the amount that people are willing to pay to decrease their risk of injury, disease or death (Glied, 1996). It is a method of evaluating costs that ask people (patients, families, experts) what they would be willing to pay to avoid a certain undesirable state of health. This approach is subjective and may be difficult to use when assessing the willingness-to-pay in the elderly and children, due to the complexity of the questions asked (Choi and Pak, 2002). The willingness-to-pay approach typically yields much higher estimates than the human capital approach.

2.3.2.3 Intangible Costs

Intangible costs are costs of pain, suffering, anxiety, grief and loss of leisure time, for which a monetary value is assigned (Haddix et al., 1996). Intangible costs are normally estimated by the willingness-to-pay (WTP) approach (Choi and Pak, 2002).

2.3.3 Time-Frame

Different studies may consider different time-frames for cost calculations (e.g., Akers et al., 1998; Albert and Eden, 1999; Benoit et al., 2000; Choi et al., 1997 and Lane and Desjardins, 2002). The annual time-frame is prevalence-based, while the lifetime time-frame is incidence-based. Different time-frames dictate the number of years included in the cost calculation.

2.3.4 Point of View

Different perspectives can also lead to different cost estimates. There are several possible perspectives. The main two are the societal perspective and the government perspective. The point of view is important to consider because certain costs are associated with one perspective verses another. For example, from an injured person's point of view, they would only consider cost incurred by them and not the cost absorbed by the government when calculating the costs of an unintentional injury. The following describe the most common points of views used.

- Society

The societal perspective considers costs to all sectors of society. It has several components. First, costs incurred by all sectors of society are included; individuals, employers, governments, the health care system, private health insurers, and/or shared arrangements between any of these sectors (Chan et al., 1996). Second, since the costs reflect what members of society give up, they also include the loss of productivity due to illness, injury or premature death (Haddix et al., 1996). Third, "the costs do not include transfer payments between parties within the society, such as social welfare payments, because these transfer payments only shift the burden from the individual to society and do not change the society's total resources" (Moore et al., 1997). Costs of administering transfer payments attributable to illness are also included, because these administrative costs would not have been consumed in the absence of illness (Choi et al., 1997).

- Government

The government's perspective considers costs to the government only. Costs to the health care and justice systems are included in this approach (Choi et al., 1997). This perspective considers costs to all sectors of the government, such as the federal, provincial and territorial and local governments (Haddix et al., 1996). Also, transfers of funds from society to the individual, such as social welfare payments, pension, and workers' compensation, are included as costs (Moore et al., 1997).

- Others

There are other perspectives. Health care providers consider costs imposed on various types of hospitals, health maintenance organizations, and other health care issues (Haddix et al., 1996). The business perspective considers the impact of illnesses on health-related employee benefits (Haddix et al., 1996). An individual considers their own out-of-pocket expenses due to illness (Haddix et al., 1996). From the individual's perspective, costs can be internal (costs borne by an individual and possibly by their families, who are also affected by an illness); or they can be external (costs borne by those who are not affected by the illness) (Choi et al., 1997).

2.4 Analysis

2.4.1 Overview

Statistical and analytical methods provide the foundation for the results and conclusions of this research. The following sections examine the different assumptions of spatial analysis and the methods and assumptions of linear regression.

2.4.2 Homoscedasticity

Homoscedasticity is another term used to describe a constant variance in a dataset or its normality. Homoscedasticity has a large role in many types of analysis. Linear regression was used in this research. In order to deal with heteroscedasticity or skewed data a transformation needs to occur. Two possible ways to normalize the data are standardization and logarithmic transformations.

- Standardization

The standard score is calculated by scaling the data with respect to its mean and standard deviation. The standard score for the mean is zero and all data are expressed in terms of their dispersal (positive or negative) around the mean (Yeates and Gomez-Insausti, 2004).

- Logarithmic Transformation

The function named Log (base 10) calculates the common (log to the base 10) logarithm of the data. It stabilizes the variance of the data.

2.4.3 Modifiable Aerial Unit Problem

The cost calculations for unintentional injuries are aspatial information. Such calculations have their own set of assumptions and limitations. Similarly, spatial information, such as residential address locations and longitude and latitude data have many assumptions and limitations as well. These impediments include precision, accuracy and issues associated with the modifiable aerial unit problem. The modifiable aerial unit problem is one consideration for aggregating data from one geographic space to another. The aggregation process produces a change in the values of the statistics computed for the variables in two different ways. First, the change in scale results in a loss of information, since there are fewer data values to work with. This is called the scale effect. Second, the choice of which regions the high resolution data are aggregated into will affect the resulting statistics, and the variation in statistic values caused by the different choices of aggregate region is called the zoning effect (Amrhein and Reynolds, 1997 as found in Yeates and Gomez-Insausti, 2004a).

2.4.4 Multiple Regression

Multiple regression is a more complex formula than singular regression. The general purpose of multiple regression (the term was first used by Pearson, 1908) is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable (StatSoft, 2003). The difference between the actual values and the predicted values is also calculated. The strength of the relation between the dependent and independent variables, taken, together, can be indicated by a multiple correlation coefficient R and a multiple coefficient of determination R^2 (Yeates and Gomez-Insausti, 2004). Two model-building techniques exist to analyse regression designs with a single dependent variable. They include Stepwise and best-subset model-building techniques. The regression equation for a multiple regression design for the first-order effects of three continuous predictor variables *P*, *Q*, and *R* would be:

$$Y = b_0 + b_1P + b_2Q + b_3R \qquad (1)$$

There are also a few assumptions and limitations of multiple regression including normality, linearity and multicollinearity (StatSoft, 2003).

- Normality

Normality is a term used to describe a constant variance in a dataset. When the data values are plotted on a graph showing the frequency of occurrence, the curve is bell-shaped in appearance (McGrew and Monroe, 2000). The highest point of the curve represents the mean, median and mode of the data and that no skewness is present. Fifty percent of the data lie to the right of the highest point or mean value and fifty percent lie to the left of the mean value (McGrew and Monroe, 2000).

- Linearity

Linearity is the assumption that there is a straight line relationship between variables. This assumption can virtually never be confirmed; fortunately, multiple regression procedures are not greatly affected by minor deviations from this assumption (StatsSoft, 2003).

- Multicollinearity

Multicollinearity occurs when two variables are highly correlated; they both convey essentially the same information. For example, a person height in cm or inches are both completely accurate, using both to as predictors in an analysis is redundant.

2.4.5 Stepwise Model-Building

One way to complete the multiple-regression model is to use a stepwise model-building technique. This process involves a number of sequential steps. First an initial model needs to be identified. Second, the model is run and the predictor variables are repeatedly added or removed using the "stepping criteria" (StatsSoft, 2003). The “stepping criteria” uses sweeps of the covariance matrix to move variables in and out of the model (JMSL, 2005). Finally, the search is terminated when stepping is no longer possible given the stepping criteria, or when a specified maximum number of steps has been reached (StatsSoft, 2003).

2.5 Chapter Summary

This chapter has provided a background to the various aspects of this research paper. The importance of the different types of injuries, the different ways to calculate costs and the various analysis transformations are all important aspects of this project.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The methods and techniques used in this project were selected and applied based on what worked best. The paradigm, hypothesis, data acquisition, datasets, variables, cost calculation and data management and analysis were all key points for the methodology of this project. Figure 3.1 provides a flow chart of the methods used.

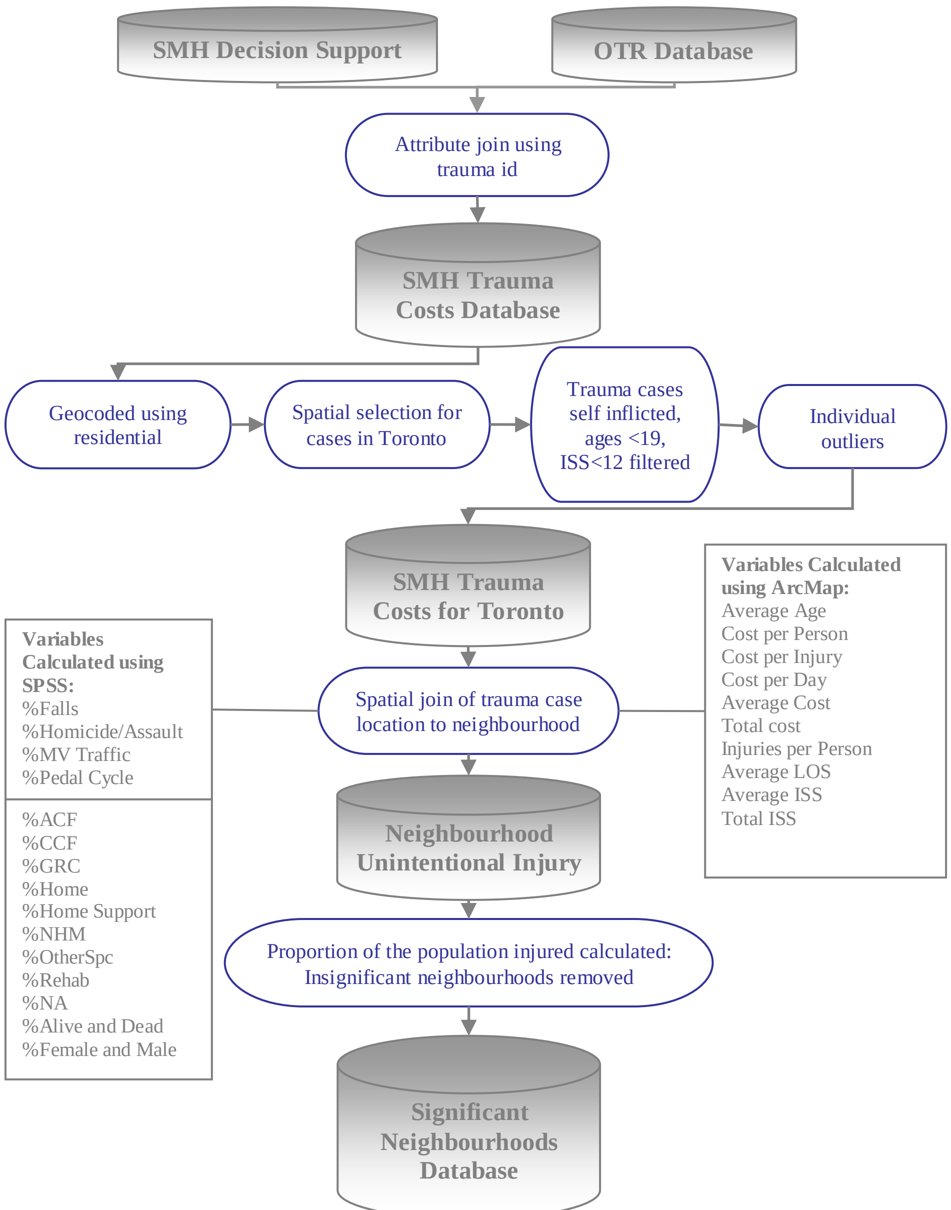

Figure 3.1 – Methodology flow chart

3.2 Paradigm

Chapter Two outlined and explained the various perspectives to calculate the costs of unintentional injury and analyze them. Based on that review and the data available for this study, the most appropriate way to determine and analyze these costs from a St. Michael's Hospital perspective was the use of the incidence-based approach to calculate the direct costs. Another criteria used for this study was the time-frame between 2001 and 2003. Indirect costs were not calculated because the cost calculation method would generalize the results spatially. The result would be that any biases from one neighbourhood's cost to another could not be determined.

3.3 Data Acquisition

3.3.1 Spatial Temporal Scale

The database that was used in this research pertains only to the residential location of St. Michael's Hospital patients. The hospital's willingness to share the data for this project is greatly appreciated. The inability to retain data from the Province of Ontario in the time allotted for this project was a disappointment. Requested databases pertaining to the whole area of Ontario were not received in due time to complete an analysis for the province.

The spatial extent of trauma and injuries are not sensitive to one hospital's catchment area. Patients can be flown into the hospital, be re-routed due to ambulance directions or simply be in the vicinity when the need for admittance to an emergency room arises. The database from St. Michael's Hospital was broken down into four subcategories for analysis. They include the City of Toronto, the Greater Golden

Horseshoe, the Province of Ontario and the rest of Canada. This area is shown in Figure 3.2.

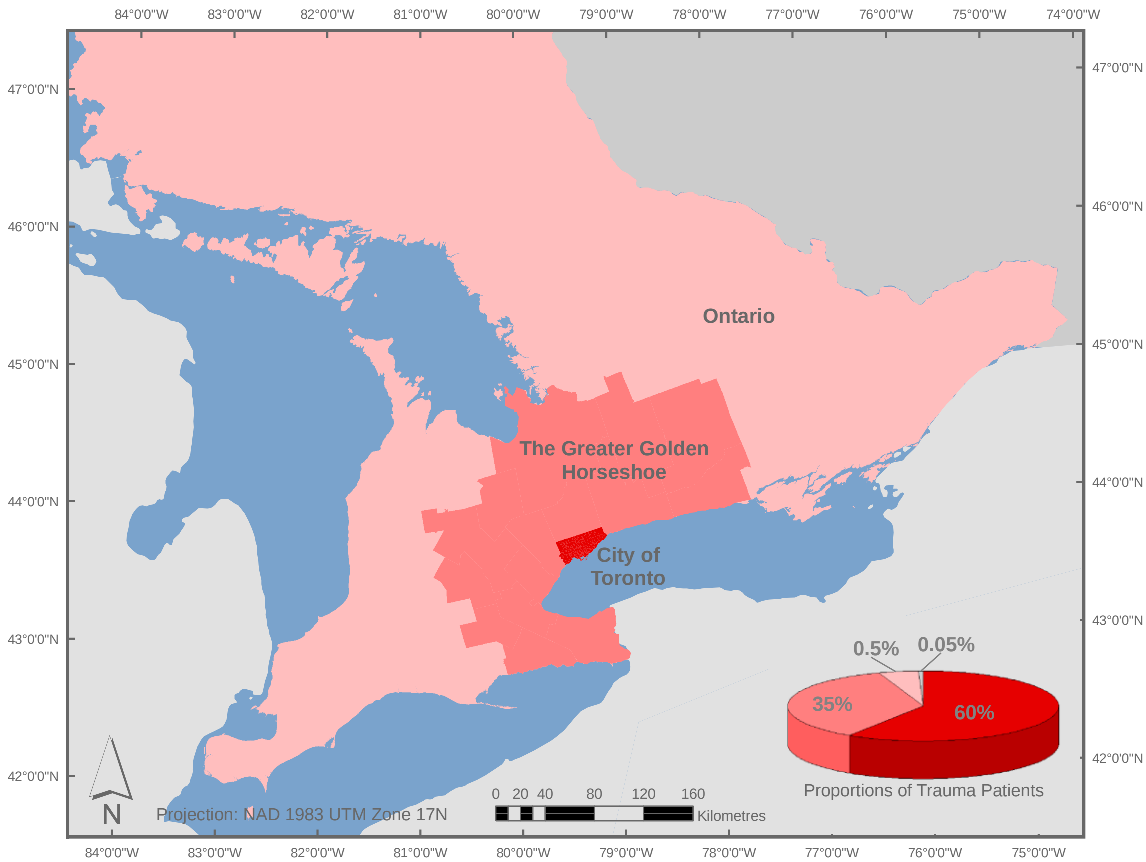

Figure 3.2 – Regional breakdown of trauma patients at St. Michael's Hospital

3.3.2 Datasets

Two of the available datasets, the St. Michael's Hospital Ontario Trauma Registry dataset and St. Michael's Hospital decision support dataset, detailed in Appendix 1, were used for this study. The Ontario Trauma Registry dataset provided the necessary medical information for St. Michael's Hospital patients between the years 2001 and 2003. This dataset was cleaned to include only the trauma patients that meet the requirements of the Ontario Trauma Registry Comprehensive dataset. St. Michael's Hospital decision support dataset provided a thorough breakdown of the emergency room costs. These two databases were merged using the trauma case number provided in both sources.

3.3.3 Neighbourhood Boundaries

The neighbourhood dataset was downloaded from the City of Toronto. These boundaries are defined by the City of Toronto and were determined to be the best unit of measurement. This is because the public is familiar with neighbourhoods and the point density of patients did not warrant a smaller unit of aggregation. Statistics Canada data at the Census Tract level was spatially joined to the neighbourhood polygons to give the population for 2001. Figure 3.3 shows the neighbourhood boundaries in Toronto.

