Neighbourhood Correlates of Childhood Injury: A Case Study of Toronto, Canada

by

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This study identifies the extent to which neighbourhood socioeconomic trends are related to intentional and unintentional child injuries, using Toronto, Ontario, as a case study. Children living in lower socioeconomic status (SES) neighbourhoods have often been found to face a higher injury death and morbidity rate than more well-off children. A likely explanation is an increase in the unequal exposure to injury-promoting environments on the basis of the income polarization (a declining middle income group). However, the strength of the inverse relationship between SES and injury is related to a number of factors, including the SES indicator chosen by the researcher. Hence, a goal of the study is to determine whether neighbourhood socioeconomic trends toward income polarization have predictive power in explaining variation in injury rates in young children aged 0-6, over and above more typical measures of SES and neighbourhood disadvantage.

Census data were used to determine socioeconomic trends. Neighbourhoods (census tracts) were divided into three distinct categories based on neighbourhood change in average individual income: neighbourhoods that have been improving, declining, and those displaying mixed trends. This analysis of neighbourhoods was merged with geo-coded hospital-based emergency department data to calculate rates of overall injuries, falls, burns and poisoning. The predictive power of neighbourhood socioeconomic trends on injury was compared to more typical
neighbourhood disadvantage measures such as income (high, medium, low), neighbourhood employment rates, education levels, and housing quality from the 2006 census.

Socioeconomic trends contributed significantly to injury outcomes, but the contribution of other neighbourhood disadvantage indicators was higher. Housing in need of repair and individuals with no university degree in a neighbourhood were positively correlated with three of four outcomes. A high immigrant population in a neighbourhood was negatively correlated with three of four outcomes. Neighbourhood socioeconomic trends had slightly more predictive power than the more typical measure of SES (high, medium or low income). Researchers should carefully consider their socioeconomic status measures when predicting injury outcomes.
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Chapter 1: Introduction

Rationale for the Study

In Canada, injury is the leading cause of death among those 1 to 44 years old (Smartrisk, 2009), and the fifth leading cause of death overall (Statistics Canada, 2008). Injury can occur unintentionally or as the result of a deliberate act of harm. In broad terms, about 90% of fatal injuries to children are classified as unintentional, meaning that the injury was not meant to harm the victim (World Health Organization, 2006). Unintentional injuries are the leading cause of death and a leading cause of disability for Canadian children, killing at least 900 children and youth each year (Health Canada, 2005), while intentional injuries are the fifth leading cause of death for children age 1-14 (Safe Kids Canada [SKC] 2006a). Although there is disagreement about what exact proportion can be prevented, researchers estimate that about 70-90% of injuries among children could be prevented by initiatives that are already known (Rivara & Grossman, 1996; SKC, 2006b).

Therefore, there are few truly random and unpreventable injuries. Injuries occur according to patterns and can be predicted and prevented. Because the economic burden of death and disability due to injury is staggering; namely, $19.8 billion for unintentional and intentional injuries in Canada (Health Nexus Santé, 2010), there is a need to further identify factors that increase children’s risk of injury so that prevention programs may be informed (Finney et al. 1993).

Milder injuries seen in the emergency department (ED) are more common than severe injuries or deaths and therefore represent a large proportion of economic burden (Thagalimasa, 2001). An estimate by Health Canada (1999) suggests that for every 670 ED visits for the
treatment of injuries, there are 40 hospitalizations and one injury-related death. ED data may provide increasingly applicable information for researchers and practitioners because hospitalizations for neurotrauma have decreased over time while treatment in EDs has increased (Colantonio et al., 2010). ED data represent a meaningful injury threshold because individuals represented in them have been assessed to require emergency medical care. Examining the population of ED attendees is also important due to the possibility their injuries could be risk factors for more serious injury problems in the future (Cataldo et al., 1992).

Identifying injury risk factors is a key task for those in the health and social service sectors. There have been calls for researchers and practitioners to develop a greater understanding of the type and nature of injury deaths, morbidities and disabilities, and also of the children who are most affected by injury (Peden, et al. 2008). According to UNICEF (2001), “the attempt to analyze and prevent child injury must therefore be further informed by knowledge of ‘who’ as well as ‘what’” (p. 14). Additional information on the ‘who’ may further illuminate what type of populations should be targeted for particular prevention programs (Cusimano, Chipman, Glazier, Rinner, & Marshall, 2007). Currently, age of victim is an important factor, with children from birth to approximately age 6 being particularly vulnerable to injury in and around their homes (SKC, 2006). Hence, studies focusing on children from birth to age 6 can help address the burden of injury.

Preventing injury is closely related to other issues of child health. There is an established relationship between socioeconomic conditions and child health, with less advantaged children generally experiencing poorer health and social outcomes than their more well-off counterparts (CICH, 2000). Area-based studies from the US and UK suggest the socioeconomic inequality in injury death rates among children has widened in recent years. A likely explanation is an
increase in the unequal exposure to injury-promoting environments on the basis of widening income differentials (Edwards, et al., 2006; Roberts & Power 1996; Singh & Kogan, 2007). These consolidations of urban advantage and disadvantage may represent an environment with which to study the relationship between socioeconomic conditions and injury. Thus, case studies in metropolitan areas may be a useful direction with which to develop greater understanding of the type and nature of injury morbidities and of the children who are most affected by injury.

Toronto, Ontario serves as an interesting case study to examine the relationship between area-level socioeconomic status and childhood injury for two reasons. First, Toronto is a unique city in the province of Ontario with respect to its high level of universal childhood safety programs. Some of these programs have been very successful and may mute the effects of hazardous social and physical environments in disadvantaged areas¹.

Second, Toronto has increasing levels of neighbourhood polarization on the basis of socioeconomic status SES and ethnocultural origin. Over the last 35 years, Toronto has become increasingly polarized on the basis of socio-economic status and ethno-cultural origin. Until the mid-1980s, Toronto was a city with a majority of middle-income neighbourhoods. Since then, Toronto has become increasingly divided into distinct socio-spatial consolidations of wealth and poverty, leading researchers to conclude there are now three distinct “cities” in Toronto (Hulchanski, et al., 2010). Based on the trends in neighbourhood average individual income over the last 35 years, these “cities” can be categorized into

- City #1, a 20% of the city’s neighbourhoods that has become increasingly affluent;

¹ For example, in the late 1990s the Toronto District School Board assessed almost 400 schools across the city and replaced all unsafe playground equipment, with a resulting drastic reduction in playground injury rates (Hemenway, 2009). The Safe Routes to School (SR2S) program in Toronto addresses child pedestrian injuries and has a high level of participation (Ontario Injury Prevention Resource Centre, 2005). Experts in child pedestrian safety have identified SR2S as the most exemplary practice of its kind (Janmohamed, 2006).
• City #2, a 40% of neighbourhoods that has displayed mixed trends; and
• City #3, a 40% that has become increasingly poor (Hulchanski et al., 2010).

Each of the three cities has distinct social and physical characteristics in addition to income: The white, non-immigrant population tends to live in the more desirable central area that possesses the most amenities, while the non-white, predominantly immigrant population tends to live in areas with fewer social and material amenities further from the city core. The “Three Cities” in Toronto also possess distinct characteristics in terms of physical condition of housing, housing tenure, and housing costs. In other words, the poor have been outbid by the more affluent in terms of neighbourhood and housing quality and location (Hulchanski et al., 2010). Rapid population growth and immigration, located in the context of a retreating welfare state and growing wage differentials, has been associated with Toronto’s decline of middle-income neighbourhoods (Hulchanski et al., 2007). These distinct consolidations of high and low-income areas may be related to injury gradients.

Consolidation of neighbourhoods on the basis of socio-economic and ethno-cultural segregation has been associated with declining social and political cohesion (Gil 1976; Raphael, 1999) and with deteriorating social, economic, and health consequences for the disadvantaged communities (Daly, Wilson & Vasdev, 2001; Fajnzylber Lederman & Loayza, 2000; Gil, 1976; Kaplan, et al. 1996; Raphael, 1999). The associations between the neighbourhood consolidation and health outcomes require further exploration in order to understand and inform health and social service intervention and prevention programs. Exploring aspects of the social, cultural, and economic environment that may contribute to area variations in injury are of analytic and policy interest. Thus, the purpose of the proposed study is to extend knowledge of the relationship between neighbourhood socioeconomic status and injury to children aged 0-6 in the
neighbourhoods of Toronto, Ontario.

Background to the Problem

Injury Trends over Time

In North America, deaths caused by injuries declined substantially during the 20th century, largely because of improved housing, heating, advances in medical and surgical care, and the increased use of injury prevention strategies such as smoke alarms and helmets (Cristoffel & Gallagher 2006). Fortunately, the overall injury death rate among children 14 years of age and under in Canada, declined by 37% between 1994 and 2003 (SKC, 2006a). The success of injury prevention efforts to date has been demonstrated by these improvements and validates the continuing investigation of the antecedents to childhood injury. However, some specific types of injury, such as pedestrian injuries and poisoning, have shown more improvements in comparison to others, such as playground falls (SKC, 2006a). In addition, some injury outcomes such as fire deaths may remain more sensitive to the immediate environment than others, due to their direct relationship with local housing quality and accessibility of emergency services (Runyan et al., 1992; Roberts & Power, 1996). Therefore, injury remains a serious and preventable problem.

Injury also does not receive the share of attention and research dollars proportionate to its magnitude (Cohen et al. 2003; SKC 2006b; Sergerie & Farley 2008). There exists a large discrepancy between what is undertaken to prevent injury and what is known about preventing injury, a discrepancy wider than that of any other major health problem (Christoffel & Gallagher 2006; Peden et al. 2008). Hence, further efforts are required to address injury as the leading cause of death and a leading cause of disability among Canadian children, with concentration on injury types and causes with the greatest morbidity and mortality.
Bridging Intentional Injury, Unintentional Injury, and Neglect

In this study on injury to children and child welfare implications, a mention of the link between unintentional and intentional injury is inevitable. However, there has been a traditional division in research and practice between intentional and unintentional injury prevention. Public health, the applied arm of epidemiology, is the discipline legislated to be responsible for unintentional injury prevention (Ministry of Health and Long-Term Care, 2008), while prevention of intentional injuries (i.e., “abuse”) has often been the purview of professions such as police and social work. However, the distinction between unintentional child injury prevention and intentional child injury prevention is not as extreme as it first appears (Cohen et al., 2003). Medical and legal practitioners may have difficulty in accurately classifying the deaths of children as intentional (Downing, 1978). Studies show that health professionals may misclassify child abuse (so-called “intentional” injury) as unintentional (Herman-Giddens et al., 1999; Lavelle, Shaw, Seidl, & Ludwig, 1995), and primary care physicians may be reluctant to report suspicious injuries (Flaherty, et al. 2008). These classification problems suggest that intentional versus unintentional injury could be regarded as a continuum rather than disparate categories (Peterson & Gable 1998). The fact that child welfare practitioners do not assess intentionality at the point of investigation demonstrates how it is a priority to address children being hurt without dividing intent into separate categories.

Physical abuse is commonly defined as deliberate and inappropriate action of a caregiver towards the child. Physical abuse is commonly regarded as an act of commission. Although a parent or caretaker may not have intended to hurt the child, physical child abuse denotes that an injury results from or could have resulted from excessive physical discipline or some other inappropriate or cruel treatment (Ontario Association of Children’s Aid Societies, 2000). In
contrast, neglect is commonly referred to as harm by omission, without malicious intent.  

Neglect is often chronic and is a driver of unintentional injury (Stowman & Donahue, 2005). Although caregivers may have caused a child’s injury, they did not intend to harm. Alcohol and drugs often play a significant role in contributing to neglect (Overpeck & McLoughlin, 1999). In fact, inadequate supervision has been found to be strongly related to injury-related deaths among children younger than 6 in the U.S. (Landon, Bauer, & Kohn, 2003; Stiffman, Schnitzer, Adam, Kruse, & Ewigman, 2002). In Ontario as well, neglect is a significant cause of unintentional injuries (Child Mortality Task Force, 1997). To accurately identify child neglect, it is necessary to distinguish between a brief parental oversight and a consistent lack of supervision (Squires & Busuttil, 1995), something that is difficult to do given the privacy of the home (Downing, 1978; Wilson, Baker, Teret, Shock, & Garbarino, 1991).