Figure 3.3 – Toronto neighbourhoods

Table 3.1 – Toronto neighbourhoods

#	Neighbourhood	#	Neighbourhood
1	West Humber-Clairville	71	Cabbagetown-South St.Jamestown
2	Mount Olive-Silverstone-Jamestown	72	Regent Park
3	Thistletown-Beaumond Heights	73	Moss Park
4	Rexdale-Kipling	74	North St.Jamestown
5	Elms-Old Rexdale	75	Church-Yonge Corridor
6	Kingsview Village-The Westway	76	Bay Street Corridor
7	Willowridge-Martingrove-Richview	77	Waterfront Communities-The Island
8	Humber Heights-Westmount	78	Kensington-Chinatown
9	Edenbridge-Humber Valley	79	University
10	Princess-Rosethorn	80	Palmerston-Little Italy
11	Eringate-Centennial-West Deane	81	Trinity-Bellwoods
12	Markland Woods	82	Niagara
13	Etobicoke West Mall	83	Dufferin Grove
14	Islington-City Centre West	84	Little Portugal
15	Kingsway South	85	South Parkdale
16	Stonegate-Queensway	86	Roncesvalles
17	Mimico	87	High Park-Swansea
18	New Toronto	88	High Park North
19	Long Branch	89	Runnymede-Bloor West Village
20	Alderwood	90	Junction
21	Humber Summit	91	Weston-Pellam Park
22	Humbermede	92	Corsa Italia-Davenport
23	Pelmo Park-Humberlea	93	Dovercourt-Wallace Emerson-Junction
24	Black Creek	94	Wychwood
25	Glenfield-Jane Heights	95	Annex
26	Dowsnview-Roding-CFB	96	Casa Loma
27	York University Heights	97	Yonge-St.Clair
28	Rustic	98	Rosedale-Moore Park
29	Maple Leaf	99	Mount Pleasant East
30	Brookhaven-Amesbury	100	Yonge-Eglinton
31	Yorkdale-Glen Park	101	Forest Hill South
32	Englemount-Lawrence	102	Forest Hill North
33	Clanton Park	103	Lawrence Park South
34	Bathurst Manor	104	Mount Pleasant West
35	Westminster-Branson	105	Lawrence Park North
36	Newtonbrook West	106	Humewood-Cedarvale
37	Willowdale West	107	Oakwood-Vaughan
38	Lansing-Westgate	108	Briar Hill - Belgravia
39	Bedford Park-Nortown	109	Caledonia - Fairbanks
40	St.Andrew-Windfields	110	Keelesdale-Eglinton West
41	Bridle Path-Sunnybrooke-York	111	Rockliffe-Smythe

	Mills		
42	Banbury-Don Mills	112	Beechborough-Greenbrook
43	Victoria Village	113	Weston
44	Flemingdon Park	114	Lambton-Baby Point
45	Parkwoods-Donalda	115	Mount Dennis
46	Pleasant View	116	Steeles
47	Don Valley Village	117	L'Amoureaux
48	Hillcrest Village	118	Tam O'Shanter-Sullivan
49	Bayview Woods-Steeles	119	Wexford/Maryville
50	Newtonbrook East	120	Clairlea-Birchmount
51	Willowdale East	121	Oakridge
52	Bayview Village	122	Brichcliffe-Cliffside
53	Henry Farm	123	Cliffcrest
54	O'Conner-Parkview	124	Kennedy Park
55	Thorncliffe Park	125	Ionview
56	Leaside-Bennington	126	Dorset Park
57	Broadview North	127	Bendale
58	Old East York	128	Agincourt South-Malvern West
59	Danforth Village East York	129	Agincourt North
60	Woodbine-Lumsden	130	Milliken
61	Crescent Town	131	Rouge
62	East End Danforth	132	Malvern
63	The Beaches	133	Centenial Scarborough
64	Woodbine Corridor	134	Highland Creek
65	Greenwood-Coxwell	135	Morningside
66	Danforth Village Toronto	136	West Hill
67	Playter Estates-Danforth	137	Woburn
68	North Riverdale	138	Eglinton East
69	Blake-Jones	139	Scarborough Village
70	South Riverdale	140	Guildwood

3.3.4 Variables

3.3.4.1 Injury

The injury variables were not analyzed on an individual case level. The precise location of individual patients could not be used because of privacy agreements between Ryerson University and St. Michael's Hospital. As a result, the level of analysis was conducted at the census tract level or a larger area. For this analysis, the neighbourhood level was determined to be a large enough area to protect the privacy of those individuals in the dataset in accordance with the privacy agreements. To aggregate the dataset to the neighbourhood level, SPSS and ArcMap were used. This was done because the dataset contains both nominal and interval measurement types.

All the nominal injury variables were processed in SPSS using the cross-tabulation technique based on neighbourhood names. For example, the number of unintentional injury types such as the number of falls in Moss Park were calculated. The different nominal variables were then converted into percentages of the injured population for analytical purposes. For example, Trinity-Bellwood had fourteen unintentional injuries of which five were caused by falls. Therefore, the percentage falls for Trinity-Bellwood would be 35.7% based on the St. Michael's Hospital trauma dataset.

ArcMap was used to aggregate the data to the neighbourhood level for integer variables and to protect the individual patient's privacy. The point locations of the patients were plotted using the x and y coordinates calculated from the address variable in the dataset. This new shapefile was then spatially aggregated using the sum function in ArcMap to the corresponding neighbourhood. The resulting shapefile contains the total and average values for all patient variables for that neighbourhood. This method created dozens of new integer variables. Of these only a few were used for analysis.

Of the available injury related variables the following were used for preliminary analysis:

> Etiology: Falls, Homicides\Assaults, Motor Vehicle Traffic Accidents, Pedal Cycles and Other (including railways, sports, water transport, undetermined, air and space transport, caused by machinery, cutting or piercing and drowning and suffocation)

Discharge Location: another acute care facility, general rehabilitation facility, special rehabilitation facility, home, home with special care, nursing home, Chronic Care Facility, N/A (variable used to indicate those deceased).

Patient Occupation: construction, manufacturing, health, services, retired, sales, student, unemployed and other.

Patient Status: alive or dead, male or female, average ISS, total ISS and average length of stay.

3.3.4.2 Cost Calculations

- Direct Cost

The direct costs consist of several variables. Included in the St. Michael's Hospital dataset are inpatient preoperative services and emergency room services. Preoperative services includes laboratory services, imaging services (x-ray, MRI, Cat Scan etc…), catheterization, pharmacy, allied health (such as physiotherapy) and ambulatory. Emergency room services include laboratory services, imaging services (x-ray, MRI, Cat Scan etc…), catheterization, pharmacy, allied health (such as physiotherapy) and ambulatory. All of these costs also include further indirect costs, still considered direct costs. These variables do not represent indirect costs as described in Chapter Two, but further direct costs. All these costs were then summed using all cases within each neighbourhood using ArcMap 9.0.

- Total Cost

Total cost was calculated by combining the all direct and indirect costs for inpatient preoperative services and emergency room services. These were then summed using all cases within each neighbourhood.

- Cost per Person

The cost per person was calculated by taking the total cost of all injuries for the neighbourhood and dividing it by the total population for the neighbourhood

- Cost per Injury

The cost per injury was calculated by dividing the total cost for the neighbourhood and then dividing it by the number of injuries in the neighbourhood.

- Total Cost per Day

The total cost per day was calculated by taking the total number of hospital days for each neighbourhood and dividing it by the total cost for each neighbourhood.

3.4 Data Management and Analysis

3.4.1 Data Preprocessing

3.4.1.1 Outliers

Before point locations were assigned to a geographic neighbourhood, a histogram and frequency table of descriptive statistics was analyzed for the presence of outliers. Two cases with costs substantially higher than the other costs were eliminated. These extreme cases do not represent the normality of the data population and would skew the analysis results.

3.4.1.2 Geographic Selection

The merged databases contained postal code information that identified each patient's residential location. These postal codes were geocoded using MapInfo and then allocated spatially using ArcMap 9.0 into the appropriate geographic region. At St. Michael's Hospital, only 60% of all trauma patients actually reside in the Toronto Census Metropolitan Area (CMA). The area with the second highest number of patients reside in the Greater Golden Horseshoe (GGH), the boundary is defined in Figure 3.2. Table 3.1 shows the breakdown of cases into each geographic region.

Table 3.2 – Geographic breakdown for number of cases in each area

Region	Number of Cases	Percent
City of Toronto	1055	59%
Greater Golden Horseshoe (except Toronto)	634	35.5%
Ontario (except GGH)	86	0.5%
Canada (except Ontario)	9	0.05%
Total	**1784**	**100%**

3.4.1.3 Trauma Intent Selection

The St. Michael's Hospital Trauma dataset contains both unintentional and intentional injury victims in its database. All intentional cases, classified as a "self inflicted injury" were removed from the database. In total, there were seventy-six self inflicted injuries in Toronto from 2001 – 2003 and another eighteen in the Greater Golden Horseshoe. A total of 979 trauma injuries were included at this stage.

3.4.1.4 Trauma Comprehensive data selection

The data from St. Michael's Hospital trauma dataset had to be further refined to remove trauma incidences that did not meet the Ontario Trauma Registry Comprehensive Data standards. This was done for two reasons. First, according to the St. Michael's Hospital trauma coordinator (Kalia, 2005), patients that did not meet these standards have an inaccurate cost calculation. The second reason is that trauma studies conducted in Ontario by the Canadian Institute for Health Information use data collected by the Ontario Trauma Registry Comprehensive Dataset. Therefore, by using the same standards as the Canadian Institute for Health Information, the findings from this research are comparable. In order to meet the Ontario Trauma Registry Comprehensive Dataset standards, trauma incidences that had an ISS score less than 12 were removed as well as all victims under the age of 19. These refinements to the dataset resulted in 669 trauma patients at St. Michael's Hospital residing in Toronto from 2001-2003.

3.4.1.5 Significant Neighbourhood Areas

In total, there are 140 government classified neighbourhoods in the City of Toronto. Figure 3.4 shows the neighbourhood number of injuries per person for all of Toronto. However, many of the neighbourhoods have statistically insignificant numbers of trauma patients for analysis. For example, a neighbourhood with a population of ten-thousand with only one injury, recorded at St. Michael's Hospital, has an insignificant number of injuries for analysis. It can be concluded that people from this neighbourhood are going to another hospital for treatment and therefore does not represent a significant neighbourhood for St. Michael's Hospital.

A benchmark was created using the Ontario Trauma Registry Comprehensive dataset. To calculate the number of significant injuries per person in a neighbourhood a few steps were taken. First, it was determined that significant neighbourhoods for the fiscal year of 2001 would be used only. This is because the population of Toronto and the neighbourhoods can only be determined for that year based on Statistics Canada Data. Once the significant areas were determined, data from 2002 and 2003 were included for the analysis. Of the remaining 669 trauma cases 236 were from the 2001 fiscal year. The population of Toronto in 2001 over the age of 19 was 1,904,790. Therefore, for every person in Toronto St. Michael's Hospital trauma unit treated 0.012389 persons. Significant neighbourhoods were determined by using the neighbourhood population over 19 years of age and dividing it by the number of trauma injuries in 2001 for that neighbourhood. In total there were 53 significant neighbourhoods that had over 0.0123 injuries per person.

Refer to Table 3.3 for list of neighbourhoods and the unstandardized variables for costs. Maps of total neighbourhood costs, costs per person, cost per injury and cost per day are in Figures 3.5, 3.6, 3.7 and 3.8 respectively.

3.4.1.6 Normal Distribution

The data from the fifty-three significant neighbourhoods were then analyzed using descriptive statistics. Histograms were created in SPSS for all the variables described above. Most of the variables were not normally distributed. For analytical purposes, such as regression and correlation analysis, the population needs to be distributed normally. Variables without zeros were converted into LOG10 format using SPSS. Those variables with zeros, such as the ones describing the etiology and place of discharge were standardized using z-scores in SPSS. Table 3.3 shows the variable and whether it was normalized using LOG10 or standardized z-score.

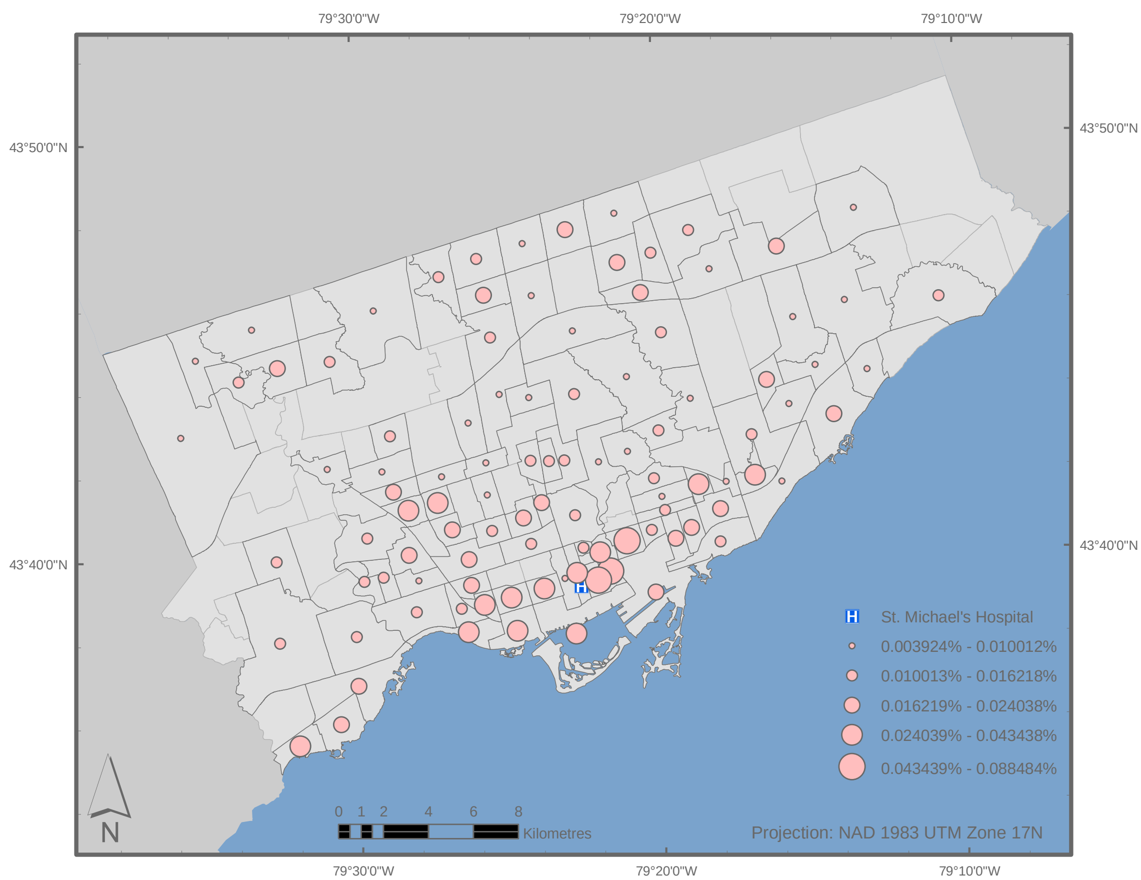

Figure 3.4 – Neighbourhood injuries per person

Table 3.3 – Neighbourhood costs

Name	Sum Grand Total	Cost per Person	Cost per Injury	Total Cost per Day
Agincourt South-Malvern West	$88,871.50	$4.93	$14,811.92	$1,184.95
Annex	$170,055.46	$6.89	$13,081.19	$1,518.35
Bayview Woods-Steeles	$9,763.39	$0.84	$4,881.69	$9,763.39
Beechborough-Greenbrook	$50,929.54	$9.01	$50,929.54	$1,958.83
Blake-Jones	$58,392.18	$8.98	$14,598.05	$1,883.62
Bridle Path-Sunnybrooke-York Mills	$83,373.32	$12.66	$41,686.66	$1,634.77
Cabbagetown-South St.Jamestown	$265,216.93	$27.02	$22,101.41	$1,829.08
Caledonia - Fairbanks	$133,056.85	$14.95	$33,264.21	$1,512.01
Casa Loma	$40,411.69	$4.86	$13,470.56	$1,347.06
Church-Yonge Corridor	$493,705.81	$23.83	$29,041.52	$1,169.92
Cliffcrest	$77,672.78	$6.42	$25,890.93	$1,553.46
Corsa Italia-Davenport	$82,935.85	$6.47	$13,822.64	$1,594.92
Don Valley Village	$432,029.74	$19.31	$39,275.43	$2,787.29
Dovercourt-Wallace Emerson-Junction	$451,822.48	$14.80	$34,755.58	$1,619.44
Dufferin Grove	$238,675.32	$22.17	$34,096.47	$1,429.19
East End Danforth	$166,296.38	$10.05	$18,477.38	$1,471.65
Greenwood-Coxwell	$227,862.16	$17.44	$32,551.74	$2,090.48
Henry Farm	$14,121.32	$1.52	$4,707.11	$1,569.04
Humbermede	$136,721.35	$11.83	$45,573.78	$1,571.51
Ionview	$244,220.33	$22.30	$81,406.78	$1,907.97
Junction	$344,577.81	$33.94	$49,225.40	$1,680.87
Keelesdale-Eglinton West	$73,268.62	$8.22	$10,466.95	$1,878.68
Kensington-Chinatown	$119,979.54	$8.05	$17,139.93	$1,131.88
Lambton-Baby Point	$131,454.13	$20.92	$65,727.07	$1,493.80
Little Portugal	$172,421.97	$15.08	$21,552.75	$1,981.86
Long Branch	$111,542.40	$12.89	$18,590.40	$1,616.56
Mimico	$122,606.10	$5.87	$12,260.61	$1,634.75
Moss Park	$1,087,789.48	$87.74	$33,993.42	$1,780.34
Mount Pleasant East	$66,916.64	$5.18	$16,729.16	$1,632.11
Mount Pleasant West	$88,211.57	$4.19	$17,642.32	$1,603.85
New Toronto	$160,434.12	$17.41	$32,086.83	$1,909.93
Niagara	$126,728.67	$12.53	$18,104.10	$1,440.10
North Riverdale	$73,589.05	$6.92	$8,176.56	$1,314.09
North St.Jamestown	$79,995.83	$5.25	$7,999.58	$1,860.37
Oakridge	$100,242.67	$14.18	$50,121.34	$2,570.32
Old East York	$72,313.36	$9.41	$24,104.45	$1,721.75
Parkwoods-Donalda	$251,821.20	$8.68	$35,974.46	$1,678.81
Pleasant View	$119,199.74	$8.26	$23,839.95	$1,528.20
Regent Park	$449,266.24	$56.79	$34,558.94	$1,670.13
Roncesvalles	$154,139.61	$11.53	$15,413.96	$2,028.15
Runnymede-Bloor West Village	$18,148.53	$2.26	$4,537.13	$1,296.32
South Parkdale	$289,606.36	$15.14	$22,277.41	$1,516.26

South Riverdale	$234,477.79	$10.44	$14,654.86	$1,662.96
Stonegate-Queensway	$110,955.90	$5.56	$22,191.18	$1,305.36
Trinity-Bellwoods	$183,765.35	$12.10	$20,418.37	$1,470.12
Waterfront Communities-The Island	$90,539.60	$5.40	$11,317.45	$1,741.15
West Hill	$126,058.72	$6.01	$21,009.79	$1,370.20
Westminster-Branson	$29,563.47	$1.42	$7,390.87	$1,970.90
Willowdale West	$22,300.88	$2.22	$7,433.63	$1,393.80
Woodbine Corridor	$324,357.87	$32.82	$54,059.64	$1,597.82
Woodbine-Lumsden	$74,691.13	$10.26	$18,672.78	$1,778.36
Wychwood	$126,874.92	$10.08	$15,859.37	$1,951.92
Yonge-St.Clair	$282,140.77	$28.46	$40,305.82	$1,906.36
Average	*$175,209.71*	*$13.99*	*$25,325.68*	*$1,821.04*

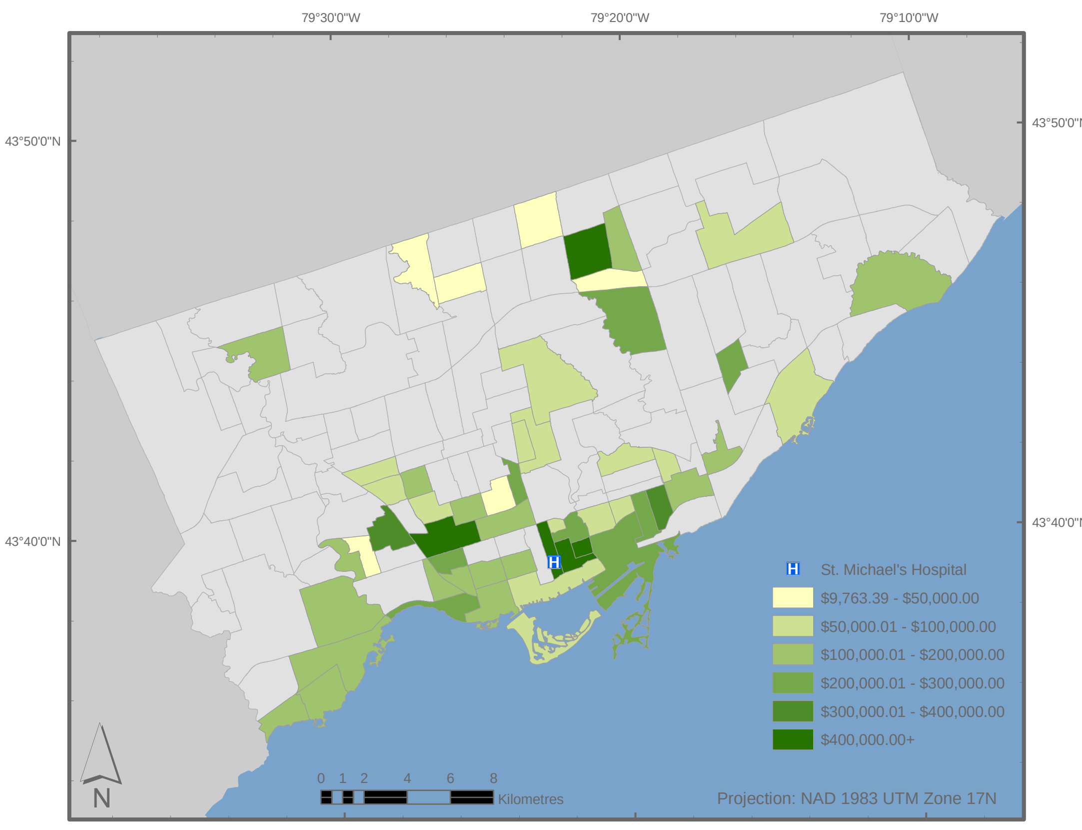

Figure 3.5 – Total neighbourhood costs

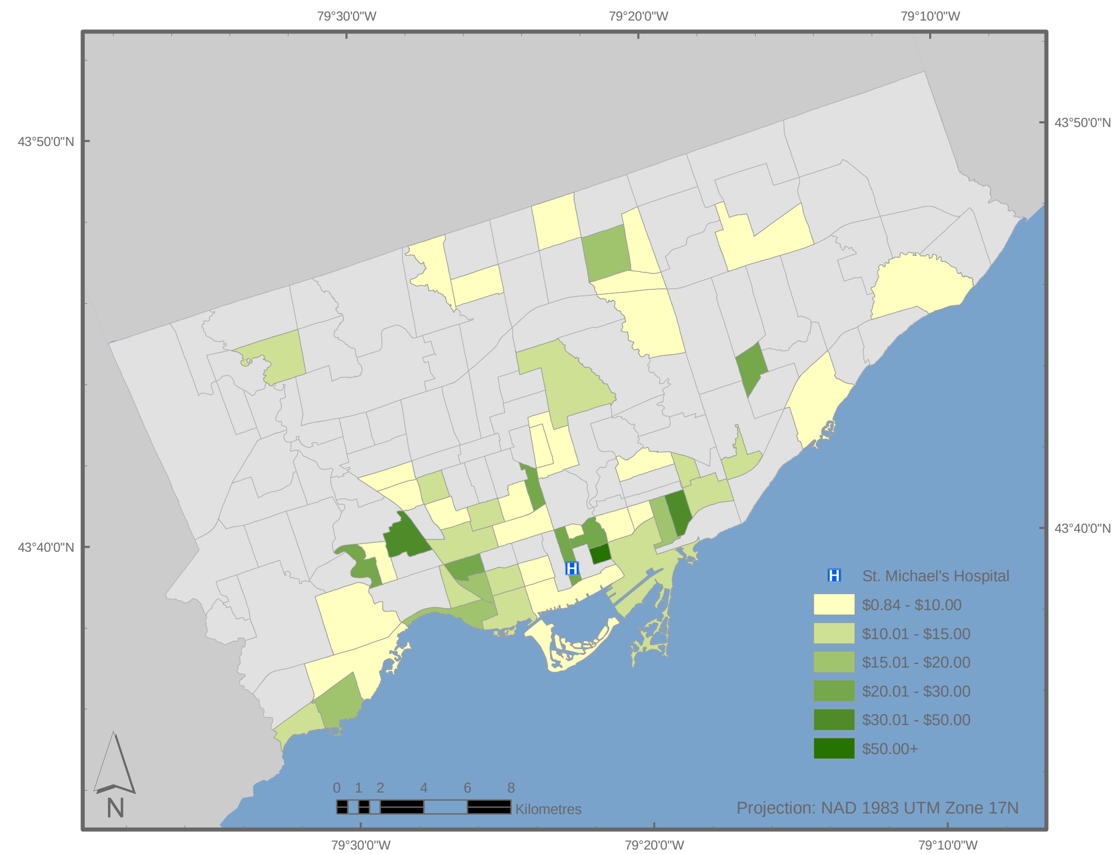

Figure 3.6 – Neighbourhood cost per person

3.4.2 Analysis

3.4.2.1 Multicollinearity

Before any analysis could be conducted using the variables in Table 3.3 a multiple collinearity matrix between variables was created and examined. To avoid multicollinearity in the analysis, variables from Table 3.3 were removed that were multicollinear. Refer to Appendix 2 for the complete matrix.

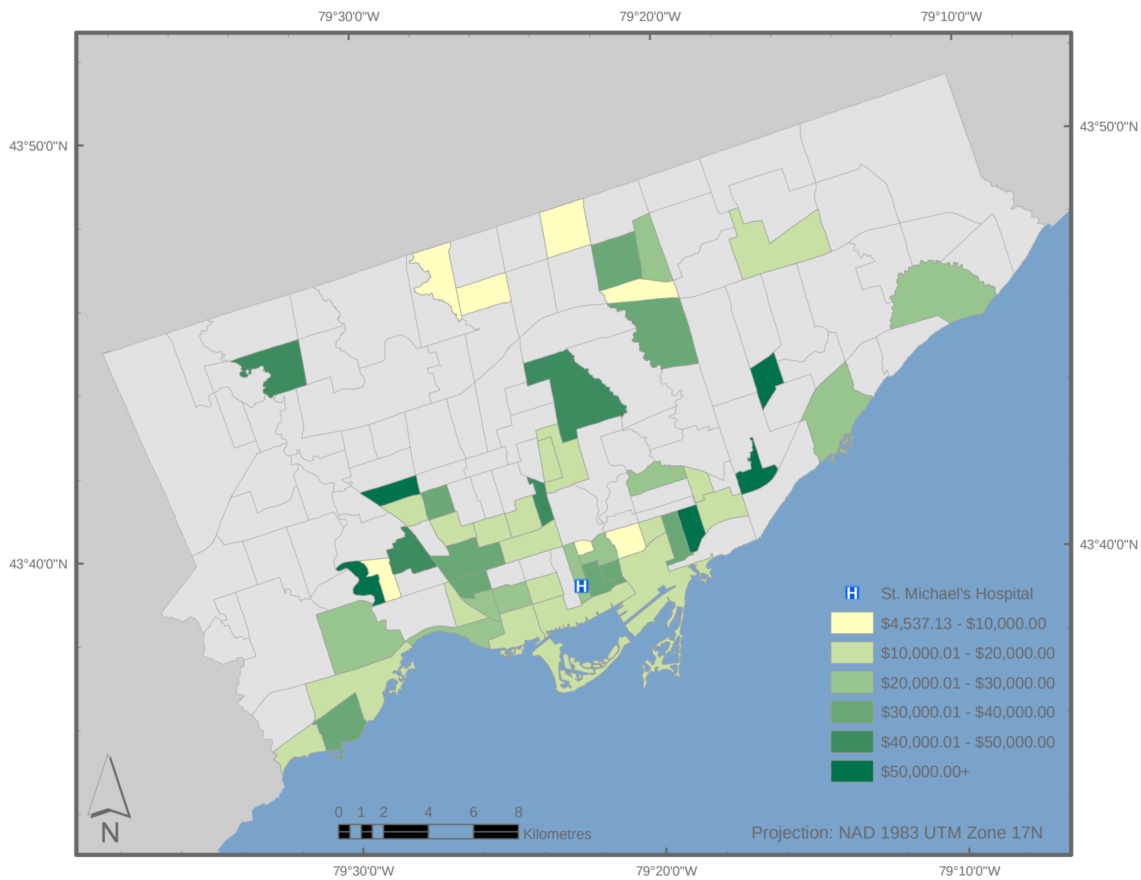

Figure 3.7 – Neighbourhood cost per injury

3.4.2.2 Linear Regression

Using SPSS, stepwise linear regression models were run to determine if the ranges in the different neighbourhood costs were accounted for by the different variables mentioned above. A linear regression model was used because all variables can be analyzed to determine if there was merit to the broad range of costs for the significant neighbourhoods. The stepwise technique runs the regression model numerous times until the best model is found. This technique also uses the most significant variables for the analysis.

The dependent cost variables including cost per person, cost per injury, cost per day and total cost, under analysis were examined using their log transformation. All independent variables were run in the step-wise analysis except for those dealing with other costs.

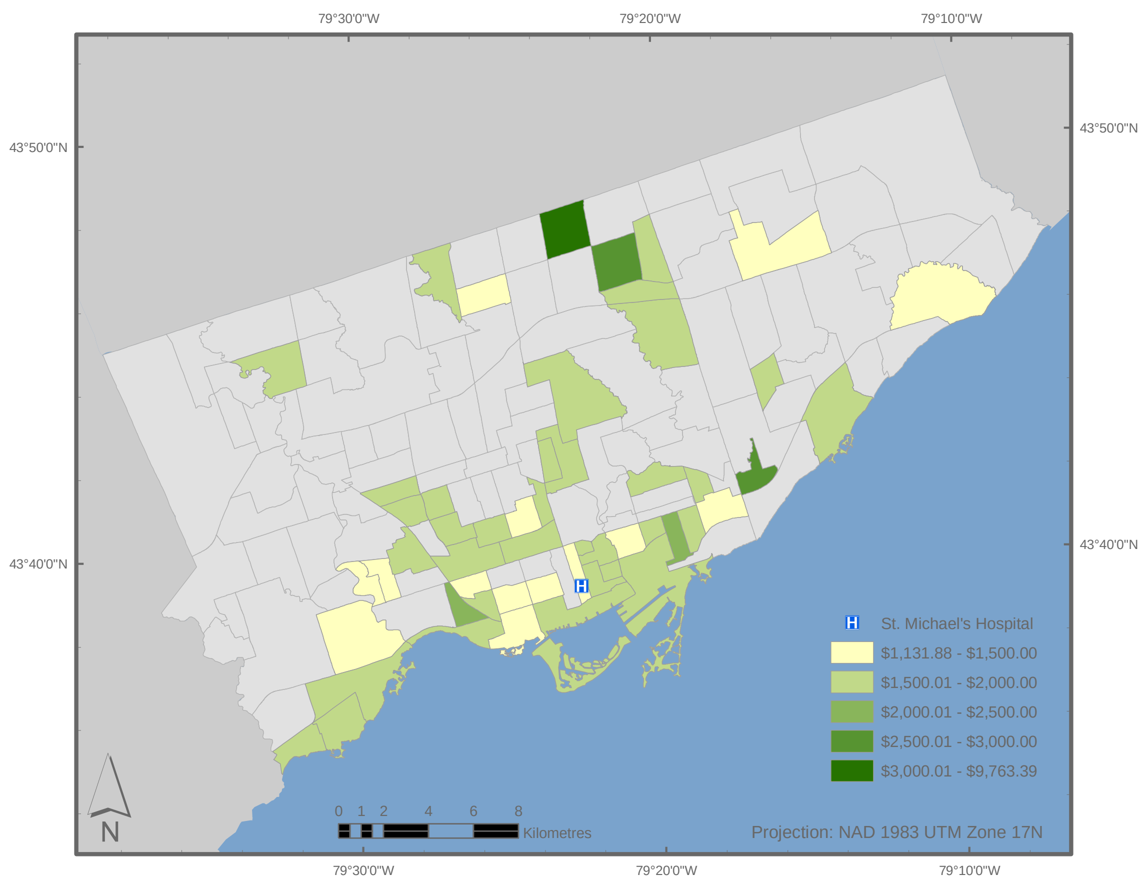

Figure 3.8 – Neighbourhood cost per day

Table 3.4 – Variable standardization method

Variable	Normalized	Variable	Normalized
Sum Grand Total	LOG10	% Falls	z-score
Cost per Person	LOG10	% Hom/Assult	z-score
Cost per Injury	LOG10	% MV Traffic	z-score
Average Cost per Day	LOG10	% Pedal	z-score
# of Injuries	z-score	% Other	z-score
Average Age	z-score	% ACF	z-score
Injuries per Person	z-score	% CCF	z-score
Average ISS	z-score	% GRC	z-score
Total ISS	z-score	% Home	z-score
Average LOS	z-score	% Home Support	z-score
% Manufacturing	z-score	% NHM	z-score
% Health	z-score	% Other	z-score
% Professional Jobs	z-score	% Special Rehab	z-score
% Other Services	z-score	% NA	z-score
% Retired	z-score	% Alive	z-score
% Other Jobs	z-score	% Dead	z-score
% Sales	z-score	% Injured at work	z-score
% Student	z-score	% Male	z-score
% Unknown	z-score	% Female	z-score
% Unemployed	z-score	NH Population 19 +	z-score
% Administrative	z-score		

3.5 Chapter Summary

This chapter describes the various methods and techniques used in this project. The transformation from raw data to normally distributed data, with little skewness, was an important aspect for the analysis. Also, the significant neighbourhoods for analysis greatly impact the results. The next two chapters discuss the results of the research and conclusions that can be drawn pertaining to the neighbourhood costs of unintentional injury.

CHAPTER 4: RESULTS

4.1 Introduction

The research conducted using St. Michael's Hospital data and the OTR database reveal results that stimulate further research and analysis for the spatial location of costs of unintentional injury.

4.2 Neighbourhood Descriptions

4.2.1 Significant Neighbourhoods in Toronto

The causes of unintentional injuries are an important aspect of the costs. The cost calculations are only for traumatic injuries with an ISS score greater than 12 and only for those patients 19 and older that were treated at St. Michael's Hospital (SMH). This is because this research adheres to the OTR Comprehensive Dataset standards and the data only applies to SMH patients. Figure 4.1 shows the various causes of injury for the significant neighbourhoods of St. Michael's Hospital. The predominant causes of injury are falls followed by motor vehicle traffic injuries and then homicides and assaults.

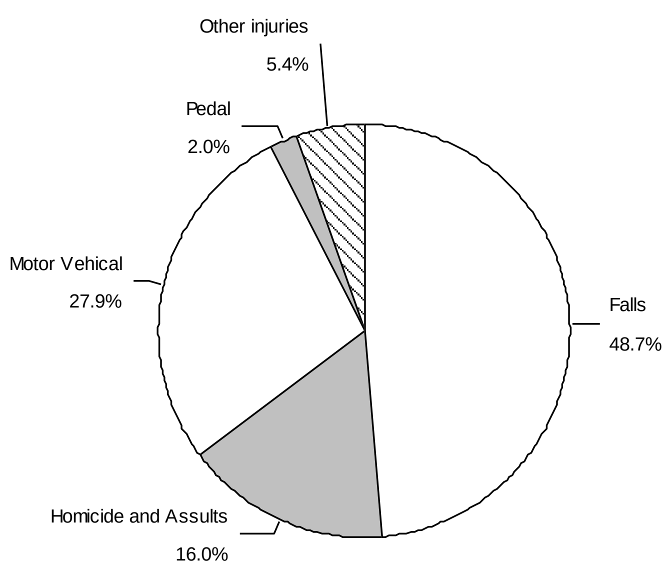

Figure 4.1 – Causes of injury proportions

The discharge status also plays a large role in the costs associated with unintentional injury. For example, if this study were to include costs beyond the emergency room, such as rehabilitation and continuing care, the direct costs of an unintentional injury would increase dramatically. For the significant neighbourhoods around St. Michael's Hospital, the majority of patients are discharged to their home, followed by discharge to their home with special care and by discharge to a general rehabilitation facility. Figure 4.2.1.2 shows the percentage breakdown of the discharge status.

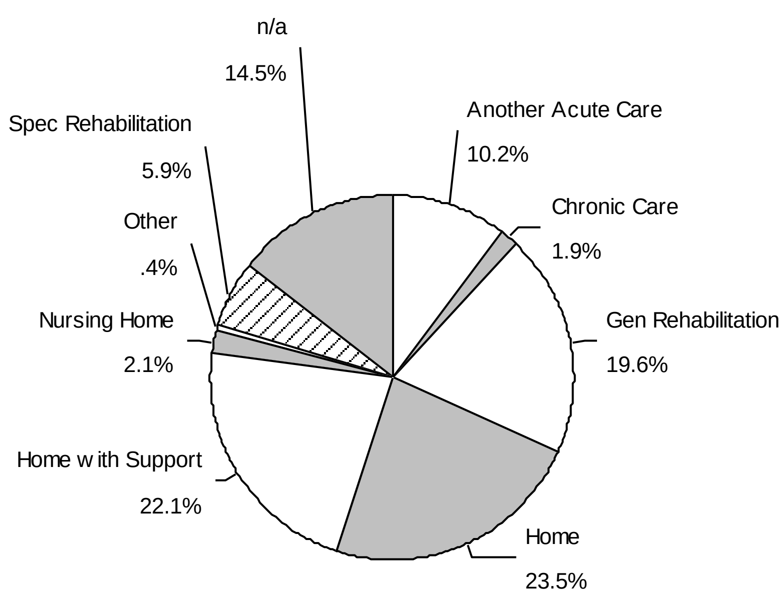

Figure 4.2 – Discharge status proportions

The gender of trauma patients from St. Michael's Hospital is shown in the figure 4.3.