    The importance of unintentional injuries caused by neglect to the profession of social work is likely to increase. One reason for the increase is that the characteristics of children and families touched by the child welfare system have changed dramatically. The typical child welfare case in the early 1990s involved severe problems such as sexual and extreme physical abuse—“intentional” injury. In the early 21st century, child welfare practitioners are increasingly encountering more chronic and multifaceted problems related to neglect, socioeconomic hardship, and domestic violence (Ministry for Children and Youth Services, 2005). The latter problems engender a negative environment where unintentional harm prevails (e.g., Bruckner 2008; Casanueva, Foshee, & Barth, 2005; Peder et al., 2008).

**Housing and Health**

Children’s development is affected by their housing. A growing body of research demonstrates a relationship between housing and health (Hwang et al., 1999; Krieger & Higgins,
2002); however, the research lacks a cohesive framework and is rather narrow in scope (Dunn, et al., 2004; Bryant, 2009). The specific research on childhood injury and housing is no exception. More work is required to illuminate the causal mechanism behind injury events. The research that does exist indicates that there is a complex relationship between housing and children’s safety and the consequent need for models that capture myriad dimensions and implications of housing when studying child injury (Dunn et al., 2006; McDonell & Skosireva, 2009).

The myriad ways that housing has been shown to be associated child safety are illustrated by the following studies: Substandard housing is related to both child maltreatment (Ernst, Meyer, & DePanfilis, 2004) and parents’ hazardous safety practices (Greaves, Glik, Kronenfeld, & Jackson, 1994; Hapgood, Kendrick, & Marsh, 2000). Frequent household moves are also associated with both unintentional injuries (Beautrais, Fergusson, & Shannon, 1982) and maltreatment (Altemeier, O’Conner, Vietze, Sandler, & Sherrod, 1984). Physical hazards are associated with injury risk for children (e.g., housing violations; O’Campo et al., 2000), in addition to aging and rented housing stock (Shenassa et al., 2004) and poorly maintained roads (Tester et al. 2004). Others suggest that high-rise apartments are unsuitable for young children (Choldin, 1984). Financial problems and poor living conditions have been found to be a source of distraction for caregivers, with a corresponding decrease in adequate child supervision (Bruckner, 2008; Peder et al., 2008). A review of the literature on housing and health by Hwang et al. (2006) suggests that housing characteristics such as stairways are related to falls, and quality of heating and smoke alarms are related to burn injuries. These studies suggest that a comprehensive model framing the relationship between housing and health outcomes includes physical, spatial, and psychological dimensions. The implications of such a model are increasingly important given the growing concern among researchers, practitioners, and the
public that affordable and adequate housing is becoming increasingly scarce (Krieger & Higgins, 2002).

**Neighbourhood Effects**

Individuals, families, businesses, and other institutions that reside in a particular neighbourhood collectively create a social context that impacts the growing child in a myriad ways, over and above the effects of family and individual characteristics (Dunn, Schaefer-McDaniel, & Ramsey, 2010). Environmental conditions such as the built environment and neighbourhoods may also represent a pathway that affects child development independent of individual characteristics. This impact is known as “neighbourhood effects.” For example, neighbourhoods with physical incivilities, such as deteriorating housing and commercial buildings, unwanted graffiti, and vandalism, have been found to be less likely to have resources available for children’s play, and less willingness among adults to intervene if children are in need than neighbourhoods without these features (Caughy, O’Campo, & Patterson, 2001). The neighbourhood effects research has more often focused on older children and adolescents as opposed to younger children, due to the belief that neighbourhood has a stronger influence on older children because they are more exposed to contexts outside their home (Dunn, Schaefer-McDaniel, & Ramsay, 2010; Ryan, Fauth, & Brooks-Gunn, 2006; Tremblay et al., 2001). The most consistent evidence of neighbourhood effects generally pertains to school-aged children (Duncan & Raudenbush, 1999; Leventhal & Brooks-Gunn, 2000). Neighbourhood effects on young children tend to be indirect because they are mediated through their parents. However, there is a small body of research focusing on the health of 0 to 6 years old children in relation to the quality of their neighbourhoods (e.g., Dunn, Schaefer-McDaniel, & Ramsay, 2010; O’Campo, Gielan, Royalty, & Wilson, 2000). This study aims to contribute to this small body of
research. Such a contribution may help address small children’s higher level of vulnerability to injury, when compared to older children, due to their lesser developmental ability to circumvent hazards.

**Statement of the problem**

*Socioeconomic Inequality and Implications for Injury*

SES is defined as a “descriptive term for a person’s position in society, which may be expressed on an ordinal scale using criteria such as income, level of education attained, occupation, value of dwelling place, etc.” (Last, 1995, p. 158). SES is a multifaceted construct because although income and wealth are important SES markers, it also takes into “account the lifestyles, attitudes, and values that define a person’s position in society” (Birken, et al. 2006). Studies in various countries have found significant differences in child injury death rates based on socioeconomic class, with higher rates of childhood injury among the lower socio-economic groups in comparison to their more well-off counterparts (e.g., Faelker, et al. 2000; Reading 1997; Woodroffe, et al. 1993, Hippisley-Cox, Groom, Kendrick, Coupland, Webber, & Savelyich, 2002; Lyons et al. 2003). Studies have also found that the social class gradient for deaths due to injuries is far steeper than any other cause of child death (e.g., Constantinides 1988; Jarvis, Towner, & Walsh 1995). The source of the additional vulnerability includes a complex array of behavioural, social and environmental factors (Gilbride 2006). Influences of SES are hypothesized to affect injury through pathways such as the quality of local resources (e.g., goods and services, crime prevention, residential stability, the built environment, social cohesion; Cubbin, LeClere, & Smith 2000). The external causation of injury emphasizes the potential relevance of the physical and social environment, including socioeconomic factors, in contributing to injury risk (Cubbin & Smith, 2002; Potter, et al., 2005).
Measures of SES

The study of the relationship between SES and injury has been complicated by the range of operational definitions of SES across studies, a complication made most apparent during attempts to synthesize the evidence (e.g., Dowswell & Towner 2002; Mackay, et al 1999). The variety of measures of SES that exist may explain some of the discrepancies in results that have been observed (Faelker 2000; Mackay et al. 1999). Socioeconomic gradients have not been observed for every injury outcome in past studies (e.g., Canadian Institute for Child Health [CICH], 1994; Canadian Institute for Health Information [CIHI] 2010). The variety of measures of SES has led to calls for researchers to standardize SES measures, to facilitate collaborative research and comparisons among populations (e.g., Mackay et al., 1999). However, it is difficult to gain consensus on an accurate measure of SES that captures its myriad of dimensions and applies to a range of populations. As an alternative, there have been requests for researchers to provide an explicit rationale as to why certain SES measures were selected for their studies, with a recommendation towards the selection of measures that accurately reflect the complex nature of SES (Cubbin & Smith, 2002). To address the latter request, the present study evaluates the relationship among a set of SES-related measures and injury in a population-based study.

Researchers and policy makers may avoid the promotion of overly simplistic policies and programs by acknowledging that SES is a multidimensional construct and study results may vary by injury mechanism, severity, type, SES measure, and/or population studied (Cubbin & Smith, 2002; Moller, 1999). Moreover, many studies measuring the effect of neighbourhood on injury represent a snapshot in time and cannot capture the ongoing shifting of events and the reciprocal and differential interaction of individuals with their environments that characterizes life (Cubbin
et al., 2000; McDonell & Skosireva, 2009; Volpe, 2004). There are multiple spheres of influence on individuals’ experiences, including SES.

Widening Inequality

Although area-based studies from the US and UK suggest the socioeconomic inequality in death rates among children has widened in recent years, (Edwards, et al., 2006; Roberts and Power 1996; Singh & Kogan, 2007), Birken et al. (2006) did not replicate the widening socioeconomic inequality in injury death rates of young children in Canadian urban areas. Moreover, studies on the relationship between non-fatal injury and area-based SES have presented results less clear-cut than that of fatal injury (e.g., CICH, 1994, CIHI, 2010; Dougherty, Pless, and Wilkins 1990; Faelker et al. 2000; Reading, 1997). Due to the likelihood of varying outcomes according to type, mechanism, severity of injury or population at hand, sweeping generalizations about the relationship between injury and socioeconomic status are misleading (Lyons et al., 2003, Poulos et al, 2007).

There have been calls for longitudinal studies that explore the causal association between changes in neighbourhood characteristics and child and youth health outcomes because such studies can determine the temporal order of events. Longitudinal studies on injury topics are rare because they are costly and time-consuming; moreover, cohort study data on injury have seldom been available for long enough to provide extensive longitudinal data (Colantonio, Parsons, & Chen, 2010). Furthermore, retention of participants often limits the findings in longitudinal panel studies (Scott, 2009). Although the research design of the present study is not longitudinal, it will assess the association between injury rates and the gradual consolidation of neighbourhoods into distinct groupings of wealth and poverty, by incorporating information on the change in the Toronto neighbourhood average individual income over time.
Theoretical Framework for the Study

The Ecological Perspective

Because appropriate countermeasures to address the range of injury risk factors may be identified at the level of the individual, family, community, or society, designing a study to identify injury risk factors and selecting an injury prevention intervention may be complicated. Therefore, an ecological understanding of child injury provides an appropriate model to guide the research about, assessment of, and selection of interventions that will promote a reduction in childhood injury rates. In an ecological model, human development occurs at several levels, from the most proximal (e.g., individual psychological states) to the most distant (e.g., the community and culture). The first level is the microsystem (individual), and the progressively more distal systems are the family (microsystem), the community (exosystem), and the culture (macrosystem). These levels constitute four systems that are nested within one another (Bronfenbrenner, 1979). Children’s outcomes, both positive and negative, are influenced by interactions within or among these levels. Life transitions or changes during the developmental course also influence child outcomes (Eamon, 2001). The ecological perspective acknowledges that the sources of childhood injury are multiple and diverse. The focus on the broad context in which individuals are embedded implies there are multiple targets for programs to prevent injury. For example, Garbarino (1988) states that injury prevention programs may address one or more sources of danger to the child, such as environmental hazards or inappropriate supervision, and be targeted to the child, caregiver, and/or community level.

Although some of the studies on children’s injuries present with an ecological perspective by studying the dynamic interplay of children and caregivers with hazards in the environment (e.g., Ernst et al., 2004; Garbarino, 1988; Morrongiello, 2005), they do not employ
an ecological study design. Ecological study designs examine variation at a group as opposed to individual level; moreover, some researchers assert these designs include both group and individual level data in hybrid mixed or multi-levels (e.g., Stevenson & McClure, 2005). A review of the research literature indicates that although ecological study designs lend themselves well to an ecological perspective, a distinction must be made between an ecological study design and an ecological perspective.

Social Determinants of Health and Ecological Perspectives

There is a relationship between the ecological framework and a number of factors known as the social determinants of health, namely, the societal conditions in which people are born and develop (Health Canada 2003). Since the Lalonde report in 1974, there has been acknowledgment in Canada that the determinants of health encompass income and social status, social support networks, education, employment and working conditions, social and physical environments, gender, culture, and personal characteristics, circumstances, and choices (Public Health Agency of Canada, 2003; Evans, Barer, & Marmor, 1994; Volpe, 2004). These determinants are clearly delineated in an ecological perspective. Although the ways in which these determinants interact with each other and with injury risk require further understanding, the relationship between social determinants of health and injury risk suggests injury prevention is amenable to a range of policies, such as those promoting prevention at the level of the individual, the community, or the state.

Corresponding with the implications of the Lalonde report in the 1970s, the ecological perspective began to strongly influence social work theory and practice (Payne, 1997). In particular, Bronfenbrenner’s (1979) pivotal work brought the ecological perspective to the foreground in social work. By focusing on the broad context in which individuals are embedded,
he provided a useful schema for simultaneously considering and integrating the multiple
determinants of human behaviour, including the role of the individual, the family, the overall
culture, and the relationships among them. Social workers found that, because their mission was
to serve people within their environments, the ecological perspective dovetailed with their
practice more than the individualizing psychoanalytic models of intervention that were popular
in the 1950s and 1960s (Sidebotham, 2001; Ungar, 2002). During the 1980s and 1990s, James
Garbarino’s combination of epidemiological and ethnographic research approaches, located
within an ecological perspective, influenced social work theory and practice (e.g., Garbarino,
1978; Garbarino, 1988). His work continues to have implications for the child welfare field due
to its comprehensive picture of neighbourhood-level processes and characteristics (Ernst, 1999).