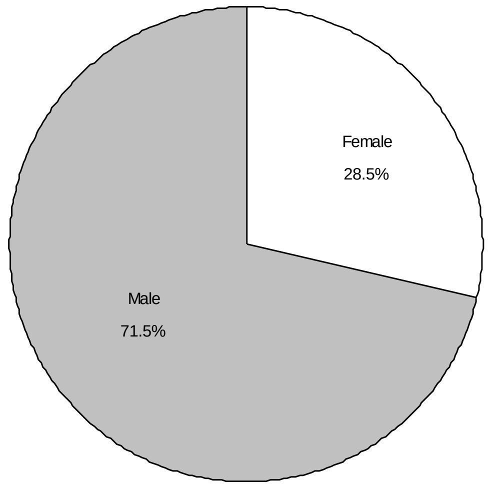

Figure 4.3 – Proportion of patients male and female

Another variable that has a role in calculating the cost of unintentional injury is the occupation of the injured. Below is a graph showing the percentage breakdown of the occupation of the patient.

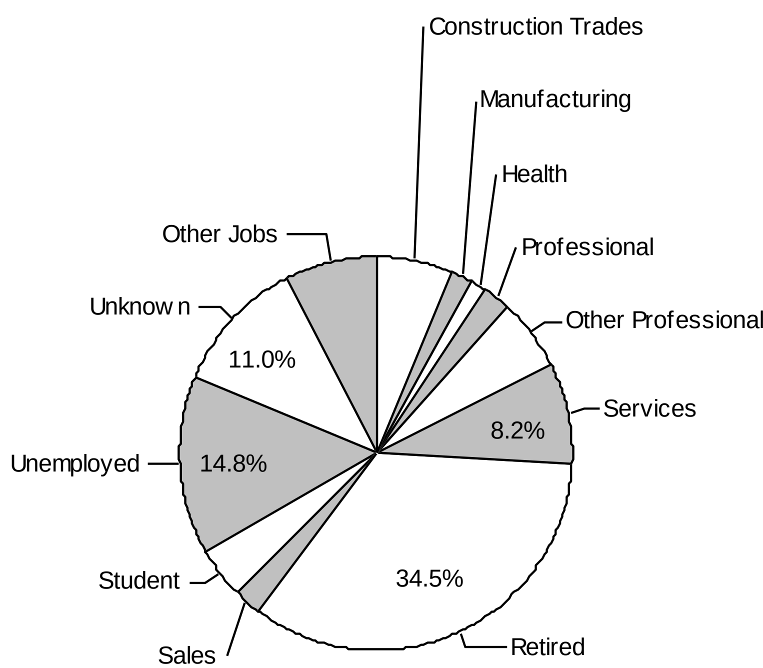

Figure 4.4 – Neighbourhood proportions of patient occupations

4.2.2 Neighbourhood Demographics

The neighbourhood demographics, such as its makeup and socio-economic characteristics, had no predictive capabilities in the multiple linear regression models. Variables such as neighbourhood income, education, ethnicity, religion, housing type, and age were tested as independent variables in the different models. None of these had any significant relationship with the dependent cost variables.

4.3 Regression Analysis Cost per Person

4.3.1 Step-wise Regression Model

The first step-wise regression model was run for the dependent variable average cost per person between neighbourhoods. This resulted in an adjusted R^2 value of 73.2%. The independent variables included Average Length of Stay (LOS) Zscore, # of Injuries Zscore and injuries from pedal vehicle incidents (Pedal) Zscore. There were 53 degrees of freedom in the lesser variance estimate and two degrees of freedom in the greater variance estimate. The F-statistic in the ANOVA test yielded a value of 48.4 indicating that this model was significant because the ANOVA null hypothesis was rejected.

4.3.2 Final Regression Model

The inclusion or exclusion of the variables above were tested using the enter method for multiple linear regression. It was found that with the same three variables: Average LOS Zscore, # of Injuries Zscore and Pedal Zscore generated the best results. These yielded the least amount of variables with a high R^2 value of 73.2%. This model was significant at 95% confidence for the F-statistic with 52, 3 degrees of freedom. Table 4.1 shows the coefficient output for the final and table 4.2 shows the ANOVA results.

Table 4.1 – The cost per person coefficient results

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	.990	.027		36.561	.000
Zscore: Avg LOS	.257	.027	.674	9.378	.000
Zscore: # of Injuries	.195	.028	.513	7.089	.000
Zscore: Pedal	8.001E-02	.028	.210	2.908	.005

Table 4.2 – The cost per person ANOVA results

	Sum of Squares	df	Mean Square	F	Sig.
Regression	5.652	3	1.884	48.458	.000
Residual	1.905	49	.039		
Total	7.557	52			

The end result reveals that the dependent variable for the neighbourhood's average cost per person increases when the neighbourhood's Average LOS Zscore, # of Injuries Zscore and Pedal Zscore increase. The predictive capabilities of this model are plotted in the figure 4.5, visually showing the accuracy of this model.

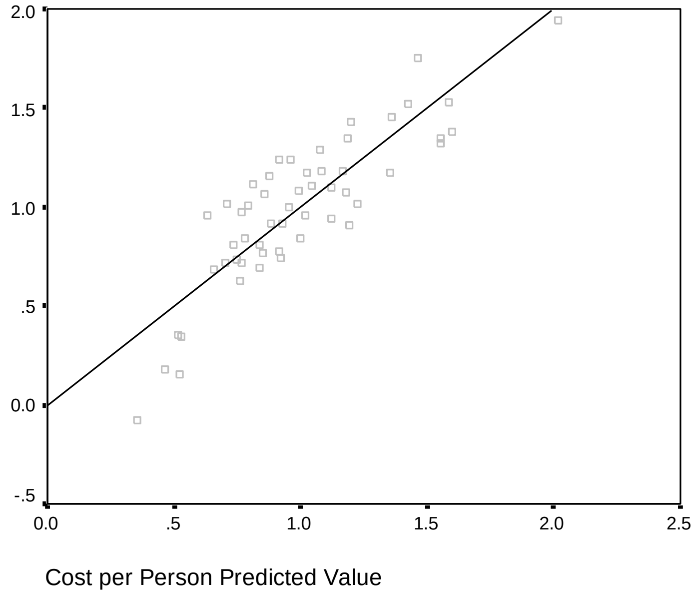

Figure 4.5 – The cost per person scatter plot for predicted versus actual values

4.3.3 Residual Values

The residual scatter plot for the dependent variable cost per person in Figure 4.6 shows a few neighbourhoods that have higher actual costs and higher residuals. These are the neighbourhoods that should have much lower costs based on this model. The costs should be lower because the predicted value is significantly smaller than the actual value. Figure 4.6 shows the residual values for each neighbourhood and Figure 4.7 shows the residual values for each neighbourhood. Table 4.10 lists the predicted and residual values for each neighbourhood.

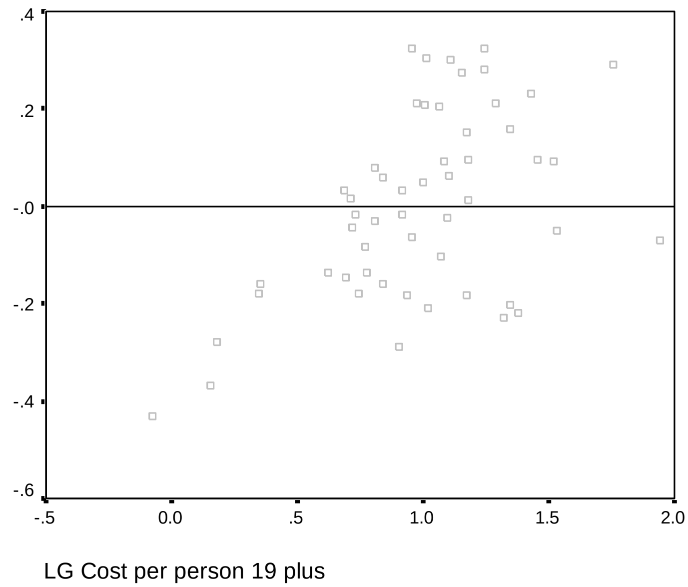

Figure 4.6 – The cost per person scatter plot of residual values

Also, the assumption of normality for the residuals of linear regression are somewhat adhered to. There is a slight positive skew, to the right, in the histogram of residuals displayed in Figure 4.8.

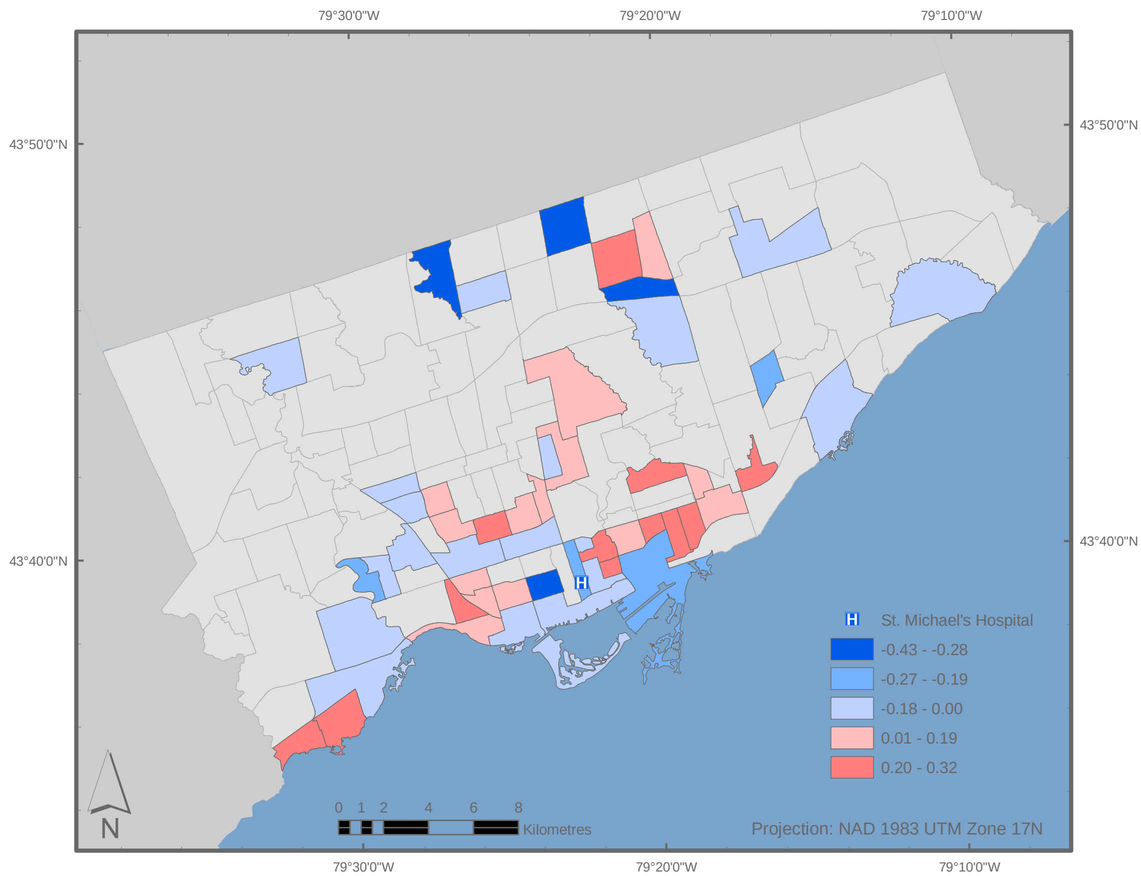

Figure 4.7 – Cost per person residual values

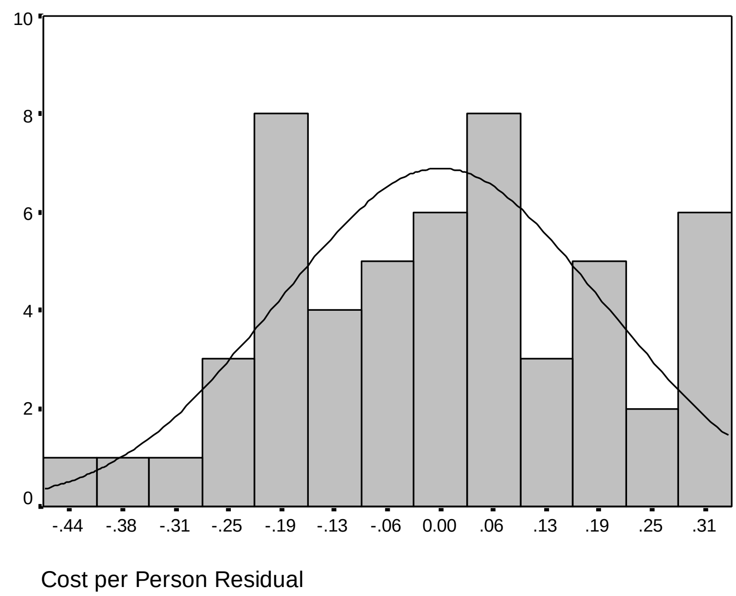

Figure 4.8 – The cost per person histogram of residual values

4.4 Regression Analysis Cost per Injury

4.4.1 Step-wise Regression Model

The step-wise regression model for the dependent variable of the average cost per injury between neighbourhoods resulted in an adjusted R^2 value of 84%.The independent variables included were Average LOS Z-Score, Other Services Z-Score and Sales Z-Score. There were 52 degrees of freedom in the lesser variance estimate and three degrees of freedom in the greater variance estimate. The F-statistic in the ANOVA test yielded a value of 92 indicating that this model was significant because the ANOVA null hypothesis was rejected.

4.4.2 Final Regression Model

The inclusion or exclusion of the variables above were tested using the enter method for linear regression. It was found that the three variables, Average LOS Z-Score, Other Services Z-Score and Sales Z-Score, yielded the best results, which were the least amount of variables with a high adjusted R^2 value of 84%. This model was significant at 95% confidence for the F-statistic with 52, 3 degrees of freedom. Table 4.3 shows the coefficient output for the final and Table 4.4 shows the ANOVA results.

Table 4.3 – The cost per injury coefficient results

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	4.315	.016		269.55	.000
Z-Score: Avg LOS	.258	.016	.884	15.886	.000
Z-Score: Other Services	4.582E-02	.016	.157	2.812	.007
Z-Score: Sales	4.232E-02	.016	.145	2.604	.012

Table 4.4 – The cost per injury ANOVA results

	Sum of Squares	df	Mean Square	F	Sig.
Regression	3.750	3	1.250	92.041	.000
Residual	.666	49	.014		
Total	4.416	52			

Therefore, the dependent variable for the neighbourhood's average cost per injury increases Average LOS Z-Score, Other Services Z-Score and Sales Z-Score increases. The predictive capabilities of this model are plotted in the figure 4.9, visually showing the accuracy of this model.

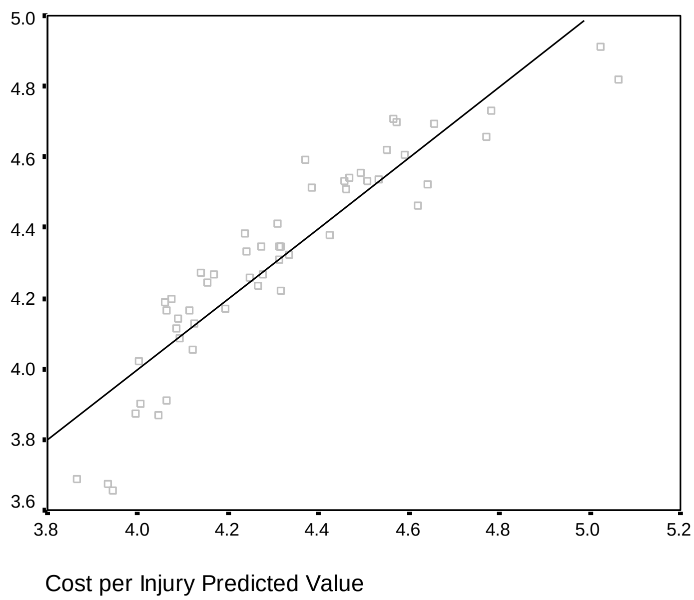

Figure 4.9 – The cost per injury scatter plot for predicted versus actual values

4.4.3 Residual Values

The residual scatter plot for the dependent variable cost per injury in figure 4.10 shows a few neighbourhoods in the middle ranges that have higher actual costs and higher residuals. There are also a few lower cost neighbourhoods per injury with low residuals.

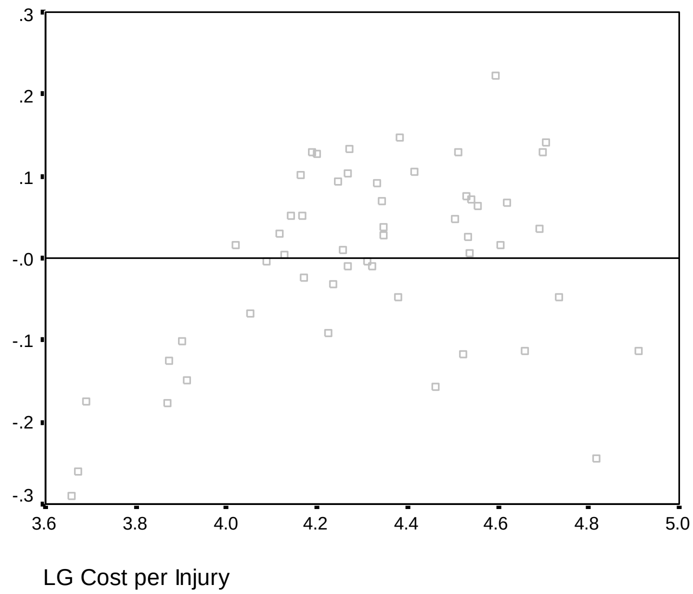

Figure 4.10 – The cost per injury scatter plot of residual values

Also, the assumption of normality for the residuals of linear regression are somewhat adhered to. There is a slight positive skew, to the right, in the histogram of residuals displayed in Figure 4.11. Figure 4.12 displays the residual values for each neighbourhood. Table 4.10 shows the predicted and residual values for each neighbourhood.

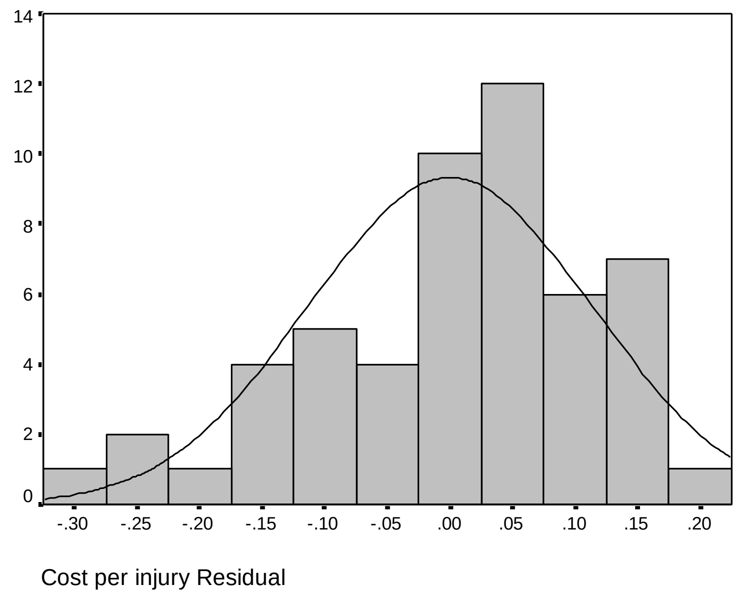

Figure 4.11 – The cost per injury histogram of residual values

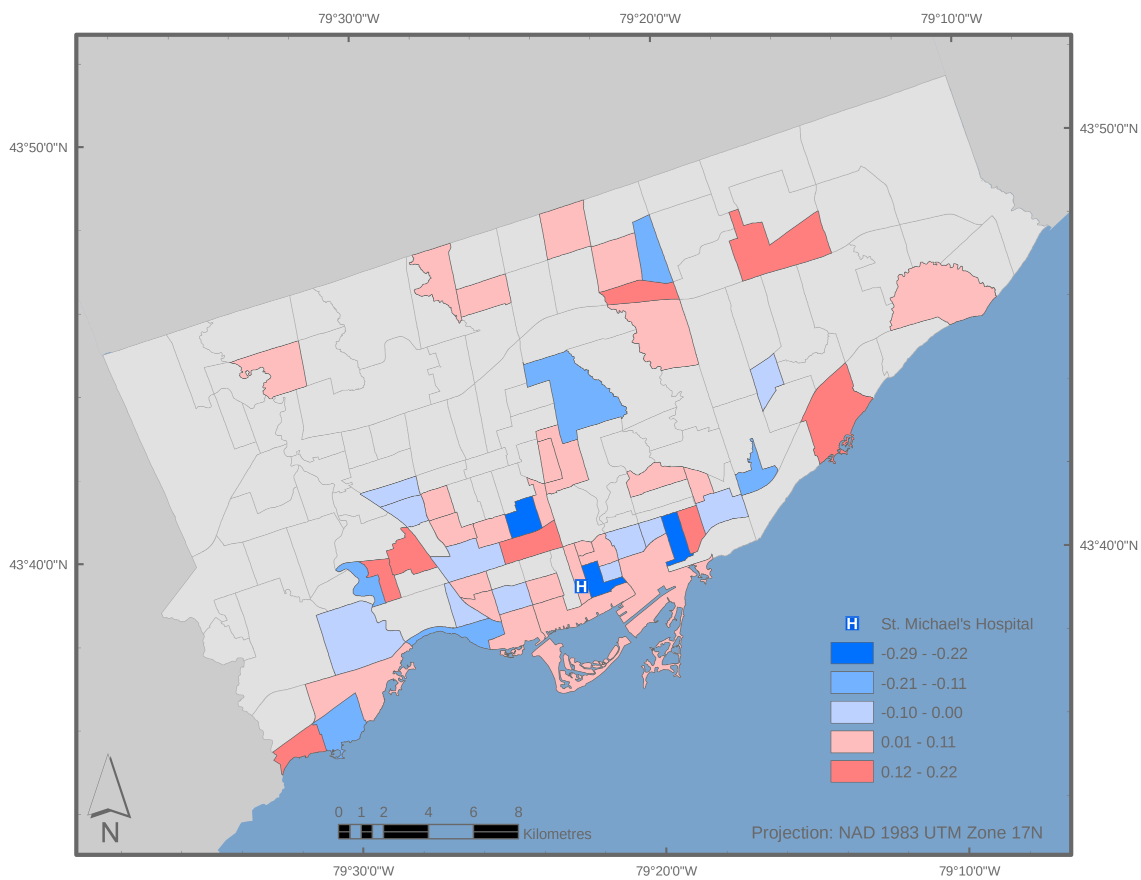

Figure 4.12 – Cost per injury residual values

4.5 Regression Analysis Total Costs per Neighbourhood

4.5.1 Step-wise Regression Model

The regression model for the dependent variable the total cost per neighbourhood when compared to other significant neighbourhoods resulted in an adjusted R^2 value of 79.5%. The independent variables included Average LOS Zscore, Total ISS Zscore and Administration Zscore. There were 52 degrees of freedom in the lesser variance estimate and three degrees of freedom in the greater variance estimate. The F-statistic in the ANOVA test yielded a value of 68.19 indicating that this model was significant because the ANOVA null hypothesis was rejected.

4.5.2 Final Regression Model

The inclusion or exclusion of the variables above were tested using the enter method for linear regression. It was found that with three variables Average LOS Zscore, Total ISS Zscore and Administration Zscore yields the best results, which were the least amount of variables with a high R^2 value of 79.5%. This model was significant at 95% confidence for the F-statistic of 68.19 with 52, 3 degrees of freedom. Table 4.5 shows the coefficient output for the final and table 4.6 shows the ANOVA results.

Table 4.5 – The total cost per neighbourhood coefficient results

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	5.083	.025		206.27	.000
Zscore: Total ISS	.264	.025	.666	10.353	.000
Zscore: Avg LOS	.234	.025	.591	9.192	.000
Zscore: Administration	-7.045E-02	.026	-.178	-2.704	.009

Table 4.6 – The total cost per neighbourhood ANOVA results

	Sum of Squares	df	Mean Square	F	Sig.
Regression	6.583	3	2.194	68.194	.000
Residual	1.577	49	.032		
Total	8.160	52			

Therefore, when the independent variables Average LOS Zscore and Total ISS Zscore, increase total cost increase. When the Administration Zscore increases the total costs decrease. The predictive capabilities of this model are plotted in the figure 4.13, visually showing the accuracy of this model.

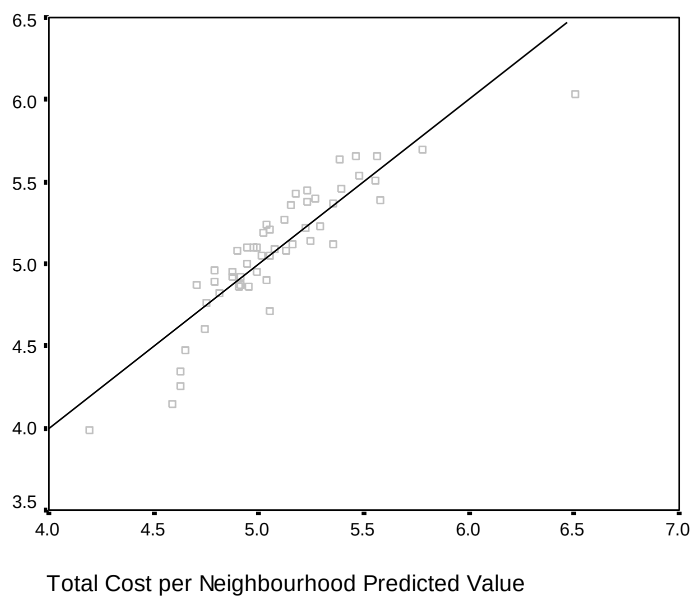

Figure 4.13 – The total cost per neighbourhood scatter plot for predicted versus actual values

4.5.3 Residual Values

The residual scatter plot for the dependent variable total cost per neighbourhood is shown in figure 4.14. Moss Park has the highest total cost and when of the lowest residual values. Also, this figure shows a few neighbourhoods in the middle ranges that have larger values. Figure 4.15 shows the residual values for each neighbourhood. Table 4.10 shows the predicted and residual values for each neighbourhood.

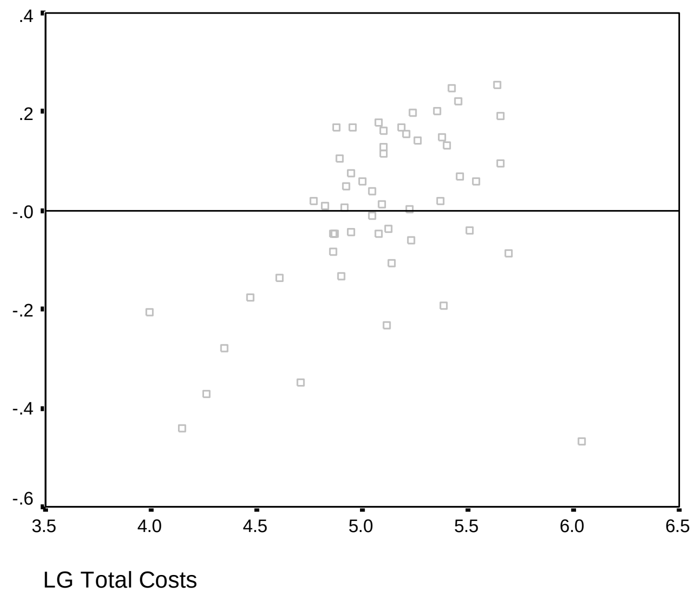

Figure 4.14 – The total cost per neighbourhood scatter plot of residual values

Also, the assumption of normality for the residuals of linear regression are somewhat adhered to. There is a slight positive skew, to the right, in the histogram of residuals displayed and displayed in figure 4.16.

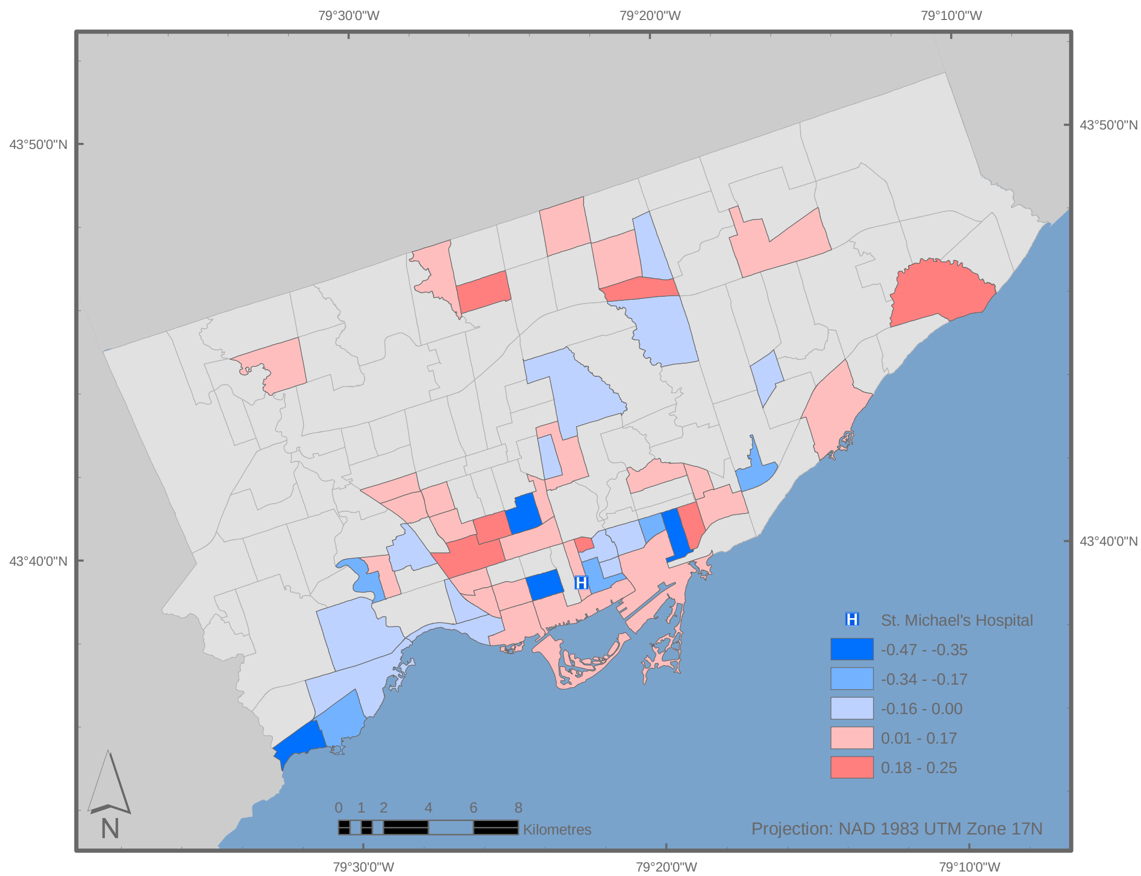

Figure 4.15 – Total neighbourhood cost residual values

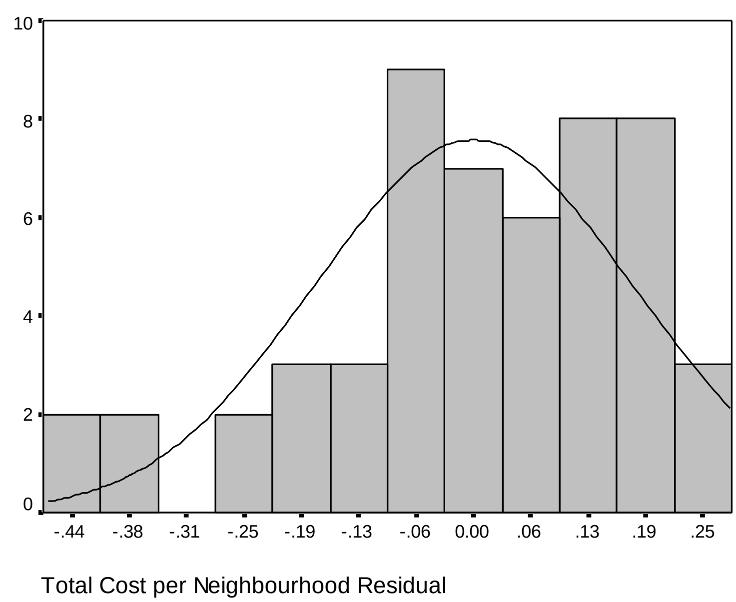

Figure 4.16 – The total cost per neighbourhood histogram of residual values

4.6 Regression Analysis Total Cost per Day

4.6.1 Step-wise Regression Model

The regression model for the dependent variable total cost per day between neighbourhoods resulted in an adjusted R^2 value of 45.9%. The independent variables included Average LOS Zscore, Student Zscore and Deceased Zscore. There were 52 degrees of freedom in the lesser variance estimate and three degrees of freedom in the greater variance estimate. The F-statistic in the ANOVA test yielded a value of 15.68 indicating that this model was significant because the ANOVA null hypothesis was rejected.

4.6.2 Final Regression Model

The variables above were analyzed using the enter method for linear regression. It was found that the three variables, Average LOS Zscore, Student Zscore and Deceased Zscore, yielded the best results which were the least amount of variables with a high adjusted R^2 value of 45.9%. This model was significant at 95% confidence for the F-statistic 15.68 with 52, 3 degrees of freedom. Table 4.7 shows the coefficient output for the final and table 4.8 shows the ANOVA results.

Table 4.7 – The total cost per day coefficient results

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	3.230	.013		244.69	.000
Zscore: Deceased	4.634E-02	.013	.355	3.461	.001
Zscore: Student	7.382E-02	.013	.565	5.526	.000
Zscore: Avg LOS	-3.209E-02	.013	-.246	-2.394	.021

Table 4.8 – The total cost per day ANOVA results

	Sum of Squares	df	Mean Square	F	Sig.
Regression	.435	3	.145	15.684	.000
Residual	.453	49	.009		
Total	.887	52			

Therefore, the dependent variable for the neighbourhood's total cost per day increases when the Student Zscore and Deceased Zscore increase and decreases when average LOS Zscore increases. This is the only model where the average length of stay reduces the cost per day. This is because the longer a patient stays in the hospital the overall costs per day decrease. The predictive capabilities of this model are plotted in the figure 4.17., visually showing the accuracy of this model.

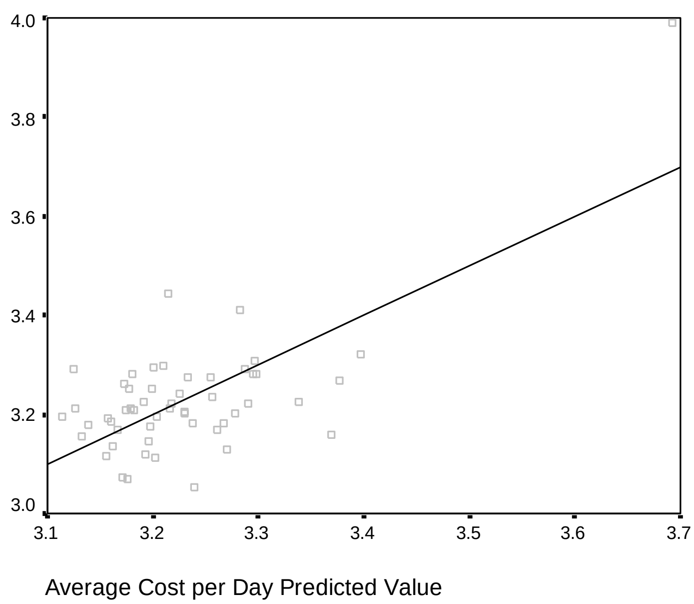

Figure 4.17 – The total cost per day scatter plot for predicted versus actual values

4.6.3 Residual Values

The residual scatter plot for the dependent variable total cost per day in figure 4.18 shows the largest variance of residuals for the low range values. Steeles neighbourhood is skewing the trend because it has a very high cost per day and a large residual. Figure 4.19 shows the residual values for each neighbourhood. Table 4.10 shows the predicted and residual values for each neighbourhood.