Since the late 1980s, the ecological perspective was further enhanced because it became
more open to considerations about power and privilege and to challenges to the status quo
(Ungar, 2002). The social determinants of health approach aligns itself with such considerations
and challenges, because it acknowledges that health is a holistic construct that results from social
relationships and material conditions. In order to improve health, the implications of broad
socioeconomic factors related to income, social status, employment, and housing quality must be
considered. Improving health outcomes becomes a matter of social justice (Raphael, 2009).
Therefore, the enhancement of children’s safety and well-being via a consideration of broad
socioeconomic factors is an activity directly relevant to the social work profession, a profession
that aims to promote social justice.

Limitations.

The ecological perspective has two primary limitations. First, there is the potential for
researchers and policymakers to commit “the ecological fallacy;” because, in ecological
research, variables are often measured at the group rather than the individual level. Ecological studies are often regarded as weaker designs than those capturing data on exposure or outcome at the individual level, because conjectures can be applied to the area level only (e.g., the population or community).

Second, it is difficult for researchers and policymakers to explain why connections exist among various factors and to pinpoint the relative influence of each in determining behaviour. The first limitation of the ecological perspective, i.e., its lack of explanation about why the connections exist, means it is hard to test empirically (Belsky, 1980; Payne, 1997; Ungar, 2002). The ecological perspective is highly inclusive and therefore offers few suggestions about what is important to include in frameworks that are designed to help explain people’s experiences or enable the prescription of responses to those experiences. The perspective does not necessarily offer directions that directly inform practice. Because the perspective is very general, it is difficult to apply it (Payne, 1997; Ungar, 2002). Human behaviour is unpredictable; therefore, given a particular situation, any one person’s decision about how to respond is difficult to predict (Sidebotham, 2001). A traditional linear interpretation of cause and effect may not be obtained using ecological theory (Payne, 1997). Indeed, the factors that may contribute to child injury are numerous, diverse, and operative at different levels (e.g., the child, the family, and community). The capacity to measure these factors is restricted.

An Ecological Model of Childhood Injury

Figure 1 presents an ecological model of childhood injury. This model is not meant to replace other theoretical models, but rather to complement and supplement them. This model is designed to be relevant to those interested in child welfare and the field of injury prevention. The figure is structured in a way that is typical of ecological models; the factors within each
concentric ring dynamically and constantly interface with each other and with the child. The factors in each ring are identified in Table 1. The factors in the outer rings represent contexts that are more distal to the child than the more proximal factors represented in the inner ring, but they do not necessarily exert less influence on, or interact less with, the child, and may even have more influence and interface with the child in some cases. The innermost ring representing the child incorporates the factors that are often the focus of the traditional individualizing perspective in both injury prevention and child protection research and practice (e.g., the cognitive or biological dimensions of the individual) while also demonstrating children’s interaction with other forces as well. The model, as a whole, corresponds with recommendations in the injury prevention literature for a framework that is broad and conducive to taking action at many levels (e.g. social support, safe physical environments, and legislative changes) (Peterson & Gable, 1998; Volpe, 2004).

The four contexts outlined in Table 1—child, family, community-level, and societal/cultural variables—affect children’s risk of injury. The overall intent of the model portrayed in Figure 1 and the contexts portrayed in Table 1 is to frame the current research and discussion on childhood injury. The four contexts are not meant to comprehensively cover all possible indicators that are relevant to childhood injury; rather, they present variables that, if researched, may further elucidate the mechanisms already known to contribute to childhood injury. The myriad child, family and community factors that contribute to the level of injury risk to the child are delineated in the model. In ecological models researchers and practitioners may target certain level(s) of risk at any one time, based on their knowledge and resources available, rather than trying to target all simultaneously (Garbarino, 1988). This study will concentrate on the third context, the relationship between neighbourhood characteristics and the occurrence of
injury (Reading et al., 2005; Shenassa et al., 2004; Soubi et al., 2004). Studies measuring the relationship between SES and childhood injury commonly use ecological study designs examining SES variation at a group or aggregate level such as the neighbourhood or community (Kendrick, et al 2005). If there is evidence for a “neighbourhood effect” on injury, there is logical justification for targeting neighbourhoods for injury prevention interventions in addition to individuals.

Although the dimension of time is not directly included in the model, time is one measure of the dynamic changes in child development and possible changes in external circumstances that may increase or decrease the risks of injury. Both time and development are important to ecological models (Ballou et al., 2002; Bronfenbrenner, 1979). Time and development over the life course affect the child at all points of the model. As represented by the arrows in the model, the level of child injury risk can settle at any point on the continuum at any point in time, according to the interplay of the various factors in the concentric rings at the moment. Hence, the model can be viewed as constantly in motion. The inclusion of time and history promotes an understanding of how individuals, groups, and communities change and make sense of their experiences (Ballou et al., 2002).

The ecological model of child injury facilitates asking the following fundamental critical questions when reviewing the literature and conducting research: Is the presentation of child injury equitable (fair, just, impartial)? Who/what is problematized? Who is and who is not the target of intervention? Asking these questions can lay the groundwork for social policy that can effectively synthesize the three areas discussed earlier in the background and statement of the problem sections of this paper (housing and health, socioeconomic inequality, and the link
between intentional and unintentional injury) with a salute to the social determinants of health. A consideration of the social determinants of health such as income, social status, and physical environment can address the shortcomings that may afflict traditional individualizing injury prevention efforts, such as viewing injury risk as problems that reside in individual deficits.

The model demonstrates that caregivers are regarded as more accountable and blameworthy if injury is due to intentional injury rather than an unintentional yet preventable injury. The inclusion of neighbourhood conditions with the issue of health and physical safety in this model will hopefully promote a holistic view of the connections between socioeconomic inequalities in neighbourhood characteristics and social inequalities in families’ general states of health.

The ecological model of childhood injury illuminates the tendency of research and programs in injury prevention to individualize risk by focusing on caregivers’ supervisory efforts, by drawing links between the perceived level of risk for injury, as influenced by child, family, and community factors, and the subsequent level of accountability attributed to the caregivers. The model makes explicit the need to be sensitive to the manifestations of poverty, such as poor housing conditions and hazardous physical environments, when examining risk levels to children and the level of accountability to ascribe to caregivers for child injury.

In the future, the model may be further refined or modified in response to the conclusions of individuals who have used it. This model can serve as a tool that may be used to meet three distinct but interrelated needs that are indicated by the review of the literature, namely, to (a) highlight the influence of behavioural, social, and environmental factors that frame individuals’ choices and circumstances; (b) conceptualize unintentional injury and child maltreatment as points on a continuum rather than as a dichotomy; and (c) call attention to inadequate housing,
poorly maintained environments, and other social determinants of health as salient external factors that affect injury rates, in addition to the consequences of individual choices. The goal is that the model may contribute to inclusive social policies by helping to meet the three needs indicated by the review of the literature above (Garbarino, 1988).
Figure 1

The Ecological Model of Childhood Injury

1, 2, 3, and 4 are identified in Table 1 attached.
Table 1
Four Contexts that affect the Risk of Injury

<table>
<thead>
<tr>
<th>Social Aspects</th>
<th>Personality</th>
<th>“Home”</th>
<th>Community</th>
<th>Society</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distractions</td>
<td>Family functioning</td>
<td>Cohesion</td>
<td>Culture</td>
</tr>
<tr>
<td></td>
<td>Attention span</td>
<td>Chaos</td>
<td>Employment rate</td>
<td>Policy</td>
</tr>
<tr>
<td></td>
<td>Persistence</td>
<td>Social support</td>
<td>Violence</td>
<td>Legislation</td>
</tr>
<tr>
<td></td>
<td>Activity level</td>
<td>Caregiver knowledge</td>
<td>Neighbourhood SES</td>
<td>Norms</td>
</tr>
<tr>
<td></td>
<td>Adaptability</td>
<td># Siblings</td>
<td>Amenities</td>
<td>Language</td>
</tr>
<tr>
<td></td>
<td>SES</td>
<td>Neighbourhood stability</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Family composition</td>
<td>Social services</td>
<td></td>
<td></td>
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<td></td>
<td>Caregivers’ mental health/health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alcohol/drug use</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Aspects</th>
<th>Biological</th>
<th>House</th>
<th>Neighbourhood</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Risks/hazards</td>
<td>Building codes</td>
<td></td>
<td>Climate</td>
</tr>
<tr>
<td>Genetic temperament</td>
<td>Crowding</td>
<td>% Rented</td>
<td>Transportation systems</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Household moves</td>
<td>Age of housing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>Tenure</td>
<td>% Housing in need of repair</td>
<td>Global political conditions</td>
<td></td>
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<tr>
<td></td>
<td>Years lived in</td>
<td>% Apartments</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Disrepair</td>
<td></td>
<td>Physical incivilities</td>
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<td></td>
<td>Subsidization</td>
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<td></td>
<td>Dwelling type</td>
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<tr>
<td></td>
<td>Safety equipment</td>
<td></td>
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</tbody>
</table>

The Epidemiological Perspective as a Competing Theory

The unique concepts of epidemiology provide an influential perspective with respect to reducing injury (Robertson, 1998). Epidemiology is defined as “the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to control of health problems” (Last, 1995, p. 55). The research methods used by epidemiologists overlap with many disciplines, including sociology, psychology, and the
biological sciences. However, epidemiology is a unique discipline that “has for at least 50 years promoted its methods to the point where one could argue they constitute a theory” (Weed, 2002, p. 56). For example, epidemiology’s host-agent-environment model has commonly been used to identify the etiology and mechanisms of injuries (Christoffel & Gallagher, 2006). In this way, the systematic variations in injury rates (e.g., according to age or gender) have been illuminated (Christoffel & Gallagher, 2006; Morrongiello et al., 2004).

Although injury may be viewed as having social origins, the presentation of injury in the epidemiological literature appears disease-oriented. Epidemiology is strongly rooted in the post-positivism of traditional science. There is a strong focus on demonstrating the association of specific health outcomes with various risk factors, often with a goal of determining causation (Peterson & Lupton, 1996). Being population-based, the discipline privileges its findings over ethnographic or case studies or statistical risk assessment (Christophel & Gallegher, 2006, p. 52). Raphael (2002) asserts that epidemiology is a biomedical approach that exerts a “paradigmatic dominance” in public health research and planning. He states that because the discipline is lacking an “explicit values base” and “critical perspective,” theories of epidemiology do not challenge the status quo of increasingly widening social inequalities. Hence, epidemiology limits the analysis of societal structures such as poverty as determinants of health and provides little impetus for change. Others may argue that the discipline of epidemiology is amenable to issues of power and privilege and in many respects has become more populist in its practice and theory development than it used to be (Krieger, 2001a; Krieger, 2001b). This latter point of view appears uncommon among epidemiologists, with many wishing to remain pragmatic and biomedical in orientation (Weed, 2002). The debate is beyond the scope of this paper, but in any event, theory development in epidemiology is not as advanced in terms of its social change
potential as it is in the ecological approach. The epidemiological approach is less compatible with social work’s orientation towards improvement in the conditions of marginalized people. The ecological model of childhood injury in Figure 1 was therefore devised to meet this orientation.

**Guiding Research Objectives**

As identified in the ecological model of childhood injury, there is a need to call attention to neighbourhood and other environmental influences as salient external factors that affect injury rates. The goal of the present study is to examine relationships between socioeconomic category of neighbourhood and childhood injury. The broad research question is: Is there a relationship between neighbourhood socioeconomic status and child injury among children 0-6? The following study objectives were devised as components of the broad research question:

1. To supplement a research design from the Centre of Urban and Community Studies that explored the relationship in the population between neighbourhood socioeconomic trends and sociodemographic characteristics.

2. To describe injury patterns at the neighbourhood (census tract) level by age group and gender for overall injury, falls, burns and poisoning that warranted a visit to the ED in Toronto, ON.

3. To determine the relationship in the population between neighbourhood income trends (a 35 year period) and injury outcomes, after adjustment for other sociodemographic characteristics.

4. To determine how accurately injury outcomes can be predicted from a linear combination of neighbourhood sociodemographic indicators including neighbourhood income trends (35 year period) and neighbourhood income status (one point in time).
5. After controlling for other sociodemographic characteristics, to determine whether and to what extent neighbourhood socioeconomic trends (35 year period) have predictive power in explaining variation in injury rates, over and above a more typical measure of SES (one point in time) among children aged 0-6 in Toronto.

6. To visually depict the distribution of childhood injury outcomes by neighbourhood income trends.

Limitations and Delimitations of the Study

Delimitations of Literature Review

All literature reviews are selective, and this one is no exception. Certain portions of the literature must be excluded. The focus of the current work is the Canadian context; hence, the literature drawn upon for the critique of the literature is limited to Western Industrialized countries. A country’s injury profile is profoundly affected by economic conditions, the stage of industrialization, and culture (Cristoffel & Gallagher 2006). The issues and needs of unindustrialized countries, countries in transition to an industrial economy, or non-Western industrialized countries may be different from those of Canada and are excluded from consideration. The prevention of injuries amongst older children and adolescents are not explored in this paper. Rather, the literature review will focus on children approximately in the developmental stage from less than a year to 6 years of age, the years when, due to their limited mobility, they are most vulnerable to the predilections of their caregivers and proximate environments (Powell & Tanz 2002). Hence, the proximate environmental realms will be a focal point of the literature review.

Delimitations of Methodology
Administrative health data.

The data analysis in this study is based on the location of the home address of injury victims rather than the actual geographical location of the injury. Hospital-related administrative datasets such as the one used in this study tend to display patient residence because these data are easily collected (Cusimano, Marshall, Rinner, Jiang, & Chipman, 2010). Because children’s injuries tend to occur near or in the home and because children are at least partially dependent on the home and neighbourhood in which they develop, the use of the home address as a proxy for injury location in the analysis is reasonable, even though the actual geographical location of the injury may be unclear (Lyons, 2003; O’Campo et al., 2000).

A further limitation when measuring injury events via the use of administrative health data is that they commonly contain only basic information about individual subjects such as age and gender, hence limiting the research questions that can be asked (Cusimano et al., 2010). The difficulty in obtaining SES-related data at the individual level often leaves researchers with the option of procuring secondary data such as those available from the census or other large data sets to approximate the characteristics of neighbourhood (McDonell & Skosireva 2009), as was done in the present study. More precise information would require more resource-intensive data collection methods such as surveys or direct neighbourhood observation (Caughy, O’Campo, & Patterson, 2001).

Another limitation is that it is unfeasible to capture the scope of injury events using one data source. The literature reflects how it is generally easier to access data on death and hospital admissions than ED visits (Krug, Sharma, & Lozano 2000; Sahai, Ward, Zmijowskyi, & Rowe, 2005). Due to resource constraints, researchers often limit their study of injury to those captured in one data source, even though their studies may be biased by the data collection procedures and
predilections common to that source, such as a tendency towards a certain patient type or level of injury severity (Thanigasalam, 2001). This limitation pertains to this study because it uses one administrative database to capture injury events among children.

Ecological study.

This is a retrospective, cross-sectional, ecological study that evaluates the relationship between neighborhood socioeconomic status and Toronto children who attended the ED for injuries. As with any ecological study, the ecological fallacy is a methodological shortcoming. There is a lack of individual-level socioeconomic data in this study; therefore, inferences are limited to the group level and not the individual level. Because socioeconomic data were not available at an individual level, conclusions about individual socioeconomic status and injury morbidity must be viewed with caution (Poulos et al., 2007). Although ecological studies cannot result in statements about the characteristics of individuals, they have merit in the field of injury prevention because it may identify risk factors arising from the built or social environment that may increase injury risk for all children in a given neighbourhood, regardless of their individual or family characteristics (Stevenson & McClure, 2005). If these risk factors are identified, neighborhoods displaying them could be targeted to promote a more comprehensive and possibly cheaper way of decreasing the burden of injury than resorting to individual-level interventions.

The modifiable areal unit problem.

Similar to other ecological studies (e.g., Durkin et al., 1994; Garbarino & Crouter, 1978; Ernst, 2000), this study will operationally define neighbourhoods by census tracts (CTs). When administrative units such as CTs are employed as a proxy for socio-spatial areas of effect in area based ecological studies, the modifiable areal unit problem (MAUP) is a potential source of
concern (Nakaya, 2000). The MAUP pertains to a variation in research results depending on the scale and zone of the socio-spatial boundaries selected. For example, the percentage of low birth weight babies must be calculated within a selected boundary because one cannot measure the percentage of low birth-weight babies at a single point (Oliver, 2001). CT boundaries or any other boundaries used to demarcate neighbourhoods are arbitrary and may not reflect the most meaningful social reality that impacts citizens’ health outcomes. Fortunately, the MAUP is inconsequential if the boundaries among areas are defined by physical or social changes directly relevant to the study topic, in contrast to definition according to administrative artifact (Reading, Haynes, & Shenassa, 2005). Although this study defines neighbourhoods by CT, the impact of the MAUP should be minimal due to boundaries among areas being meaningfully related to changes relevant to the study topic.

Spatial autocorrelation

Perhaps a more pressing spatial concern than the MAUP is the possibility of spatial autocorrelation. Traditional analytic approaches assume independence of outcomes; however, neighbourhoods sharing a boundary (i.e., from adjacent spatial units) may not be independent. Areas close together in space often are more similar to each other in terms of their measurements and measurement errors than areas that are not. If the relative outcome of two points are related to their distance, conventional regression techniques would produce standard errors that are too small, and consequently result in a tendency to conclude relationships exist when they really do not (Type 1 error) (Freisthler, Gruenewald, Ring, & LaScala, 2008; University of California at Los Angeles, n.d.).

In order to test for spatial autocorrelation, an Exploratory Spatial Data analysis (EDSA) can test whether the spatial data deviates from a random pattern. If they are spatially
autocorrelated, the researcher may control for the spatial correlation by using spatial regression procedures such as Spatial Random Effects Panel Models or Generalized Least Squares Models (Freisthler et al., 2008). However, the state of the research is such that few studies that examine the relationship between neighbourhoods and child welfare outcomes detect, describe, or adjust/predict for spatial autocorrelation. For example, a recent review on the influence of neighbourhoods on child maltreatment shows that only 4 out of 25 studies controlled for or accounted for the spatial processes of neighborhoods with advanced statistical techniques. Most studies assumed independence among spatial units and used traditional analytic approaches (Coulton, Crampton, Irwin, Spilsbury & Korbin, 2007). The present study also assumes independence among spatial units by using a traditional analytic approach.

**Definition of Terms**

*Census Tracts (CTs) as Operational Definitions of Neighbourhood*

CTs are small levels of geography for urban agglomerations described by Statistics Canada (2007) as “small, relatively stable geographic areas, that usually have a population of 2,500 to 8,000” (¶ 1). Salient and easily recognizable physical features such as major streets or railways demarcate them (Leventhal & Brooks-Gunn, 2003; Statistics Canada, 2007). There are 522 inhabited CTs in the city of Toronto, ranging in size from .07 to 28.72 square kilometers, with populations ranging from approximately 1000 to over 8000 (Cusimano et al., 2010). On average, each CT has a population of about 4,700 people (Hulchanski, 2007). The large number of CTs in a city the size of Toronto provides ample data for analytic purposes.

CTs are commonly used as an acceptable proxy for neighbourhoods because they correspond with a large amount of sociodemographic census data that can be used to define and characterize a relatively small socio-spatial unit (Boyle & Lipman, 1998; Hulchanski, 2008).
CTs are small entities that display relative within-group homogeneity and that come close to the lived experience of neighbourhood (Garbarino & Crouter, 1978; Hulchanski, 2007; Kim, 2004; Sampson, 1992). The United Way and CCSD (2004) suggest that CTs are a realistic proxy in terms of quantifying neighbourhood for research purposes. Moreover, a Canadian analysis of neighbourhood SES influences on health found that definitions of neighbourhoods, as defined by CTs, were very similar to that of neighbourhoods as defined through consultation with community groups and residents (Ross, Tremblay, & Graham, 2004).

**Definition of Injury**

In comparison to other health conditions, injury has unique definitional characteristics because of its sudden and acute nature and external causation (Cubbin & Smith 2002, Potter, et al. 2009; Scott 2009). A general definition of injury commonly used in the field of injury prevention and control is "any unintentional or intentional damage to the body caused by acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation interacting with the body in amounts or at rates that exceed the threshold of human tolerance" (Baker, O'Neill, & Ginsburg, 1992). This definition encompasses poisoning and is therefore used in this study.

**Definition of Socioeconomic change and SES**

The present study uses the Neighbourhood Change Community University Research Alliance (CURA) definition of neighbourhood socioeconomic change. Specifically, the CURA research initiative categorized Toronto neighbourhoods according to the change in the census tract average individual income as a percentage of the Toronto CMA average, from 1970-2005. Neighbourhoods are divided into:
• City #1, whose income increased 20% or more (comprises 20% of the city or 100 CTs);
• City #2, whose increase or decrease in income is less than 20% (comprises 40% of the city or 208 CTs);
• City #3, whose income decreased 20% or more (comprises 40% of the city or 206 CTs).

This study will also use the Neighbourhood Change CURA’s definition of neighbourhood income levels (SES) as defined by a percentage of the Toronto CMA average individual income in 2005:

• High income, whose average individual income is more than 120% of the Toronto CMA average (98 CTs or 19% of the city);
• Middle income, whose average individual income is within 80-120% of the Toronto CMA average (152 CTs or 29% of the city);
• Low income, whose average individual income is more than 20% below that of the Toronto CMA average (274 CTs or 52% of the city).

According to the Neighbourhood Change CURA definition of neighbourhood income levels, both poor and wealthy neighbourhoods in Toronto are more common today than 35 years ago, while neighbourhoods with average incomes are less common today than 35 years ago. Specifically, in the early 1970s about two-thirds of the City of Toronto's neighbourhoods (66%) were middle-income. By 2005, the middle-income neighbourhoods had decreased to less than one-third (29%). From 1970 to 2005, the proportion of low income neighbourhoods increased from 19% to 53%, and the proportion of high income neighbourhoods increased from 15% to 19%. The results of the trend towards income and geographic polarization are stark (Hulchanski, 2010). Maps of the neighbourhood income trends from the Neighbourhood change CURA analysis are available in Appendix B. The map depicts that very wealthy and very poor
neighbourhoods are presently more numerous than they were in 1970. The increased exposure of the population to low-SES neighbourhoods makes the study of the possible relationship between low SES and child injury an important task.

Organization of Thesis
The contents of this thesis are organized in chapters. Chapter One provides an introduction to the problems and thesis overview. Chapter Two presents the review of the literature, a critique of the literature, a summary of what is known and unknown about the literature, and the potential contribution of this study to the literature. Important empirical and theoretical underpinnings that substantiate the significance and relevance of neighbourhood effects on childhood injury are covered. Chapter Three is a description of the methodology for the analyses, including the analytic approach and framework, modeling strategy and statistical analyses. Chapter Four presents the results for each analyses. Chapter Five includes a discussion and interpretation of the findings. In addition, policy and practice implications and directions for future research are explored in Chapter Five. Specifically, this chapter explores some future directions that can provide evidence that will help health and social service professionals frame their decisions and actions in regards to planning injury prevention programs.
Chapter 2: Literature Review

Review Methodology of Literature relevant to Child Injury and Neighbourhood Socioeconomic Status

Two areas of existing literature--child maltreatment (“intentional” injury and neglect) and unintentional injury (so-called “accidents”)--were searched to see whether and to what extent neighbourhood SES characteristics were related to childhood injury. The specific objectives of the literature review were to: 1. describe the definitions and types of SES measures and neighbourhoods used in the study of childhood injury; and 2. critique the nature and quality of evidence regarding the relationship between neighbourhood SES and childhood injury. Thus, the review provides an overview of what is known about the relationship between neighbourhood SES and injury and it situates the study within the relevant literature.

The types of study designs considered for the literature review were interventional and observational studies. These designs appeared most relevant for exploring the association between neighbourhood SES and the incidence of childhood injury because they suggest causal relationships or identify correlations between socioeconomic characteristics and child injury. Hence, an ultimate aim of these studies is to provide evidence for the development, implementation, and evaluation of injury prevention programs. This goal is similar to that of the present study.

The child maltreatment literature was considered for review if the outcome focused on injury or mortality, rather than reported, suspected, or substantiated maltreatment only. Hence, a large amount of the child maltreatment literature did not fit the review criteria\(^2\). There is a

\(^2\) The child maltreatment literature tended to have a different focus than the injury literature. Canadian child abuse data indicate 74\% of physical abuse cases did not note physical injury. Physical abuse cases encompass caregiver behaviours that that involve the risk of harm, not only injuries that have already occurred. Of substantiated physical abuse cases in Canada, 21\% documented a physical injury that was not severe enough to require medical treatment,
research gap on the specific physical sequelae of child abuse (i.e., intentional injury inflicted by caregivers).