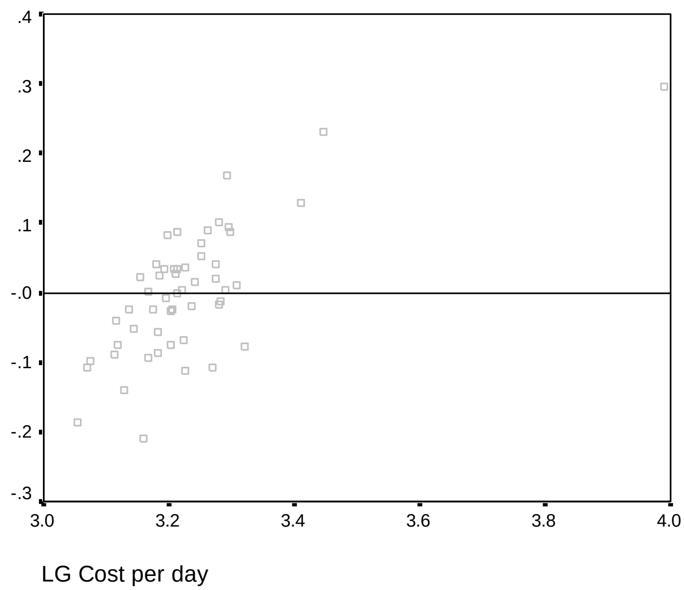

Figure 4.18 – The total cost per day scatter plot of residual values

Also, the assumptions of normality for the residuals of linear regression are adhered to and displayed in figure 4.20.

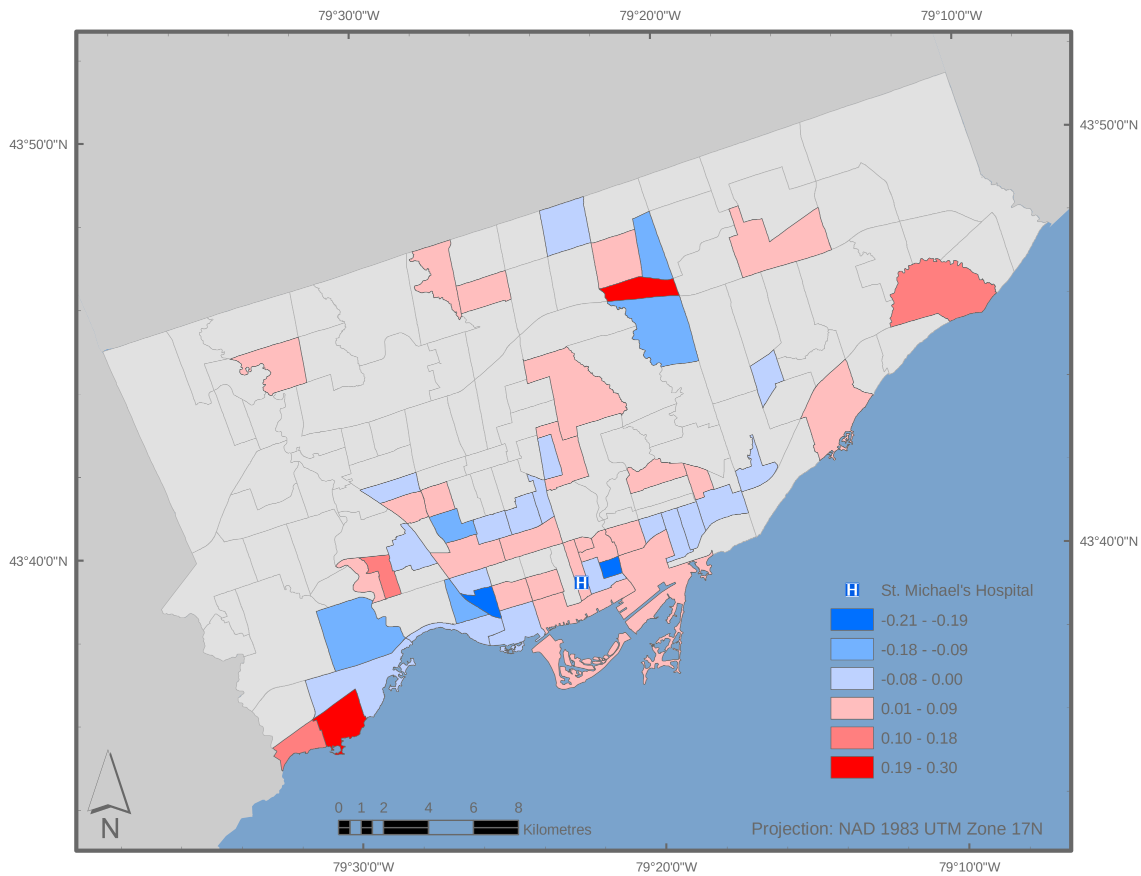

Figure 4.19 – Neighbourhood cost per day residual values.

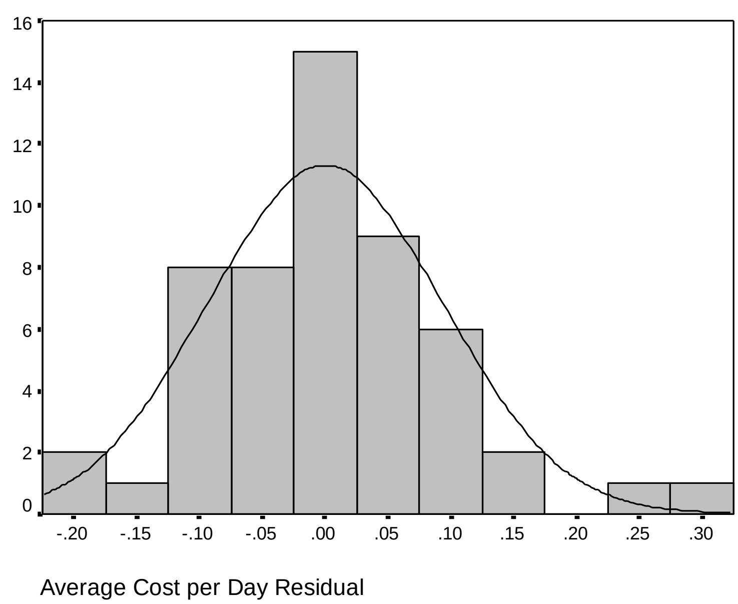

Figure 4.20 – The cost per person histogram of residual values

4.7 Regression Summary

The following two tables, 4.9 and 4.10, show the results for the final multiple linear regression models conducted in the previous sections. Table 4.9 shows the dependent variables adjusted R^2 results and the independent variables used to calculate the adjusted R^2. Table 4.10 shows the final multiple regression residuals and predicted values in LOG10 format.

Table 4.9 – Final multiple regression analysis R^2 results with independent variables.

Dependent Variables	**Cost per Person**	**Cost per Injury**	**Total Cost per Neighbourhood**	**Total Cost per Day**
Adjusted R^2	73.2%	84%	79.5%	45.9%
Independent Variables	+ Zscore: Avg LOS + Zscore: # of Injuries + Zscore: Pedal	+ Z-Score: Avg LOS + Z-Score: Services + Z-Score: Sales	+ Zscore: Avg LOS + Zscore: Total ISS - Zscore: Administration	- Zscore: Avg LOS + Zscore: Deceased + Zscore: Student

If the residual value was over predicted (having a negative value greater than one standard deviation) and predicted to have a large cost (greater than one standard deviation), these were the neighbourhoods with the potential for higher unintentional injury costs. These are the neighbourhoods not costing St. Michael's Hospital as much money as other neighbourhoods.

Table 4.10 – Final multiple regression residuals and predicted values in LG10 format (the red coloured values represent values plus one standard deviation above the normal, while the blue numbers represent values minus one standard deviation or more).

Neighbourhood	Cost per Person		Cost per Injury		Total Cost		Avg Cost per Day	
	Predicted	Residual	Predicted	Residual	Predicted	Residual	Predicted	Residual
Moss Park	2.01	-.07	4.46	.08	6.50	-.47	3.20	.05
Church-Yonge Corridor	1.60	-.22	4.62	-.16	5.78	-.09	3.18	-.11
Dovercourt-Wallace Emerson-Junction	1.35	-.18	4.47	.07	5.56	.09	3.18	.03
Regent Park	1.46	.29	4.53	.01	5.46	.19	3.29	-.07
Don Valley Village	1.07	.21	4.37	.22	5.38	.25	3.21	.23
Junction	1.58	-.05	4.66	.04	5.48	.06	3.19	.03
Woodbine Corridor	1.42	.09	4.78	-.05	5.55	-.04	3.28	-.07
South Parkdale	1.17	.01	4.31	.04	5.39	.07	3.24	-.06
Yonge-St.Clair	1.36	.10	4.59	.02	5.23	.22	3.18	.10
Cabbagetown-South St.Jamestown	1.20	.23	4.27	.07	5.18	.25	3.17	.09
Parkwoods-Donalda	1.12	-.18	4.49	.06	5.27	.13	3.34	-.11
Ionview	1.55	-.20	5.02	-.11	5.58	-.19	3.30	-.02
Dufferin Grove	1.19	.16	4.51	.03	5.23	.15	3.13	.02
South Riverdale	1.23	-.21	4.12	.05	5.35	.02	3.22	.00
Greenwood-Coxwell	.96	.28	4.38	.13	5.16	.20	3.40	-.08
Trinity-Bellwoods	.99	.09	4.31	.00	5.12	.14	3.17	.00
Little Portugal	1.08	.09	4.24	.09	5.04	.20	3.21	.09
Annex	1.00	-.16	4.09	.03	5.29	-.06	3.27	-.09
East End Danforth	.95	.05	4.28	-.01	5.22	.00	3.26	-.09
New Toronto	.92	.32	4.46	.05	5.05	.16	3.29	-.01
Roncesvalles	.86	.21	4.06	.13	5.02	.17	3.30	.01
Humbermede	1.18	-.10	4.77	-.11	5.24	-.11	3.11	.08
Caledonia - Fairbanks	1.02	.15	4.64	-.12	5.16	-.04	3.14	.04
Lambton-Baby Point	1.55	-.23	5.06	-.24	5.35	-.23	3.20	-.02
Wychwood	.79	.21	4.07	.13	4.99	.12	3.29	.00
Niagara	1.12	-.02	4.25	.01	4.94	.16	3.37	-.21
West Hill	.92	-.14	4.33	-.01	4.97	.13	3.16	-.02
Mimico	.85	-.08	4.09	.00	5.08	.01	3.22	.00
Kensington-Chinatown	1.19	-.29	4.27	-.03	5.13	-.05	3.24	-.19
Pleasant View	.88	.03	4.43	-.05	4.90	.18	3.16	.02
Long Branch	.81	.30	4.17	.10	5.01	.04	3.17	.03
Stonegate-Queensway	.92	-.18	4.32	.03	5.05	-.01	3.16	-.04
Oakridge	.88	.27	4.57	.13	4.94	.06	3.28	.13
Waterfront Communities-The Island	.75	-.02	4.12	-.07	4.79	.17	3.23	.02
Agincourt South-Malvern West	.84	-.15	4.19	-.02	4.99	-.04	3.17	-.10
Mount Pleasant West	.76	-.14	4.15	.09	4.87	.07	3.23	-.03
Bridle Path-Sunnybrooke-York Mills	1.04	.06	4.55	.07	4.87	.05	3.13	.09
Corsa Italia-	.73	.08	4.09	.05	4.91	.00	3.23	-.03

Davenport								
North St.Jamestown	.77	-.05	4.00	-.10	5.04	-.13	3.38	-.11
Cliffcrest	.84	-.03	4.31	.10	4.79	.10	3.16	.03
Woodbine-Lumsden	.71	.30	4.14	.13	4.71	.17	3.18	.07
North Riverdale	.78	.06	4.06	-.15	4.91	-.05	3.19	-.07
Keelesdale-Eglinton West	.93	-.02	4.00	.02	4.95	-.08	3.23	.04
Old East York	.76	.21	4.24	.15	4.90	-.05	3.26	-.02
Mount Pleasant East	.70	.02	4.32	-.09	4.82	.01	3.18	.03
Blake-Jones	.63	.32	4.06	.10	4.75	.02	3.25	.02
Beechborough-Greenbrook	1.02	-.06	4.57	.14	5.06	-.35	3.12	.17
Casa Loma	.65	.03	4.12	.00	4.74	-.14	3.27	-.14
Westminster-Branson	.52	-.37	4.05	-.18	4.65	-.18	3.20	.09
Willowdale West	.53	-.18	4.00	-.13	4.63	-.28	3.20	-.05
Runnymede-Bloor West Village	.51	-.16	3.95	-.29	4.63	-.37	3.20	-.09
Henry Farm	.46	-.28	3.93	-.26	4.59	-.44	3.20	-.01
Bayview Woods-Steeles	.35	-.43	3.86	-.17	4.19	-.21	3.69	.30
Mean	*.9902*	*.0000*	*4.3151*	*.0000*	*5.0829*	*.0000*	*3.2301*	*.0000*
Standard Deviation	*.32968*	*.19140*	*.26856*	*.11313*	*.35582*	*.17414*	*.09141*	*.09329*
+/- one SD	*1.31/0.66*		*4.58/4.05*		*5.44/4.73*		*3.32/3.14*	

If the residual value was under predicted (having a positive value greater than one standard deviation) and predicted to have a large cost (greater than one standard deviation), these were the neighbourhoods with the potential for lower unintentional injury costs. These are the neighbourhoods where a prevention program would be of greatest use. They are costing the hospital more money than they should such as Regent Park. If the residual value was over predicted, having a negative value greater than one standard deviation, and predicted to have a low cost, greater than one standard deviation; these were the neighbourhoods where the potential for even lower unintentional injury costs treated at St. Michael's Hospital. These are neighbourhoods where the costs should be lowered as well.

4.8 Cost per Person Summary

The average cost per person is the only cost variable that gives a true representation of the neighbourhood population cost. This is due to the fact that all the different neighbourhoods in Toronto have different populations. Taking these values into consideration provides a more quantifiable outlook on neighbourhood costs. For example, the following figures show the three neighbourhoods with the highest and lowest cost per person and the proportions of the independent variables that were used in the multiple-linear regression model.

Moss Park had 31 trauma patients for a total of 611 hospital days. Figure 4.21 and 4.22 represent the proportion of patients in Moss Park by the length of stay and the cause of injury.

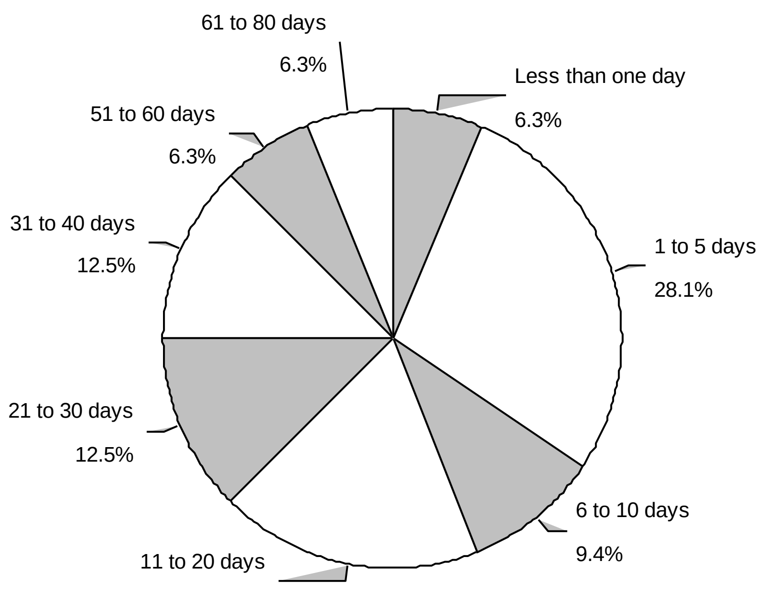

Figure 4.21 – Moss Park trauma patient’s length of stay

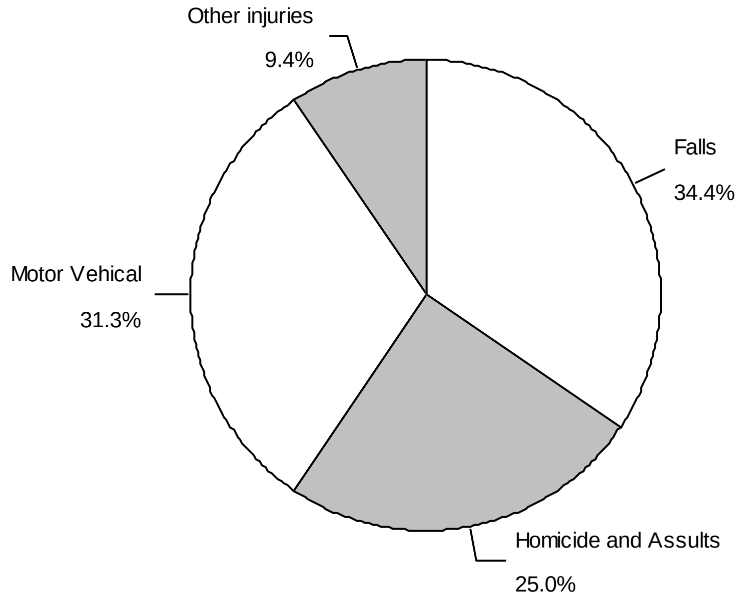

Figure 4.22 – Moss Park trauma patient's cause of injury

Regent Park had 17 trauma patients for a total of 269 hospital days. Figure 4.23 and 4.24 represent the proportion of patients in Regent Park by the length of stay and the cause of injury.