The specific search strategy is presented in Appendix A. After merging the databases of the various article sources, a single database of published works was created. Each citation was screened, including the abstract if available. Specifically, the existing literature was selected with the following criteria in order to identify the studies most applicable to the research topic:

1. It examined the association between at least one measure of neighbourhood SES and child injury rates in the main research question;

2. It was conducted at the ecological area-level or used a mixed or multilevel design where units of interest include both area-level and individual-level data;

3. It included one or more of the outcomes included in this study;

4. It included data on children in the 0-6 age bracket;

5. It was population-based or accessed a representative sample; and

6. It conducted significance tests or displayed confidence intervals.

7. It was published in the last 20 years.

If two or more studies by the same author met the criteria, care was taken to ensure that different outcomes or a different sample was used between the studies. Hand-searches of reference lists rounded out the search strategy. Due to previous literature reviews related to the topic, it was difficult to specify the original number of articles identified from past hand searches of the literature versus what was found in more recently. Although efforts were made to gather unpublished studies, the extent to which publication bias and selective outcome reporting

while 5% required medical treatment (Trocmé et al., 2007). Hence, physical abuse cases requiring medical treatment may represent an extreme manifestation of physical abuse.
influenced the findings of this literature review is unknown. Due to contact with colleagues and injury prevention experts, one unpublished study and one report was identified.

Because most of the identified studies were observational, reporting guidelines for observational studies (Stroup, Berlin, Morton, Olkin, Williamson, Rennie, et al., 2000) were used to protect against selection biases and make explicit the methods used to conduct the literature review. These protective measures were considered especially important for studying the relationship between neighbourhood SES and child injury because of the heterogeneity among studies that has challenged past authors in this topic area (e.g., Laflamme, Hasselburg, & Burrows, 2009; Mackay et al., 1999).

The screening and selection of literature revealed that the association between neighbourhood SES and child injury has not been investigated in Canada to the extent that it has been in Europe and the USA. The literature from the USA and Europe may have limited generalizability to the Canadian context for a number of reasons. For example, there is variation in the level and nature of immigration and ethnic segregation in neighbourhoods across Canada, USA, and Europe, such as that among country of origin and years in host country. This variation may influence injury rates identified for immigrant and ethnic enclaves (see Pressley, Barlow, Kendrig, & Paneth-Pollak, 2007). In addition, there are differences among countries in regards to how injuries are identified and treated (Faelker et al., 2000). Finally, measures of neighbourhood SES in countries outside of Canada, such as the Townsend index in Britain or the Carstairs index in Scotland, have limited applicability to the Canadian context. Due to the heterogeneity across countries that limits generalizability to Canada, a general review and critique of the international literature provided a context for this study. The Canadian literature was deemed most relevant to this study and hence most fitting for a detailed review and critique.
Thus, a detailed deconstruction of study design and results was then conducted for the small number of Canadian studies that were identified.

**Summary of the International Literature**

Across and within countries, there was a diversity of foci in the studies. There were a wide variety of SES measures used, age groups examined, and injury types and severities. Sex or gender was consistently incorporated into the research designs. Both longitudinal and cross-sectional studies were identified. There was one American area-based longitudinal study that examined the trends in socioeconomic disparities in injury mortality by income category: Singh & Cohen (2007) indicated that the disparity widened over time. The lower-SES children did not enjoy the decrease in injury rates to the same extent as their more well-off counterparts. This widening disparity has been corroborated by studies collecting individual-level SES data rather than area-level data (Roberts & Power, 1996; Scohler, Hickson, & Ray, 1999). The widening differential was been presented to be a result of increasing polarization in material and social conditions.

A positive relationship between socioeconomic deprivation and injury was shown with several American and European area-based studies. These studies had cross-sectional designs that indicated more disadvantaged areas had higher injury rates than the more privileged. However, this relationship did not hold among all injury types (e.g., Reimers & Laflamme, 2005) ages (e.g., Walsh & Jarvis, 1992), or neighbourhood definitions (Waldron, 2000). Often, more severe injuries showed a stronger relationship with low SES than more mild ones (Durkin et al., 1994; Kendrick, Mulvaney, Burton, & Watson, 2005; Pomerantz, Dowd, & Buncher, 2001). Although casual mechanisms were not identifiable in these cross-sectional studies, increased risk in the disadvantaged areas was attributed to increased exposure injury-promoting social (e.g.
percent in poverty; percent female headed households) and physical (e.g., percent vacant housing; percent crowded) environments (Durkin, Davidson, Kuhn, O’Conner, & Barlow, 1994; Hippisley-Cox et al., 2002; Freisther, Gruenewald, Ring, & LaScala, 2008; Lyons, Jones, Deacon, & Heaven, 2003; Reimers & Laflamme, 2005; Pomerantz et al., 2001; Walsh & Jarvis, 1992). Hence, structural and sociological influences on human behaviour were illuminated with these ecological studies.

Recently, European and American studies have employed multilevel modeling techniques that attempted to attribute the variation in injury outcome to different levels of aggregation, namely, the individual/family and the neighbourhood (Haynes et al., 2003; Kendrick et al., 2005; Reading, Langford, Haynes, & Lovett, 1999, Reading, Jones, Haynes, Daras, & Emond, 2008; Shennassa, Stubbindick, & Brown, O’Campo et al., 2000). Such designs attempted to identify the multiple, nested, levels of the problem, yet consequently converged on and discussed all relevant levels. Similar to the studies that were strictly area-based, an array of neighbourhood socioeconomic characteristics was used in the multilevel studies to explore the correlation between neighbourhood socioeconomic status and injury. Overall, the conclusion of the majority of the multilevel studies was that although individual and family factors accounted for the majority of the variance in injury, a small but significant association was found between neighbourhood characteristics and injury, independent of individual family factors. These characteristics were not necessarily neighbourhood poverty or deprivation per se, but also markers of deteriorating or substandard physical environments (e.g., O’Campo et al., 2000; Reading et al., 2004).

As was the case with the studies that used the area as the only unit of analysis, a complex picture was presented in the multilevel studies, with the relationship between injury and SES
varying due to factors such as age (e.g., O’Campo et al., 2000) and injury type (e.g., Kendrick et al., 2005). In addition, some of the studies found residual variation between neighbourhoods remained unexplained (e.g., O’Campo et al., 2000; Reading et al., 1999). An information gap was the lack of detailed household-level socioeconomic data. In summary, many of the multilevel studies lacked precision on individual-level measures such as parenting practices and the socioeconomic status of individual households. Access to detailed household-level socioeconomic data as well as neighbourhood-level socioeconomic data would help to separate individual (compositional) from place (contextual) effects (Haynes et al., 2003). However, the extent to which contextual and compositional effects can and should be separated is controversial, with some authors arguing that individuals and the places they inhabit are intrinsically linked (Mitchell, 2001; Stevenson & McLure, 2005).

Recognizing that the division between unintentional injury and child maltreatment is somewhat arbitrary, the American literature had the most overlap between unintentional injury, assault, and child abuse or neglect injuries within studies. These studies indicated that neighbourhoods with higher rates of unintentional injury also had higher rates of intentional injury, indicating a common etiology between the two types of injury (e.g., Durkin et al., 1994; Freisther, Gruenewald, Ring, & LaScala, 2008; McDonell, 2007; McDonell & Skosireva, 2009). The small amount of studies included in the review that identified injuries arising from assault, child abuse, and other intentional injuries appear to over-represent children from low SES areas in contrast to those from more privileged areas (e.g., Durkin et al., 1994; Freistler et al., 2008).

The one large-scale experimental intervention found in the literature deserves mention, although the only neighbourhood factor tested was average income. This intervention—the Moving to Opportunity Program—provided a higher level of causal evidence than observational
studies in the form of a housing subsidy that encouraged families residing in disadvantaged American neighbourhoods to relocate to wealthier places. Post-intervention, this program measured a variety of health and social outcomes for children. Results indicated improved perceptions of safety and decreased short-term injury rates for children in the intervention group compared to the control (Fortson & Sanbonmatsu, 2009; Katz, King, & Liebman, 2001). The overall results of the study, however, have been mixed and remind researchers not to make sweeping statements about the effects of neighbourhood on child health outcomes (Small & Feldman, 2011).

Conclusion of the Findings of the International Literature

A clear conclusion that is not in dispute is that boys are at greater risk than girls across injury types and ages; however, few studies compared boys and girls injury rates across different neighbourhood SES categories. Otherwise, the wide variation with respect to model specification and outcomes make it difficult to draw broad conclusions about which indicators are most highly associated with injury. Despite the challenges in drawing definitive conclusions, the general trends of the research findings in the international literature indicate that three lessons can be inferred: 1. There appears to be a small but significant association between neighbourhood disadvantage and childhood injury; however, the strength of the association is conditional upon population studied, injury severity, injury outcome examined, and measure of neighbourhood SES; 2. Neighbourhood characteristics appear less important than individual and family characteristics in explaining cross-sectional variation in injury outcomes. 3. Neighbourhood effects appear more apparent using severe injury outcomes in comparison to more minor ones, with poorer neighbourhoods being more likely to be associated with severe outcomes than the more privileged ones. As a whole and for each injury cause and type, the data
suggest that low SES is disadvantageous to child safety, but patterns vary by mechanism and severity of injury, age group affected, and geographical region.

**Critique of the International Literature**

According to Reading et al. (2008), many of the multilevel studies on the topic have been underpowered; thus, effects may be underestimated. This criticism is relevant to the international literature reviewed. Secondary data have dominated the literature and have limitations in their examination of the impact of neighbourhood SES on injury, such as a lack of specific information on subpopulations and key variables. As mentioned in the review of the international literature, several studies were limited because they lacked access to detailed household-level data on SES and parenting practices (e.g., Haynes et al, 2003; Reading et al., 1999; Shenassa et al., 2004). The studies that were able to capture several individual-level risk factors in the analysis (i.e., Kendrick et al., 2005; Reading et al., 2008) appeared to identify more overall risk at the individual level than the neighbourhood level, in comparison to studies lacking these individual-level risk factors. This identification indicates that injury variation among neighbourhoods may be accounted for by characteristics of individuals and families that cluster in certain neighbourhoods.

The level of evidence gleaned by the non-experimental studies that comprise the bulk of the literature review is low on the traditional research hierarchy. The majority of studies reviewed is cross-sectional and correlational and thus cannot unambiguously identify the direction of causation. Randomized controlled studies manipulating neighbourhood-level or policy-related variables present more unequivocal evidence about the direction of cause and effect, but are difficult to conduct due to the cost and magnitude of government investment.
involved (Manley, van Ham, & Doherty, 2011). Hence, the Canadian literature was accessed for further insight into the relationship between area-level SES and childhood injury.

**Canadian Literature**

A table of descriptive information for each Canadian study is summarized in Table 2 in a format typical for literature reviews.
<table>
<thead>
<tr>
<th>Citation</th>
<th>Design</th>
<th>Data</th>
<th>Outcome</th>
<th>Method</th>
<th>Neighbourhood SES indicator Covariates/adjustments</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birken et al., 2006</td>
<td>Ecological, Longitudinal</td>
<td>Death Registry; Census, Canadian children &lt; 15 yrs</td>
<td>Unintentional, Specific causes, regression Deaths</td>
<td>Poisson regression</td>
<td>Neighbourhood Income quintiles, % living under LICO in urban CTs</td>
<td>Age Sex Women with education &lt; Grade 9 Male unemployment Rented homes (sensitivity analysis) Fall, suffocation, and pedestrian deaths: Gradient of ↑ injury with ↓ income (p &lt; .05). MVC and cyclist deaths: Relationship between deaths and SES insignificant. Narrowing of injury related socioeconomic gradients over time.</td>
</tr>
<tr>
<td>Birken et al, 2009</td>
<td>Ecological Cross-sectional</td>
<td>Death registry, Census, Canadian children &lt;15 years</td>
<td>Homicide, Unknown intent regression death,</td>
<td>Poisson regression</td>
<td>Neighbourhood Income quintiles, % living under LICO in urban CTs</td>
<td>Age</td>
</tr>
</tbody>
</table>
Results similar when unknown intent deaths included in analysis.