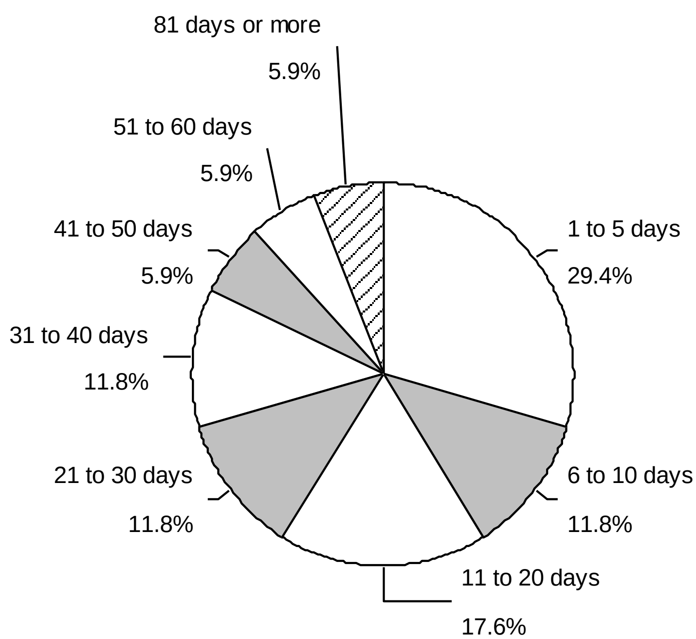

Figure 4.23 – Regent Park trauma patient's length of stay

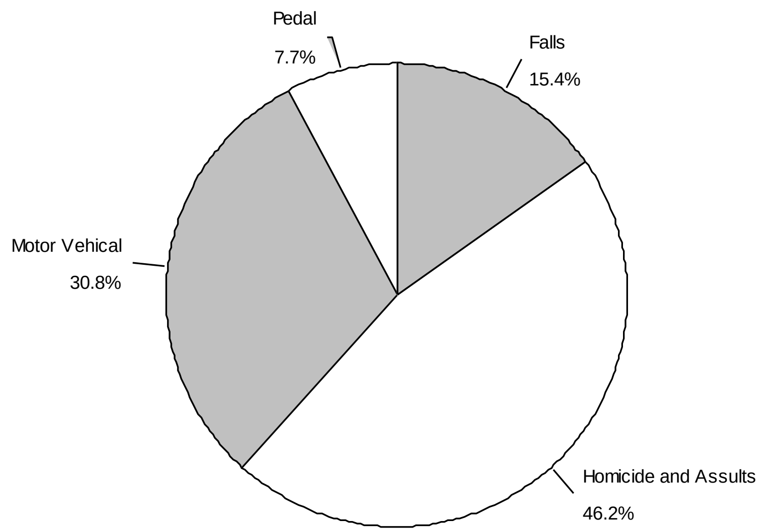

Figure 4.24 – Regent Park trauma patient's cause of injury

The Junction had 7 trauma patients for a total of 205 hospital days. Figure 4.25 and 4.26 represent the proportion of patients in Junction by the length of stay and the cause of injury.

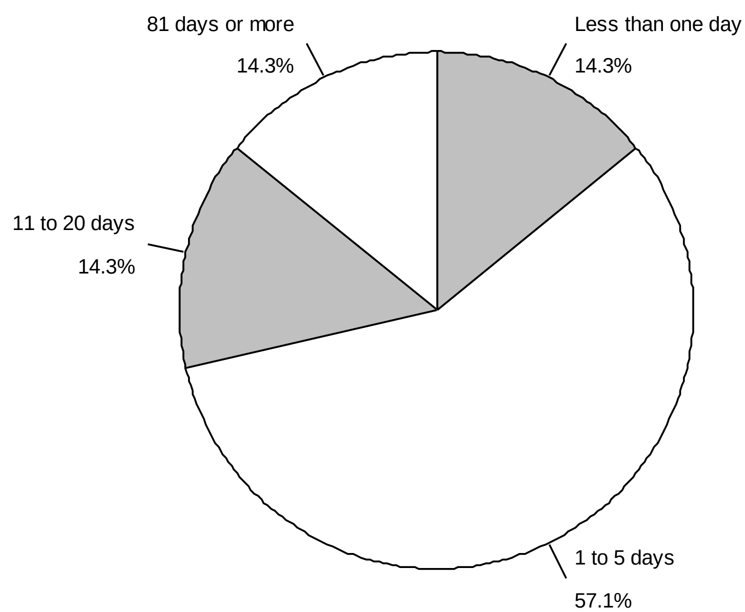

Figure 4.25 – Junction trauma patient's length of stay

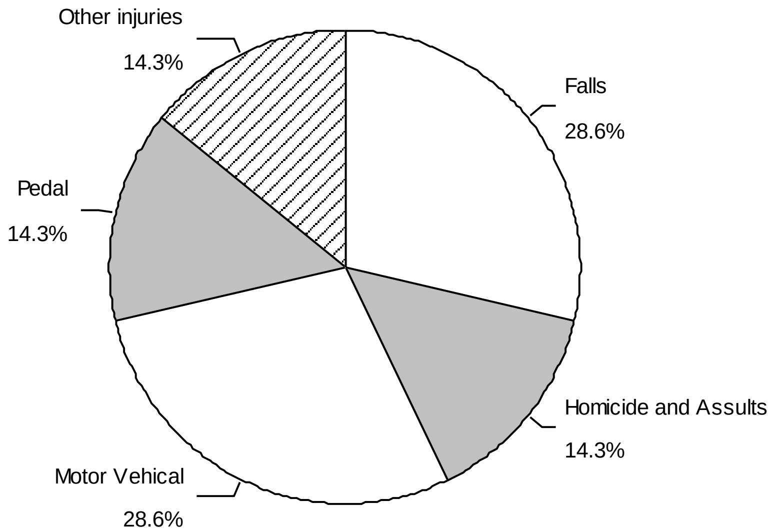

Figure 4.26 – Junction trauma patient's cause of injury

The three neighbourhoods that have the least cost per day are Herny Farm, Westminister-Branson and Bayview Woods-Steeles. The total cost per person in these neighbourhoods is $3.78. There were a total of 9 injuries for 25 hospital days. These factors, low number of injuries and short hospital stays, contribute to the extremely low costs per person.

4.9 Chapter Summary

This chapter highlighted the results for the descriptive information of the significant Toronto neighbourhoods as well as highlights the different cost variables. A few of the neighbourhoods have above average predicted costs and some have below average predictive costs. This analysis can be used to identify neighbourhoods with high costs to St. Michael's Hospital and ones that are higher or lower than predicted. This information could then be used to impact policy and prevention programs.

CHAPTER 5: CONCLUSION

5.1 Introduction

This chapter presents the limitations of the research conducted using the Ontario Trauma Registry Comprehensive dataset and St. Michael's Hospital decision support dataset for the years 2001 to 2003. The cost conclusions that can be drawn from this information are limited as well. Future research expansion ideas are presented at the end of this summary.

5.2 Limitations

The analysis of direct cost of unintentional injuries in Toronto, from the perspective of St. Michael's Hospital, has a few limitations. The years under examination are one limitation. More current data would yield more relevant results to the situation occurring today. Also, longer trends of unintentional injury may be different from the results presented in this paper. More years of data would allow for better conclusions, especially where there are low numbers of injured. Another limitation is the total cost calculation. At St. Michael's Hospital, the calculation of the indirect-direct costs that make up the total costs are under re-evaluation. A satisfactory method for calculating these costs has not been achieved.

To completely examine the costs of unintentional injury more data were needed. The indirect cost of unintentional injury was not examined; this would have raised the total costs of unintentional injury significantly and provided a better synopsis. Costs such as lost earnings, secondary care and continuing treatment all add to the overall cost of an injury.

The trauma patients under examination represent only one scenario of unintentional injury. There are also unintentional injuries with an Injury Severity Score of less than twelve and there are unintentional injuries for ages younger than nineteen years to consider. In addition, unintentional injuries that are not treated at hospitals are not included in the data as well as unintentional injuries that a coroner's office would record.

Another limitation when examining Toronto are the other hospitals treating trauma patients that have not been included in this study. St. Michael's Hospital treated 35% of trauma patients over the age of 19 from the comprehensive dataset. The other 65% were treated at Sunnybrook Hospital.

Protecting the privacy of those injured is a further limitation of this study. Data from St. Michael's Hospital were aggregated from point information to neighbourhood polygons. Specific information on individual cases was lost because this information could not be fully disclosed.

5.3 Research Conclusions

5.3.1 Data Summary

The following points summarize the results of the data analysis.

- The top five neighbourhoods costing St. Michael's Hospital the most money are Moss Park ($1,087,789.48), Church-Yonge Corridor ($493,705.80), Dovercourt-Wallace Emerson-Junction ($451,822.47), Regent Park ($449,266.23) and Don Valley Village ($432,029.73). Those that are costing the hospital much more than expected include Regent Park and the Don Valley Village.

- The top five neighbourhoods costing St. Michael's Hospital the most money per person are Moss Park ($87.73), Regent Park ($56.79), Junction ($33.93), Woodbine Corridor ($32.81) and Yonge-St.Clair ($28.45). based on the model, only Regent Park has costs significantly greater than expected.
- The top five neighbourhoods costing St. Michael's Hospital the most money per day are Bayview Woods-Steeles ($9,763.38), Don Valley Village ($2,787.28), Oakridge ($2,570.32), Greenwood-Coxwell ($2,090.47) and Roncesvalles ($2,028.15). Of these Bayview Woods-Steeles and Don Valley Village have costs significantly higher than expected.
- The top five neighbourhoods costing St. Michael's Hospital the most money per injury are Ionview ($81,406.77), Lambton-Baby Point ($65,727.06), Woodbine Corridor ($54,059.64), Beechborough-Greenbrook ($50,929.54) and Oakridge ($50,121.33). These neighbourhoods are predicted accurately to the model. However, Ionview and Lambton-Baby Point have predicted costs that are much higher than the actual costs.

5.3.2 Geographic Clusters

Cluster analysis techniques were run on the actual cost variables as well as the residual values from the different multiple linear regression models. It was concluded that no spatial clustering is present between the neighbourhoods and distance to the hospital does not play a factor in determining costs.

5.3.3 Recommendations

St. Michael's Hospital could put in place prevention programs at the top five, high cost neighbourhoods. Cost savings by prevention could be significant at these neighbourhoods. However, where there was a high significant residual value for the dependent variables outlined in the table 4.10, these are the neighbourhoods where costs should also be lower. Essentially, these neighbourhoods are not costing the most but are costing more than they should be. For example the cost per person in Regent Park had a LOG10 predicted value of 1.46 or $28.84 the actual value was $56.23. This result indicates that there is a $27.39 difference between what Regent Park cost per person actually was and what it should be. Similarly, the total cost at Regent Park had a high LOG10 residual value of 0.19. This indicates that there was a great difference between what the actual total cost and the predicted total cost. The total cost per day was $446,683.59 and a predicted value of $288,403.15 a difference of $158,280.03. Therefore, this neighbourhood costs St. Michael's Hospital more money than expected.

5.3.4 Future Research

More research should be conducted on the neighbourhood cost of unintentional injuries. This can be done in numerous ways. An analysis of the complete OTR database at the postal code level would be very beneficial especially if it were combined with the other necessary databases. This would enable one to calculate direct, indirect and total costs using the methods produced by Smart Risk. This could identify million or billion dollar neighbourhoods.

A more accurate calculation of direct costs of all hospitals, not just St. Michael's Hospital, could be conducted and used for definite costs and not just implied costs. Discrepancies for the cost per person and total costs, done in this study could be done for all the hospitals in Ontario.

This paper offers insight into how spatial information can be used to analyze the similarities and differences of geographic regions. Hopefully these research findings will act as a facilitator for future research.

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APPENDICES

APPENDIX 1 Dataset Definitions

1.1 Office of the Chief Coroner, Ontario

Organization Housing the Data Source

- The Office of the Coroner is mandated under the Coroners Act to investigate the cause of death and make recommendations to prevent further deaths. There are 350 coroners that cover the 9 regions in Ontario. The Office of the Coroner supports injury surveillance by providing injury surveillance groups and researchers with information based on the data collected in the Coroner's Information System.

Purpose of the Data Source

- The primary purpose of the Office of the Coroner is to fulfill the requirements of the Coroners Act by investigating individual deaths to determine the identity of the deceased; when, where and how the death occurred (the medical cause of death) and by what means the death occurred (Natural, Accident, Suicide, Homicide or Undetermined). The other purposes include reporting to the Minister of Community Safety and Correctional Services, the Ontario Registrar-General, Statistics Canada and Health Canada; upon request, providing information to family and insurance representatives for specific cases; providing data to various organizations with respect to conditions such as SIDS, suicide and head injury; providing data or file sharing with the Ontario and the national trauma registries; and, working with academic researchers. Data is also available to police, with appropriate safeguards, to assist with criminal and missing persons investigations. The Office also has a large library of jury recommendations and responses relating to Coroners Inquests. Data analysis is generally quantitative. Data are broken out by region and by broad categories such as means of death, (e.g. suicide, motor vehicle collision). Other analysis is performed for internal purposes to support quality assurance.

Injury-Related Content

- Classification of injury event: internal classification
- Geographic locators: street address, city, province, (for the injured person's place of residence) postal code
- Demographic variables: age, date of birth, sex
- Unique identifiers: assigned case number
- Place of injury occurrence : street address, city, province
- Place of death: street address, city, province
- Nature of injury: free text field and customized
- Multiple causes of injury: cause of death (e.g. trauma) and involvements (e.g. alcohol) are coded and supplemental information is documented in a free text field
- Anatomical location: free text field

- Multiple injuries: not recorded
- Index of injury severity: not applicable
- Pre-event circumstances: internal codes, free text field (e.g. equipment, environment, personal factors)

Data Collection Methods

- All unnatural deaths are investigated. Reported natural deaths are investigated at the coroner's discretion. Although anyone can report a suspicious death to a coroner, notification is usually done by the police, hospital, or health care providers. The investigating coroner collects primary data from the scene of death and reports findings. If necessary, the coroner also collects data from the autopsy and data gathered from the deceased's family or the police. Most reporting is done on paper; some reporting is done electronically. The regional coroner reviews the information and it is entered in the Coroners' Information System database and sent to the Toronto office, where data are checked again and verified for accuracy.

1.2 Ontario Trauma Registry

Organization Housing the Data Source

- The Ontario Trauma Registry (OTR) was established in May 1992. It is funded by the Ontario Ministry of Health and Long Term Care and housed in the Canadian Institute of Health Information (CIHI). CIHI is a national, non-profit organization working to improve the health of Canadians and the health system by providing high quality, timely health information. CIHI's mandate is to develop and maintain an integrated approach to Canada's health information system.

Purpose of the Data Source

- The OTRs main purpose is to help reduce injury and death in the province by identifying, describing, and quantifying trauma. This information plays a role in the planning and evaluation of injury control and prevention programs, examining legislative changes and cost expenditures, assisting in resource allocation decisions, and contributing to cost reductions.
- The OTR has three data sets that each serves different purposes.
    1. The OTR Minimal Data Set (OTR MDS) contains demographic, diagnostic, and procedural data on all acute car injury hospitalizations in Ontario. It also includes in-hospital deaths due to injury.
    2. The OTR Comprehensive Data Set (OTR CDS) contains detailed data on patients hospitalized due to major trauma in 11 lead trauma facilities in Ontario. Demographic, pre-hospital and hospital care, patient outcomes and six-month follow-up data are included in the data set. It does not, however, capture all trauma patients across the province.

3. The OTR Death Data Set (OTR DDS) contains data on all deaths due to injury that occur in Ontario. It includes demographic data, cause of death, injury details, and factors contributing to death.

Injury-Related Content

- Classification of injury events: OTR MDS - ICD-9 and ICD-10-CA OTR CDS - ICD-9 CM and ICD-10 OTR DDS - mapped to ICD-9 E- codes
- Geographic locators : OTR MDS - postal code (for the injured person's place of residence) OTR CDS - residence code OTR DDS - province, postal code
- Demographic variables : OTR MDS - age, date of birth, sex OTR CDS - age, date of birth, sex, occupation, language spoken OTR DDS - age, date of birth, sex
- Unique identifiers : OTR MDS - institution number, chart number, Ontario health card number OTR CDS - institution number, chart number, Ontario health card number, trauma number OTR DDS - deceased's name, file number, investigation number
- Place of injury occurrence : OTR MDS - ICD-9, ICD-10-CA OTR CDS - ICD-9 CM, geo codes OTR DDS - environment codes Nature of injury: OTR MDS - ICD-9, ICD-10-CA OTR CDS - ICD-9 CM OTR DDS - mapped to ICD-9 Anatomical location: OTR MDS - ICD-9, ICD-10-CA OTR CDS - ICD-9 CM OTR DDS - not recorded
- Multiple injuries: OTR MDS - ICD-9, ICD-10-CA OTR CDS - ICD-9 CM OTR DDS - not recorded
- Index of injury severity: OTR MDS - not recorded OTR CDS - AIS scale, ISS, GCS score, RTS, TRISS OTR DDS - not applicable
- Pre-event circumstances: OTR MDS - not recorded OTR CDS - personal factors (including blood alcohol level) Protective equipment usage, environment (excluding weather) OTR DDS – limited personal factors (such as alcohol involvement and protective devise use)

Data Collection Methods

- Data for the OTR CDS are received electronically on a monthly basis from 11 lead trauma facilities across Ontario that collect and code the data using Collector®, a trauma specific software. Twice a year the OTR undergoes a reconciliation process with the trauma centres. The OTR MDS is collected from the hospital health records that are sent to CIHI's Discharge Abstract Database. Once reconciled and finalized for the year the data set is downloaded to the OTR. The OTR DDS is collected from the files of the Ontario Office of the Chief Coroner. Trauma components from these files are incorporated into the OTR DDS. The OTR cannot identify First Nations/North American Indian, Inuit, or Métis populations.

1.3 St. Michael's Hospital Decision support dataset

- Trauma Number
- Emergency room and Inpatient Preoperative Services
- Emergency room and Inpatient Laboratory Services
- Emergency room and Inpatient Imaging Services (x-ray, Magnetic Resonance Imaging (MRI), Cat Scan..etc)
- Emergency room and Inpatient Cathethorization
- Emergency room and Inpatient Pharmacy
- Emergency room and Inpatient Allied Health such as physio and others
- Emergency room and Inpatient Ambulatory
- Emergency room and Inpatient Direct Cost
- Emergency room and Inpatient Total Cost
- Total Costs (Indirect Costs plus Direct Costs)
- Six digit postal code

APPENDIX 2 Multicollinearity Matrix

	Pop 19 plus	# of Injuries	Total ISS	Avg ISS	Total Age	Avg Age	Total LOS	Avg LOS	Female	Male	NAWork	Awork	Falls	Hom_As	MV	Pedal	Oinj
Population 19 plus	1.00	0.40	0.40	-0.07	0.39	-0.04	0.26	-0.14	0.07	-0.07	0.03	-0.03	-0.07	0.10	0.00	-0.16	0.11
# of Injuries	0.40	1.00	0.98	-0.03	0.97	-0.11	0.84	-0.06	-0.04	0.05	0.11	-0.11	-0.16	0.25	-0.06	0.11	0.06
Total ISS	0.40	0.98	1.00	0.12	0.96	-0.09	0.83	-0.03	-0.01	0.01	0.11	-0.11	-0.14	0.20	-0.05	0.13	0.05
Avg ISS	-0.07	-0.03	0.12	1.00	0.00	0.28	0.07	0.34	0.34	-0.34	0.00	0.00	0.19	-0.27	0.01	0.15	-0.12
Total Age	0.39	0.97	0.96	0.00	1.00	0.09	0.81	-0.07	0.04	-0.04	0.14	-0.14	-0.02	0.12	-0.10	0.09	0.00
Average Age	-0.04	-0.11	-0.09	0.28	0.09	1.00	-0.09	-0.02	0.41	-0.41	0.10	-0.10	0.70	-0.58	-0.24	-0.07	-0.28
Total LOS	0.26	0.84	0.83	0.07	0.81	-0.09	1.00	0.39	0.04	-0.03	0.15	-0.15	-0.17	0.18	0.03	0.09	0.02
Avg LOS	-0.14	-0.06	-0.03	0.34	-0.07	-0.02	0.39	1.00	0.10	-0.09	0.07	-0.07	-0.06	-0.19	0.26	0.02	-0.05
Female	0.07	-0.04	-0.01	0.34	0.04	0.41	0.04	0.10	1.00	-0.99	0.22	-0.22	0.15	-0.31	0.16	-0.06	-0.14
Male	-0.07	0.05	0.01	-0.34	-0.04	-0.41	-0.03	-0.09	-0.99	1.00	-0.20	0.20	-0.15	0.28	-0.13	0.07	0.15
Not injured at work	0.03	0.11	0.11	0.00	0.14	0.10	0.15	0.07	0.22	-0.20	1.00	-1.00	0.15	0.05	-0.02	-0.04	-0.45
Injured at work	-0.03	-0.11	-0.11	0.00	-0.14	-0.10	-0.15	-0.07	-0.22	0.20	-1.00	1.00	-0.15	-0.05	0.02	0.04	0.45
Falls	-0.07	-0.16	-0.14	0.19	-0.02	0.70	-0.17	-0.06	0.15	-0.15	0.15	-0.15	1.00	-0.48	-0.60	-0.11	-0.48
Homicide and Assults	0.10	0.25	0.20	-0.27	0.12	-0.58	0.18	-0.19	-0.31	0.28	0.05	-0.05	-0.48	1.00	-0.30	-0.07	0.13
Motor Vehical	0.00	-0.06	-0.05	0.01	-0.10	-0.24	0.03	0.26	0.16	-0.13	-0.02	0.02	-0.60	-0.30	1.00	-0.01	0.05
Pedal	-0.16	0.11	0.13	0.15	0.09	-0.07	0.09	0.02	-0.06	0.07	-0.04	0.04	-0.11	-0.07	-0.01	1.00	-0.06
Other injuries	0.11	0.06	0.05	-0.12	0.00	-0.28	0.02	-0.05	-0.14	0.15	-0.45	0.45	-0.48	0.13	0.05	-0.06	1.00
Construction Trades	0.07	-0.02	-0.03	-0.03	-0.05	-0.13	-0.11	-0.25	-0.16	0.12	-0.66	0.66	-0.19	0.31	-0.17	0.03	0.31
Manufacturing	-0.16	-0.06	-0.08	-0.15	-0.03	0.20	-0.06	-0.10	0.00	0.01	0.09	-0.09	0.29	-0.17	-0.24	0.20	-0.07
Medicine, Health	-0.05	0.01	0.03	-0.05	0.02	0.11	-0.08	-0.17	0.08	-0.08	0.07	-0.07	0.15	-0.12	-0.06	-0.12	0.02
Other Professional Jobs	-0.15	-0.10	-0.07	0.11	-0.13	-0.19	-0.11	-0.09	-0.04	0.05	0.08	-0.08	0.00	0.15	-0.22	0.12	0.15
Other Professional, Administration	-0.23	-0.25	-0.22	0.40	-0.24	0.12	-0.12	0.21	0.18	-0.17	0.15	-0.15	0.08	0.02	-0.09	0.01	-0.08
Other Services	0.08	0.07	0.04	-0.17	0.01	-0.15	0.09	0.07	-0.14	0.15	-0.01	0.01	-0.26	-0.07	0.37	0.02	0.02
Retired	0.12	-0.03	-0.03	0.13	0.15	0.83	-0.04	-0.04	0.30	-0.29	0.11	-0.11	0.58	-0.48	-0.21	-0.15	-0.16
Sales	-0.03	0.12	0.11	-0.05	0.10	-0.11	0.16	0.02	-0.20	0.20	-0.03	0.03	0.14	0.05	-0.12	0.05	-0.23
Student	0.01	-0.10	-0.11	-0.11	-0.19	-0.42	-0.03	0.06	-0.10	0.10	0.11	-0.11	-0.16	0.27	0.00	0.03	-0.06
Unemployed	0.03	0.32	0.31	-0.23	0.24	-0.46	0.29	0.07	-0.22	0.24	0.03	-0.03	-0.46	0.13	0.38	0.00	0.18
Unknown	0.07	0.04	0.06	0.05	-0.03	-0.36	0.01	0.04	-0.12	0.09	-0.02	0.02	-0.22	0.33	-0.05	0.24	-0.02
Other Jobs	-0.15	-0.20	-0.19	0.02	-0.21	-0.15	-0.23	-0.10	0.11	-0.12	-0.02	0.02	-0.01	0.08	-0.05	-0.12	0.05
Another Acute Care Facility	-0.07	-0.23	-0.25	-0.09	-0.16	0.37	-0.26	-0.30	0.06	-0.05	0.03	-0.03	0.24	-0.18	-0.06	-0.13	-0.12
Chronic Care Facility	0.24	0.29	0.29	0.00	0.33	0.15	0.34	0.08	0.16	-0.15	0.24	-0.24	-0.02	-0.05	0.08	0.17	-0.11
General Rehabilitation Facility	-0.03	-0.03	-0.02	-0.01	-0.04	-0.20	0.10	0.34	0.06	-0.05	-0.08	0.08	-0.40	-0.17	0.63	0.10	-0.03
Home	-0.02	0.10	0.07	-0.25	0.00	-0.41	0.05	-0.18	-0.28	0.27	0.00	0.00	-0.16	0.44	-0.29	0.25	0.11
Home with Support Services	0.04	-0.08	-0.08	0.15	-0.10	0.02	-0.14	-0.02	0.17	-0.18	-0.05	0.05	0.00	0.11	-0.13	-0.30	0.24
Nursing Home	0.25	0.27	0.25	-0.07	0.31	0.07	0.07	-0.19	0.17	-0.16	0.12	-0.12	0.11	-0.06	-0.08	0.05	-0.05
Other	-0.11	0.27	0.22	-0.17	0.26	-0.03	0.13	-0.12	-0.06	0.06	0.02	-0.02	-0.08	0.06	0.02	0.05	0.03
Special Rehabilitation Facility	0.05	-0.02	-0.03	-0.03	-0.02	0.09	0.02	-0.05	-0.01	0.00	-0.20	0.20	0.16	-0.16	-0.04	-0.03	-0.05
Deseased	-0.08	0.06	0.11	0.24	0.12	0.19	0.08	0.09	-0.12	0.12	0.15	-0.15	0.35	-0.04	-0.34	0.01	-0.16

	Trades	Man	Health	Pro	Admin	Services	Retired	Sales	Student	Unemp	unk	Ojobs	AAC	CCF	GRF	Home	HomeS	NH	Other	SRF	Died
Population 19 plus	0.07	-0.16	-0.05	-0.15	-0.23	0.08	0.12	-0.03	0.01	0.03	0.07	-0.15	-0.07	0.24	-0.03	-0.02	0.04	0.25	-0.11	0.05	-0.08
# of Injuries	-0.02	-0.06	0.01	-0.10	-0.25	0.07	-0.03	0.12	-0.10	0.32	0.04	-0.20	-0.23	0.29	-0.03	0.10	-0.08	0.27	0.27	-0.02	0.06
Total ISS	-0.03	-0.08	0.03	-0.07	-0.22	0.04	-0.03	0.11	-0.11	0.31	0.06	-0.19	-0.25	0.29	-0.02	0.07	-0.08	0.25	0.22	-0.03	0.11
Avg ISS	-0.03	-0.15	-0.05	0.11	0.40	-0.17	0.13	-0.05	-0.11	-0.23	0.05	0.02	-0.09	0.00	-0.01	-0.25	0.15	-0.07	-0.17	-0.03	0.24
Total Age	-0.05	-0.03	0.02	-0.13	-0.24	0.01	0.15	0.10	-0.19	0.24	-0.03	-0.21	-0.16	0.33	-0.04	0.00	-0.10	0.31	0.26	-0.02	0.12
Average Age	-0.13	0.20	0.11	-0.19	0.12	-0.15	0.83	-0.11	-0.42	-0.46	-0.36	-0.15	0.37	0.15	-0.20	-0.41	0.02	0.07	-0.03	0.09	0.19
Total LOS	-0.11	-0.06	-0.08	-0.11	-0.12	0.09	-0.04	0.16	-0.03	0.29	0.01	-0.23	-0.26	0.34	0.10	0.05	-0.14	0.07	0.13	0.02	0.08
Avg LOS	-0.25	-0.10	-0.17	-0.09	0.21	0.07	-0.04	0.02	0.06	0.07	0.04	-0.10	-0.30	0.08	0.34	-0.18	-0.02	-0.19	-0.12	-0.05	0.09
Female	-0.16	0.00	0.08	-0.04	0.18	-0.14	0.30	-0.20	-0.10	-0.22	-0.12	0.11	0.06	0.16	0.06	-0.28	0.17	0.17	-0.06	-0.01	-0.12
Male	0.12	0.01	-0.08	0.05	-0.17	0.15	-0.29	0.20	0.10	0.24	0.09	-0.12	-0.05	-0.15	-0.05	0.27	-0.18	-0.16	0.06	0.00	0.12
Not injured at work	-0.66	0.09	0.07	0.08	0.15	-0.01	0.11	-0.03	0.11	0.03	-0.02	-0.02	0.03	0.24	-0.08	0.00	-0.05	0.12	0.02	-0.20	0.15
Injured at work	0.66	-0.09	-0.07	-0.08	-0.15	0.01	-0.11	0.03	-0.11	-0.03	0.02	0.02	-0.03	-0.24	0.08	0.00	0.05	-0.12	-0.02	0.20	-0.15
Falls	-0.19	0.29	0.15	0.00	0.08	-0.26	0.58	0.14	-0.16	-0.46	-0.22	-0.01	0.24	-0.02	-0.40	-0.16	0.00	0.11	-0.08	0.16	0.35
Homicide and Assults	0.31	-0.17	-0.12	0.15	0.02	-0.07	-0.48	0.05	0.27	0.13	0.33	0.08	-0.18	-0.05	-0.17	0.44	0.11	-0.06	0.06	-0.16	-0.04
Motor Vehical	-0.17	-0.24	-0.06	-0.22	-0.09	0.37	-0.21	-0.12	0.00	0.38	-0.05	-0.05	-0.06	0.08	0.63	-0.29	-0.13	-0.08	0.02	-0.04	-0.34
Pedal	0.03	0.20	-0.12	0.12	0.01	0.02	-0.15	0.05	0.03	0.00	0.24	-0.12	-0.13	0.17	0.10	0.25	-0.30	0.05	0.05	-0.03	0.01
Other injuries	0.31	-0.07	0.02	0.15	-0.08	0.02	-0.16	-0.23	-0.06	0.18	-0.02	0.05	-0.12	-0.11	-0.03	0.11	0.24	-0.05	0.03	-0.05	-0.16
Construction Trades	1.00	-0.03	-0.11	0.22	-0.19	-0.15	-0.10	-0.10	-0.19	-0.11	0.06	0.13	-0.06	-0.18	-0.10	0.19	-0.01	-0.04	-0.02	0.19	-0.04
Manufacturing	-0.03	1.00	-0.09	0.11	-0.08	-0.07	-0.04	0.02	-0.12	-0.18	-0.05	0.26	0.10	0.02	-0.16	0.07	0.17	0.00	0.05	0.07	-0.19
Medicine, Health	-0.11	-0.09	1.00	0.06	-0.12	-0.13	0.10	-0.11	-0.08	-0.08	-0.05	0.05	-0.18	-0.07	-0.12	0.04	-0.03	-0.04	-0.05	0.37	0.15
Other Professional Jobs	0.22	0.11	0.06	1.00	-0.15	-0.21	-0.15	-0.13	-0.12	-0.05	0.19	0.48	-0.21	-0.12	-0.10	0.21	0.07	-0.15	-0.07	-0.11	0.17
Other Professional, Administration	-0.19	-0.08	-0.12	-0.15	1.00	-0.23	-0.09	-0.07	0.22	-0.19	-0.12	-0.18	-0.09	-0.12	-0.09	-0.04	0.23	-0.03	-0.05	-0.19	0.14
Other Services	-0.15	-0.07	-0.13	-0.21	-0.23	1.00	-0.16	-0.10	0.03	0.09	-0.22	-0.13	0.01	-0.04	0.20	0.05	-0.19	-0.01	0.03	-0.03	-0.08
Retired	-0.10	-0.04	0.10	-0.15	-0.09	-0.16	1.00	0.01	-0.45	-0.41	-0.34	-0.30	0.39	0.18	-0.18	-0.32	-0.15	0.11	-0.08	0.12	0.21
Sales	-0.10	0.02	-0.11	-0.13	-0.07	-0.10	0.01	1.00	-0.01	-0.04	0.03	-0.16	0.04	0.12	0.10	0.10	-0.21	-0.12	0.06	0.19	-0.15
Student	-0.19	-0.12	-0.08	-0.12	0.22	0.03	-0.45	-0.01	1.00	0.00	0.00	-0.03	-0.16	-0.15	0.10	0.19	-0.09	-0.18	-0.09	-0.01	0.04
Unemployed	-0.11	-0.18	-0.08	-0.05	-0.19	0.09	-0.41	-0.04	0.00	1.00	-0.12	-0.24	-0.26	0.09	0.38	-0.08	-0.01	0.12	0.18	-0.11	-0.18
Unknown	0.06	-0.05	-0.05	0.19	-0.12	-0.22	-0.34	0.03	0.00	-0.12	1.00	0.15	-0.20	0.15	-0.12	0.32	0.00	0.07	0.12	-0.17	0.04
Other Jobs	0.13	0.26	0.05	0.48	-0.18	-0.13	-0.30	-0.16	-0.03	-0.24	0.15	1.00	0.12	-0.23	-0.13	-0.02	0.39	-0.17	-0.14	-0.09	-0.17
Another Acute Care Facility	-0.06	0.10	-0.18	-0.21	-0.09	0.01	0.39	0.04	-0.16	-0.26	-0.20	0.12	1.00	-0.07	-0.22	-0.35	0.08	-0.19	-0.14	0.00	-0.28
Chronic Care Facility	-0.18	0.02	-0.07	-0.12	-0.12	-0.04	0.18	0.12	-0.15	0.09	0.15	-0.23	-0.07	1.00	0.01	-0.18	-0.05	0.05	0.01	-0.01	-0.01
General Rehabilitation Facility	-0.10	-0.16	-0.12	-0.10	-0.09	0.20	-0.18	0.10	0.10	0.38	-0.12	-0.13	-0.22	0.01	1.00	-0.35	-0.20	-0.17	-0.05	-0.20	-0.40
Home	0.19	0.07	0.04	0.21	-0.04	0.05	-0.32	0.10	0.19	-0.08	0.32	-0.02	-0.35	-0.18	-0.35	1.00	-0.36	0.12	0.24	0.10	0.14
Home with Support Services	-0.01	0.17	-0.03	0.07	0.23	-0.19	-0.15	-0.21	-0.09	-0.01	0.00	0.39	0.08	-0.05	-0.20	-0.36	1.00	-0.20	-0.02	-0.31	-0.30
Nursing Home	-0.04	0.00	-0.04	-0.15	-0.03	-0.01	0.11	-0.12	-0.18	0.12	0.07	-0.17	-0.19	0.05	-0.17	0.12	-0.20	1.00	0.33	0.08	0.14
Other	-0.02	0.05	-0.05	-0.07	-0.05	0.03	-0.08	0.06	-0.09	0.18	0.12	-0.14	-0.14	0.01	-0.05	0.24	-0.02	0.33	1.00	-0.11	-0.16
Special Rehabilitation Facility	0.19	0.07	0.37	-0.11	-0.19	-0.03	0.12	0.19	-0.01	-0.11	-0.17	-0.09	0.00	-0.01	-0.20	0.10	-0.31	0.08	-0.11	1.00	-0.07
Deseased	-0.04	-0.19	0.15	0.17	0.14	-0.08	0.21	-0.15	0.04	-0.18	0.04	-0.17	-0.28	-0.01	-0.40	0.14	-0.30	0.14	-0.16	-0.07	1.00