<table>
<thead>
<tr>
<th>Study</th>
<th>Study Type</th>
<th>Data Sources</th>
<th>Study Variables</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brownell et al., 2002</td>
<td>Cross-sectional</td>
<td>Population Health Research Data Depository; Vital Statistics Data; Manitoba Vital Statistics Data</td>
<td>Intentional, Unintentional, Death, Hospitalization Specific causes</td>
<td>T-tests and correlation analysis on average income of EAs and income quintiles, based on average income of EAs and WCAs.</td>
</tr>
<tr>
<td>Brownell et al., 2010</td>
<td>Longitudinal</td>
<td>Administrative hospital data, Census, Manitoba &lt;20 yrs</td>
<td>Intentional, Unintentional, Overall, Specific causes</td>
<td>GEE regression Deciles based on Neighbourhood Disadvantage Index (4 variables) in DAs.</td>
</tr>
<tr>
<td>CIHI, 2008a</td>
<td>Cross-sectional, Ecological</td>
<td>Discharge Abstract Database, Unintentional Hospitalization Rate</td>
<td>Unintentional, Compare Standardized rates on DIHWPQ (social and economic factors)</td>
<td>Tertiles based on Age, Pan-Canadian rates show SES gradient of ↑ rates over time.</td>
</tr>
</tbody>
</table>

3 Socioeconomic Factor Index  
4 Regional Health Authority  
5 Winnipeg Community Areas  
6 Generalized Estimating Equations
<table>
<thead>
<tr>
<th>CIHI, 2010</th>
<th>Ecological, Cross-sectional</th>
<th>National Trauma Registry, Minimum Data Set, Fichier des hospitalisations MED-ECHO, Census, Canadians &lt; 14 yrs</th>
<th>Unintentional Hospitalization due to MVC and falls</th>
<th>Standardized Rates Neighbourhood income quintiles based on average income in DAs</th>
<th>Age</th>
<th>Falls: hospitalization rates did not vary significantly among income quintiles. MVCs: SES gradient observed. Lowest income quintiles had highest rates</th>
</tr>
</thead>
</table>

7 Enumeration Areas
<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Methodology</th>
<th>Data Source</th>
<th>Injury Type</th>
<th>Analytical Approach</th>
<th>SES Measure</th>
<th>SES and Injury Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gagné &amp; Hamel, 2009</td>
<td>Ecological, Cross-sectional</td>
<td>Administrative hospital data, Quebec 1-14 yrs</td>
<td>Unintentional, Overall, Specific causes, Specific diagnoses</td>
<td>Poisson regression on DIHWPQ (social and material deprivation) for DAs&lt;sup&gt;8&lt;/sup&gt;</td>
<td>Age, sex, residence location between quintiles, the presence of the other dimension on the DIHWPQ (Percent with no high school diploma, employment ratio, average income, percent single-parent families, percent persons living alone, percent persons separated, divorced or widowed).</td>
<td>Hospitalization more strongly associated with material deprivation than social deprivation. Burns, poisoning, pedestrian, and MVCs: Higher RRs in deprived areas than privileged areas. Falls or sports/recreation injuries: RRs not higher in deprived areas.</td>
</tr>
<tr>
<td>Lee, 2009</td>
<td>Ecological, Cross-sectional</td>
<td>NACRS DADS, Census 10 Ontario Cities,</td>
<td>Intentional, Unintentional, Hospitalizations, ED visits, Mechanical</td>
<td>Linear regression CUMI (4 variables) based on quartiles in urban CTs</td>
<td>Age, Sex, The other dimensions on the CUMI</td>
<td>Relationship between SES and injury varied with the city and type of injury.</td>
</tr>
</tbody>
</table>

<sup>8</sup> Dissemination areas
<table>
<thead>
<tr>
<th>Injuries only.</th>
<th>Low SES Toronto children had lower injury rates than low SES children in other cities, across most dimensions. Unintentional injury: Consistent negative relationship with ethnic diversity.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macpherson et al., 2005</td>
<td>Ecological, Cross-sectional, NACRS DAD Ontario 0-6 yrs 0-14 yrs ED visits Hospitalization Specific causes Compare Standardized rates Average family income of the residential postal code area. Age Sex Children in the lowest income areas are 40% more likely to be injured than those in the highest income areas. Rural children have higher rates than urban children.</td>
</tr>
<tr>
<td>Oliver &amp; Kohen, 2009</td>
<td>Cohort HMBD Census, Canadians &lt;19 yrs Census Unintentional, MVC, hospitalizations Poisson regression Linear Trend Test Neighbourhood income quintiles based on average income in Urban and Rural DAs Age Sex Vehicle occupant hospitalization: In urban areas, rates higher in middle income areas while highest and lowest income areas had similar rates. Pedestrian/cyclist:</td>
</tr>
</tbody>
</table>
In urban areas, Gradient of ↑ injury with ↓ income. In rural areas: Gradient not evident but injury rates higher in poor areas.  

<table>
<thead>
<tr>
<th>Study</th>
<th>Study Design</th>
<th>Cohort</th>
<th>Population</th>
<th>Methodology</th>
<th>Predictor Variables</th>
<th>Risk Factors</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oliver &amp; Kohen, 2010</td>
<td>Ecological</td>
<td>HMBD Census, Canadians &lt;19 yrs</td>
<td>Unintentional, Hospitalization, Specific causes</td>
<td>Linear Trend Test</td>
<td>Neighbourhood income quintiles based on average income in Urban DAs</td>
<td>Age, Sex</td>
<td>Poisoning, cut/pierce, fire: Gradient observed, with lower income areas having higher rates than higher income (p &lt;.05). Falls, drowning, suffocation, transport: Significant trend observed only for 0-9 yr olds</td>
</tr>
<tr>
<td>Soubhi et al., 2004</td>
<td>Longitudinal</td>
<td>NLSCY&lt;sup&gt;9&lt;/sup&gt;, Census, Canadians &lt;12 years</td>
<td>Medically attended injury within last year.</td>
<td>Logistic regression</td>
<td>% single female headed households, % families with income &lt; $20,000, Neighbourhood disadvantage index (5)</td>
<td>Age, Sex, # persons in dwelling, Family characteristics, Previous child injury, Parent</td>
<td>Protective effect of single female-headed households. Neighbourhood SES disadvantage a small risk factor for aggressive children.</td>
</tr>
</tbody>
</table>

<sup>9</sup> National Longitudinal Survey for Children and Youth
| Thanigasa-lam, 2001 | Ecological, Multilevel, Contextual, Cross-sectional | Alberta health administrative databases, Census, Edmonton, <17 yrs old | Overall injury, sprains, strains, dislocation, fractures, burns, poisoning, medically attended injury, hospitalization | Linear regression, contextual analysis, HLM | Median family income in CTs | % unemployed, % with high school diploma, levels, % housing in need of repair, % crowded dwellings, income inequality, % lone parents, % moved in last year | At the individual- and CT-levels, fractures, dislocations, sprains and strains: Related to higher SES. Burns, poisonings and hospitalizations were related to lower SES. Poisonings: Related to low SES and a high % of lone parent families. CT level factors did not predict likelihood of hospitalization
|---|---|---|---|---|---|---|---|
Although there was a paucity of studies on this topic in Canada, different geographic locales across the country were represented in a general way (East, West, Central). Some studies were pan-Canadian while others focused on a single city or province. Not surprisingly, the Canadian literature had less variation in neighbourhood definitions than the international literature. Statistics Canada’s definitions dominated the classification of neighbourhoods, namely, EAs, CTs, and DAs, providing some consistency across studies. However, half of the fourteen identified studies concentrated on urban neighbourhoods only. This concentration is not unusual given that the literature on neighbourhood effects on health appears to focus more on demarcating urban neighbourhoods than rural ones. In addition, there is a marked disregard of the suburbs in this research area so it is hard to find suburban injury rates. Rates were found to be higher in rural areas than urban areas (Brownell et al., 2002; Macpherson et al., 2005; Oliver & Kohen, 2009), possibly due to differences between rural and urban areas in health care access and utilization, but differential exposure to hazardous environments and differential uptake of prevention strategies may play a role (Brownell et al., 2002).

Most of the studies had similar designs. None of the studies checked for spatial autocorrelation and addressed it if present; rather, traditional analytic approaches were used. All the studies met the conventional definition of ecological studies with the exception of two. Thanigasalam (2001) incorporated multilevel modeling, while Soubhi, Raina, & Kohen (2004) performed a single-level analysis of multilevel data. Health agencies contributed three reports to the literature (CIHI, 2008a; CIHI, 2010; Macpherson et al., 2005); which mainly compared standardized rates and therefore were brief. All of the studies accessed secondary data, usually in the form of administrative health databases. Thus, the literature review identified
homogeneity among several aspects of the study designs, largely due to being constrained by the available data sources and neighbourhood boundaries in the country.

The ratio of injury hospitalization rates between low and high SES Groups was lower than the Canadian average in most Ontario and Quebec cities. However, it was higher than average in the prairie cities of Regina, Saskatoon, and Winnipeg, showing the presence of a steeper gradient (CIHI, 2008a). A strong association between low SES and injury in prairie cities was reinforced by a study by Brownell et al. (2002) that shows a strong cross-sectional correlation in Manitoba between high injury rates and low SES. In addition, there are indications that the temporal change in the child injury gradient has been unkind to low SES children in Manitoba: The socioeconomic gradient in injury hospitalizations has widened over time to their detriment (Brownell et al., 2010). To provide contrast, Birken et al (2006) have shown that SES-related inequities in mortality rates have narrowed over time among the overall population of urban Canadian children. However, it must be noted that the injury outcomes differed across the Birken and Brownell studies.

One area in which heterogeneity is evident is the range of model specifications related to injury risk factors. There appeared to be three main ways with which to measure SES-related risk factors in the Canadian literature. First, there were Canadian deprivation indices relevant to health and social research. While there are some similarities in the choice of variables used among the 7 indices found in this review, each was slightly different, reflecting the various methods used to select the variables that comprise the index. Second, LICO or neighbourhood income status was used as a single variable to measure poverty in some studies. Finally, some studies used a number of “raw” measures alone or in addition to an index or other measures of neighbourhood poverty. Clearly, there is no gold standard for measuring SES in Canada.
Another point of divergence across the studies was the range of injury outcomes. Although few studies investigated injuries from the ED independently, many of the studies investigated injury deaths and hospitalizations as outcomes, or combined outcomes into broad injury categories. Some of the studies specifically investigated homicide or assault (Birken, et al., 2006; Brownell et al., 2010), while others were less specific in terms of the causal mechanisms of the presented outcomes (CIHI, 2008a). Some authors focused on injury diagnoses rather than the external causes (Gagné & Hamel, 2009; Thanigasalam, 2001). One study broadly depicted provincial rates in maps (Macpherson et al., 2005). Similar to the findings of international reviews on the topic (Mackay et al., 1999; Laflamme, Hasselburg, & Burrows, 2009), the Canadian literature was difficult to compare and integrate due to the range of outcomes studied.

Conclusion of the Findings of the Canadian Literature

There has been an increase of Canadian studies on the research topic in recent years; however, the numbers remain small enough to make it difficult to infer conclusions about the relationship between SES and childhood injury. The analysis of the Canadian literature illuminated some general patterns, although the dependency on context that characterizes this research topic suggests they must be viewed with caution. One pattern is that the association between SES and injury is significant but minimal. For example, the Canadian study that employed multilevel techniques (Thanigasalam, 2001) suggested that there is variation in risk of childhood injury by SES characteristics inherent to residential neighbourhood, and independent of individual-level risk factors. The amount of variation explained at the CT level was minimal for most outcomes.
The second pattern is that injury rates for young children appeared to vary less overall than injury rates including all children (Macpherson et al., 2005). However, the SES gradient appeared fairly flat for older children as well as younger children when falls were examined (CIHI, 2010; Oliver & Kohen, 2010). When examining injury severities or proxies for injury severity, more severe injuries appear to be associated with low SES more strongly than less severe injuries (e.g., Brownell et al., 2002; Gagné & Hamel, 2010; Thanigasalim, 2001), but this finding did not hold across all studies (Faelker et al., 2000). The general trend of more severe injuries a stronger association with low SES than the more minor ones was mirrored in the international literature (see Cubbin & Smith, 2002).

In summary, injury rates across Canada did not follow a consistent pattern. The pattern varied by mechanism and severity of injury, age group affected, and geographical region. The paucity of Canadian data and the variety of outcomes and measures used among the studies that do exist make it difficult to draw general conclusions. However, the heterogeneity across the country is consistent with recent work by Small and Feldman (2012) that suggests the effects of SES are related to context. For example the effect of neighbourhood poverty may depend on the city and the subpopulation studied.

Critique of the Canadian Literature

There were some methodological challenges regarding data sources. Most of the studies in this review analyzed administrative health data, and hence were subject to bias due to possible coding limitations and differential patterns of health care access and utilization according to SES and geographical region. The weaknesses of secondary data analysis mentioned in the discussion of the international literature are applicable here. Due to low base rates for some outcomes, some studies were underpowered. The results for some outcomes and some age sub-
categories may not have been statistically significant due to small sample sizes (Brownell et al., 2010; Faelker et al., 2000; Lee, 2009). The limitations of the studies entail that the synthesis of study results into general conclusion must be done with caution.

As previously mentioned in this paper, an explicit values base appears to be lacking in the biomedical framework that dominates the epidemiological literature. Conceptual frameworks to explain the causal links through which social and neighbourhood contexts may be associated with various injury outcomes are generally lacking in the literature, and the Canadian literature is no exception. Thus, there appeared to be a some conjecture in the studies, such as the suggestion that high income groups, in comparison to less privileged groups, may be at lower risk for traffic injury due to their safer driving practices (Oliver & Kohen, 2009). The variation in the relationship between SES and injury across cities, however, suggests sources of resiliency and protective factors exist in disadvantaged neighbourhoods in at least some contexts. These sources may deserve further exploration.

**Summary of what is unknown in the topic areas**

The international and domestic review of studies reveals that there is a dearth of Canadian multilevel studies on this topic with which to compare to the international multilevel studies and to conventional ecological studies. The results of the one multilevel study found were harmonious with the results of the other Canadian literature: Overall, the Canadian literature indicates that it is slightly disadvantageous to child safety to live in a low SES area, but the results vary according to contextual and individual-level factors.

A key unknown that deserves discussion pertains to the use of a variety of SES measures. The studies reviewed reflect the numerous attempts to construct indices of SES, ever since the Chicago School and social area analysis studies in the 1960s (Small & Feldman, 2012). These
indices are often used to condense a large number of variables. Although there was overlap in the choice of variables used among the indices and the variables selected for this study, most of the Canadian indices excluded demographic variables, such as ethnicity and immigration status (CIHI, 2008a). A number of potentially meaningful variables may be excluded from studies of socioeconomic inequalities in injuries. What is often unknown is the justification among researchers for using certain SES measures in comparison to other options (Cubbin & Smith, 2002). Soubhi et al. (2004) explored and included numerous predictors in greater detail than the other studies, and hence has a place in this review, even though the single-level analysis of multilevel data may give an inaccurate estimate of the impact of neighbourhood effects.

As mentioned earlier in this review, there is a knowledge gap on the specific physical sequelae of child abuse (i.e., intentional injury inflicted by caregivers), although the Canadian Incidence Study (CIS), a national child maltreatment surveillance study, helps address some of the unknown (Trocmé, Lajoie, Fallon, & Felstiner, 2007). If using administrative health data, the ICD-10 classification system for injuries and diseases provides a standardized system with which to identify and analyze various aspects of injury. The literature acknowledges that there are important limitations in terms of ICD-10 coding with respect to child abuse. For example, recent data indicate that only 21% of child homicide deaths were coded as child abuse (Birken et al., 2009). The restrictive National Center for Health statistics definitions of child abuse, along with current administrative practices of medical personnel, may lead to underestimation of child abuse deaths such that the true rate is unknown (Birken et al., 2009). There are currently weaknesses in health records databases in terms of measuring deaths due to child abuse.

The final unknown worthy of discussing is the lack of conceptual information that illuminates the links between environment and behaviour. This knowledge gap represents a
challenge to prevention programming and a call for action. Regardless, the ecological research of the type discussed in this review can provide implications for policy and community practice. Modification of contexts and external environments can provide an effective means of injury prevention even if causal factors are not clearly elucidated (Laflamme, Hasselburg, & Burrows, 2009; Volpe, 2004). Given that many methodological and theoretical issues still need to be addressed by researchers in order to elucidate causal factors (Diez Roux, 2004), the modification of contexts and external environments is a useful endeavor. Meanwhile, researchers will continue with the challenge of developing theories and methods to investigate the complex, multidirectional paths between individual outcomes and neighbourhoods.

Potential Contribution of this Study to the Literature

There has been a resurgence of interest in recent years about the influence of the community socioeconomic environment on individual health. The concern among researchers, practitioners, and the public about increased poverty due to demographic shifts in labour force participation, immigration and household composition have fueled much of this interest (Cubbin & Smith 2002; Robert, 1999; Leventhal & Brooks-Gunn, 2003). In order to improve health outcomes, the implications of a broad range of social, environmental, and economic factors must be considered. These considerations provide a rationale for investigating the performance of a new measure of SES with respect the variation in injury rates as a case study of Toronto. Specifically, this study is the first to link the Toronto Neighbourhood Change research group’s Neighbourhood Change CURA’s “Three Cities” analysis of neighbourhoods to health outcomes. This analysis incorporates longitudinal information (35 years) on the change in the Toronto neighbourhood average individual income. The “Three Cities” measure incorporates information on the historical contexts of neighbourhoods and how they are changing due to
economic and social conditions and government policies. The performance of the measure as a predictor of injury outcomes will be further assessed with a sensitivity analysis using a more conventional one-point-in-time measure of neighbourhood income status.

This study will be one of the first Canadian studies to contribute analysis of immigration status to the problem of neighbourhood-based variation in child injury. Ethnicity or immigration status was seldom included as a predictor in the Canadian studies although it has been acknowledged as an important determinant of health (CIHI, 2008a). In addition, this study will be one of the first in Canada to contribute information on socioeconomic inequality with ED visits as an outcome. Most studies in this topic area use death, hospitalization, or specific injuries, or a combination of measures to define outcomes. Thus, this study will can contribute information on whether and to what extent the relationships found between SES and more severe outcomes such as death or hospitalization hold for ED visits. By mapping these rates, it will be the first known study to provide a visual picture of injury rates throughout the city.

The final contribution of this study pertains to a long term, cumulative goal. An enduring controversy is whether prevention programming should be offered universally to the whole population or instead target specific “high-risk” individuals, groups, or areas. The debate on universal versus targeted programs has continued for over 30 years (Moller, 1997). As shown in Figure 1, the chosen target of intervention is largely dependent on the perception of who or what the problem is. If characteristics of the neighbourhood are associated with injury rates, avenues of health and social service intervention may be illuminated. Hopefully, an accumulation of research evidence will result in clearer policy decisions. Because there is a paucity of Canadian research and some discordant results in the research on the topic, the present study was largely
exploratory, mainly aspiring to generate hypotheses, but some endeavors were made to explain the relationships found among variables.
Chapter 3: Methods

The methods of this study are presented in this chapter. First, the data sources, operationalization, and rationale for the selected variables are presented. Next, the analytic strategies are delineated and justified.

Research Design

Source and Description of Injury Data

To create a unique dataset that represents both sociodemographic characteristics and clinical information collected during ED visits, two sources of population-based data were merged. One source represents injury events in CIHI’s National Ambulatory Care Reporting System (NACRS) database for ED/ambulatory visits, and the other represents the census-derived sociodemographic characteristics of Toronto from the Neighbourhood Change Community-University Research Alliance (CURA). The hospital-based data of the NACRS and the CURA data of Toronto neighbourhoods are compatible because they both are geo-coded with the CT as the operational definition of neighbourhood. The Neighbourhood Change CURA and NACRS data were merged and aggregated to the CT level to make the CT the unit of analysis.

NACRS data were made available via an agreement with the Ministry of Health and Long-Term care and the Injury Prevention Research Office of St. Michael’s Hospital. The data are owned by the hospital with terms stipulated by the Ministry for their use. Although Ontario is the only province in Canada currently required to submit ED data for the NACRS, the introduction of the NACRS represents a progression toward the universal collection of ED data (Sahai et al., 2005). Ontario residents injured and attending EDs in other jurisdictions are not captured in this study; therefore, the true rate of ED visits for the population of interest may be underestimated. The NACRS offers a unique opportunity for analysis from a population-based
perspective because the vast majority of the Ontario population possesses public health insurance (Colantoni, Parsons, & Chen, 2010); and because the NACRS is event-based, a unique visit for a particular individual can be identified (CIHI, 2010).

NACRS represents individuals who died before arrival at hospital, who died in EDs, or died in the hospital. However, deaths that occurred outside of the hospital environs cannot be captured by the NACRS. The findings of this study may be biased if residents living in neighborhoods of a particular SES category were more susceptible to these injury deaths than residents of other neighbourhoods. The prevalence of these deaths is unknown and reveals a surveillance gap and possible underreporting (Colantonio, Savarino, et al., 2010). Indeed, estimates are that 50% of all injury deaths occur at the scene of death and never attend hospital (Lee, 2009). However, injury deaths are rare in comparison to injury morbidity; hence, the NACRS data are assumed to be reasonably comprehensive.

The quality of the NACRS data depends on the accuracy and completeness of the coding of patients’ charts within health records departments (Gibson, Richards, & Chapman, 2008). NACRS has recently been validated with respect to injury and good agreement with chart coding was found with 5% misclassifications at the 2-digit block level (CIHI, 2008b). A 99% geocoding rate was found for the NACRS dataset in this study, meaning that 99% of events were successfully assigned a CT. In summary, a reasonable degree of completeness and accuracy can be reflected in the injury events captured by this study.

**Outcome Variables**

**Coding**

There are no universal guidelines for researchers to define injuries documented as Canadian ED visits. Thus, a review of the literature and expert consultation was a precursor to
selecting cases in the NACRS that represent injuries. The International Classification of Diseases 10 (ICD-10) coding system used in the NACRS reflects both the nature of the injury (e.g., fracture) and an external code based on the cause (e.g., fall). Specifically, NACRS possesses up to ten reasons for each visit to an ED, including a main problem and nine other problems, each of which may represent a diagnosis, condition, or circumstance (CIHI, 2005). The external causes may be further divided into intentional, unintentional, and undetermined intent injuries. Thus, as recommended by some authors, injury may simultaneously be defined by its external causation and by the resulting impairment to the body (e.g., Cubbin & Smith, 2002; Potter et al., 2009). Because the influence of neighbourhood factors should vary by the external cause of injury, and not just by the diagnosis, injury was operationalized in this study as a child age 0-6 visiting the ED for a primary injury designated with an ICD-10 external cause of injury code and an ICD-10 nature of injury (diagnosis) code. Specifically, a case was selected for the analysis if an injury diagnosis was defined as the main problem pertaining to the hospital visit. Next, the first external cause of injury code in any of the nine subsequent fields of data was subsequently selected. This algorithm was also used to select injury cases in previous literature (Macpherson, personal communication, September 15, 2009; Macpherson, Schull, Manuel, Cernat, Redelmeier, & Laupacis, 2005). In this way, ICD-10 nature of injury and external cause codes indicating falls, burns, and poisoning injuries were selected for this study. Individuals may have more than 1 record depending on how many times they attended the ED over the study period. A summary of inclusion and exclusion criteria of ED visits and the outcome variables captured for this study are shown in Figure 2, and are further delineated in Appendix C.
Figure 2
Summary of Outcome Variables and Inclusion and Exclusion Criteria for NACRS

NACRS Database

Exclusion Criteria
- Iatrogenic injuries (ICD-10 range T80-T88)
- Unplanned return visit to the same ED within seven days.
- Planned return visit or follow up to the ED for the same clinical condition.
- Transfers to another ED

Inclusion Criteria
- Age 0-6
- Unplanned ED visit for new Clinical Condition, or
- Patient referred for ED Service Provider Assessment.
- Sustained an injury between fiscal years 2002-2005 inclusive.
- Valid Toronto Forward Sortation Area (First three digits of postal code).
- Injury or poisoning was the principal diagnosis (ICD-10 range S00-T98); AND the first external cause of morbidity was assigned (ICD-10 range V0-Y36, Y85-Y87, Y89).
  - Any injury = V01-Y36, Y85-Y87, Y89;
  - Fall = W00-W19; X80; Y01; Y30;
  - Fire/hot object or substance = X00-X19; X76-X77; X97-X98; Y26-Y27; Y36.3,
  - Poisoning: X40-X49; X60-X69; X85-X90; Y10-Y19; Y35.2

Visit Information Acquired
Age, gender, year of injury, residential CT, mechanism and type of injury, number of injury visits per person

Study Database
Visits aggregated into injury rates among 510 census tracts.
Selection of external causes for analysis

Identifying the outcomes posing the highest risk to children is essential in terms of establishing priorities for prevention. Injury was operationalized in this study as overall injuries, fall injuries, poisoning and fire/hot object/substance injuries according to the ICD-10 codes previously outlined in this paper. In this study, the ecological model of childhood injury provided a rationale for combining injuries deemed of unintentional, intentional, and undetermined intent into a set of comprehensive injury outcomes. These comprehensive outcomes are similar to those presented as injury-related ED visits in the Injuries in Ontario Atlas (Machperson et al., 2005). For the present study, overall injury was selected as a starting point to assess the broad impact of socioeconomic status on injury. Falls were selected due to being the most common cause of injury among children. Motor vehicle-related injuries notwithstanding, burns and poisonings have been documented the next most common cause of injury among young children (Kohen, Soubhi & Raina, 2000; Macpherson, et al., 2005; Oliver & Kohen, 2010; Pickett, Streight, Simpson & Brison, 2003). However, burns and poisoning have low base rates in comparison to falls (Kohen et al., 2000; Macpherson, et al., 2005; Oliver & Kohen, 2010; Pickett, Streight, Simpson & Brison, 2003). However, three other related criteria were also noted with respect to selecting outcome variables: a relationship with SES, biological imperatives, and their relevance to social work.

A relationship with SES

Several studies have found burns to have the strongest negative association with socioeconomic status in comparison to other types of injury (Baker, O’Neill, Ginsburg & Li, 1992; Durkin et al., 1994; Oliver & Kohen, 2010; Roberts, 1997; Santer & Stocking, 1991), perhaps due to poorly maintained housing, heating, and safety equipment (Grossman, 2000). Poisoning has also been noted to have an inverse relationship with SES (Roberts, 1997; Santer &
Stocking, 1991). Some researchers suggest that children living in disadvantaged areas have more access than those in privileged areas to hazardous items such as cigarette lighters and medications due to crowded and cramped conditions (Grossman, 2000; Kitzman, Cole, Yoos, & Olds, 1997; Santer & Stocking, 1991). A more controversial but related proposition is that a high rate of smoking, alcohol consumption, and drug use in disadvantaged areas increases poor children’s risk of fires, burns, and inadvertent poisoning through exposure and neglect (Grossman, 2000). This proposition is of interest to health and social service professionals because it has bearing on whether and to what extent programming should target disadvantaged environments. In addition, there is a generally a lack of research on burns and poisoning outcomes in the literature (Laflamme, Hasselburg, & Burrows, 2009). Thus, investigation of burns and poisoning is warranted for this study.

**Biological imperatives**

Children face a variety of injury risks that correspond to the development of the perceptual and cognitive abilities to effectively appraise them (Mercy, Sleet, & Doll, 2003). Considering the interaction of the environment with developmental explanations for a variety of child behaviours can help to produce guidelines for designing primary or secondary prevention programs (Mercy, Sleet, & Doll, 2003, p. 10). Children will learn to roll, grasp objects, and crawl while under one year of age. They will also learn to put objects in their mouths. This rambunctious behaviour continues at 1-3 years as children learn to climb and to drink, putting them at risk for falls, burns and poisonings (Peder, 2008). As children become more mobile with age, structures such as stairs (SKC, 2006b) can present fall hazards to children who are still developing skills such as coordination and balance (Zelizer, 1985; SKC, 2006b). Biological imperatives are also relevant to tertiary prevention or rehabilitation because after a burn or
poisoning occurs, children are more likely to sustain a severe injury than adults due to their smaller mass and greater fragility (Peden et al., 2008). In summary, falls, burns, and poisoning are salient sources of injury for young children due to developmental imperatives that social workers and others working in children’s services would find of interest.

Relevance to Social Work

Because a young child’s home and proximate environment is a source of scrutiny by social workers and related professions, the focus of this study was on injuries likely to occur in the immediate surroundings of the child’s home and neighbourhood. Land transport injuries such as motor vehicle collisions, although a significant source of childhood injury, were not selected as a specific outcome for this neighbourhood-based study due to their higher likelihood than falls, burns, and poisonings to occur away from a child’s own home or neighbourhood. Land transport injuries also have a unique connection to biomechanics, engineering, infrastructure, and the economy. The nature of transport-related injuries suggests the need for unique programs and decisions in this area (Volpe & Lewko, 2006). These unique solutions would be difficult for social workers and related professions to implement on a large scale without substantial contributions from other disciplines and agencies.

Source of Socioeconomic Status Measures

The present research uses research findings from the Neighbourhood Change CURA as primary variables. The CURA initiative used census data to categorize Toronto neighbourhoods into the “Three Cities,” namely, those that are socioeconomically declining, socioeconomically improving, or displaying mixed trends. Using data from 1971 to 2006 to determine SES trends in Toronto’s neighbourhoods, the CURA analysis identified for 2006 three clusters of census tracts based on neighbourhood SES. To obtain these clusters, the average income of the
residents 15 and over in the census tract was divided by the average individual income for all residents 15 and over in the Toronto Census Metropolitan Area (CMA). This division was done for 1970 and 2005. Consequently, an “individual income ratio” for each census tract was obtained. Next, the percentage increase or decrease in the two ratios between 1970 and 2005 was calculated (Hulchanski, 2010). That is, the change in the average status of the residents in each neighbourhood over 35 years was illuminated.

Several methodological issues were addressed by the Neighbourhood Change CURA pertaining to the categorization of income and neighbourhoods:

- Individual income was used in the analysis because it includes more individuals and is more comprehensive an income measure than employment income\(^{10}\).
- Due to the census questions pertaining to individual income in the previous calendar year, the data are from the year previous to when the census data were collected.
- To control for inflation over the years, the average CT income was divided by the average income of the entire Toronto CMA for each year of interest\(^{11}\).

Thus, the information on the long-term direction of income change rather than the amount of change was captured (Hulchanski, 2010).

The Neighbourhood Change CURA also used census data to calculate a more conventional measure of a one-point-in-time snapshot of neighbourhood SES that shows “who lives where” in the City of Toronto (Hulchanski, 2010). The CMA 2005 average individual income of $40,704 was used as the benchmark for comparison (Hulchanski, 2010). Rather than the summary 35 year trend, this measure showed the average individual income relative to the Toronto CMA, in

\(^{10}\) Individual income is the census category for income from all sources, including employment income, pensions, social assistance and investment income.

\(^{11}\) Using the Toronto CMA’s average income rather than simply Toronto’s as the denominator acknowledged the connection between the labour and housing markets in the city and its suburbs and was conducive to comparing income changes over time between Toronto and the suburbs (Hulchanski, 2010).
Toronto neighbourhoods for three categories in a specific year (2005). This more conventional “snapshot” SES measure illuminates the end result of the gradual consolidation of Toronto into the “Three Cities” with their increasingly disparate income levels.

Importantly, this snapshot measure shows the “Three Cities” and the disparities among them are a fairly new phenomenon given that they did not exist in 1970, when the majority of individuals in Toronto fell into the middle-income category. Compared to the Neighbourhood Change CURA project’s base year (1970), the proportion of middle-income neighbourhoods had fallen, while the proportion of both poor and wealthy neighbourhoods has increased.

The evidence suggests that neighbourhoods trending downwards and upwards in socio-economic status for 35 years have led to the increase in both affluent and poor neighbourhoods, while neighbourhoods with average incomes are much less common. The neighbourhoods with long-term trends toward poverty or wealth may be different than the neighbourhoods that have remained relatively stable over the 35 years (Hulchanski, 2010). For example, individuals living in declining neighbourhoods have had to adapt to transition, such as declining neighbourhood resources, amenities, and growing anomie (Furstenberg, 1993). Thus, when examining the relationship between injury rates and neighbourhood socioeconomic status in Toronto, one hypothesis that needs to be tested relates to neighbourhood income trends, which compares two points in time, providing a dynamic look at change in geographic clusters. In short, it is important to juxtapose socioeconomic trends over time with a snapshot in time in order to determine their similarities or differences in predicting injury rates.

Both neighbourhood income trends and neighbourhood SES have been used as primary variables in this study, although more focus will be on neighbourhood income trends because it has never been studied as a risk factor for childhood injury before. The use of the
neighbourhood income trends variable to explain variation in childhood injury may add depth to the knowledge of the relationship between childhood injury and socioeconomic status. As seen by the literature review in this paper, neighbourhood SES at one point in time has previously presented with a variety of operational definitions as an independent variable in injury-related studies. Neighbourhood SES was also included as an independent variable in this study because it decreased the reliance on the single-indicator relationship between injury and SES in the form of the neighbourhood income trend indicator, and provided an assessment of the relative power of the association of these two primary variables with various types of injury. Table 3 further describes the Neighbourhood Change CURA’s operationalization of the SES measures that are used as primary variables for a secondary analysis in this research study.
Table 3  
*Description of Primary Variables from the 2006 census used in the Analysis*

<table>
<thead>
<tr>
<th>SES Measure</th>
<th>Neighbourhood Levels</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neighbourhood Income Trends</td>
<td>1 = Improving: 100 CTs, or 20% of the city. • An increase of 20% or more in the average individual income of its residents between 1970 and 2005 relative to that of the Toronto CMA.</td>
<td>The change in Toronto neighbourhoods according to the change in census tract average individual income as a percentage of the Toronto CMA average individual income, from 1970-2005.</td>
</tr>
<tr>
<td></td>
<td>2 = Mixed Trends: 208 CTs, or 43% of the city. • The average income of its residents went up or down by no more than 20% between 1970 and 2005, relative to the Toronto CMA.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 = Declining: 206 CTs, or 39% of the city. • A decline of 20% or more in average individual income of its residents between 1970 and 2005 relative to the Toronto CMA.</td>
<td></td>
</tr>
<tr>
<td>Neighbourhood Income Status (SES)</td>
<td>1 = High Income: 98 CTs or 19% of the city. • More than 120% of the CMA average income for 2005.</td>
<td>Neighbourhood income levels as a percentage of the Toronto CMA average individual income in 2005.</td>
</tr>
<tr>
<td></td>
<td>2 = Middle Income: 152 CTs or 29% of the city. • 80% to 120% of the CMA average income for 2005.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 = Low Income: 274 CTs or 52% of the city. • Less than 80% of the CMA average income for 2005.</td>
<td></td>
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</tbody>
</table>

*Source and Description of Covariates*

Income levels represent only one facet of neighbourhood socioeconomic status among Toronto CTs. Other sociodemographic indicators from the 2006 census have been included in the analysis as covariates because they may also explain variability in injury rates. These sociodemographic indicators may influence children’s exposure to hazards or their ability to avoid hazards by manifesting differential exposure to injury-promoting physical and social
environments. Differential exposures to these risk factors may have been prompted by widening neighbourhood income inequalities.

The sociodemographic indicators were initially selected by the Neighbourhood Change CURA to examine to what extent social and spatial polarization exist in Toronto, in domains shown to be related to but distinct from income levels (Hulchanski, 2010). These indicators were included in the CURA “Three Cities” analysis and consequently demonstrated that they defined characteristics of the status of neighbourhoods in addition to the income-based SES measures. A preponderance of these characteristics may represent a socially disadvantaged environment that may present child-rearing challenges. The declining income neighbourhoods were found to have the highest profile of social disadvantage in comparison to the most socially advantaged improving income neighbourhoods, with the mixed trends neighbourhoods falling in between the two. For example, there were differences among the “Three Cities” in terms of the immigration status, single parent status, and other key variables (Hulchanski, 2007; Hulchanski, 2010). Hence, these sociodemographic indicators represent important markers of “who lives where” (Hulchanski, 2010). These indicators can be seen as both a cause and an effect of the neighbourhood income trends identified by the Neighbourhood Change CURA (Hulchanski, 2010). For example, an excess of physical decay and building code violations of a given neighbourhood may pose an injury risk to children and also encourage people with means to move away. Hence, further resource depletion and physical decline occurs in that neighbourhood, which further promotes injury risk.

As shown in the literature review of this paper, the injury and child maltreatment literature provides a basis for the same neighbourhood sociodemographic indicators used in the Neighbourhood Change CURA to represent causal pathways for injury. Thus, a replication of
the use of these sociodemographic indicators to define the characteristics of the city was appropriate. Measures of social disadvantage, housing quality, and neighbourhood stability were represented in the study according to the ecological theory presented in Figure 1 and by the literature’s discussion of possible area-based inequalities among risk factors. All of the indicators used reflect actual percentages. The indicators initially selected for the analysis and a non-exhaustive summary of studies that have used these indicators is shown in Table 4.
### Table 4

*Description of Sociodemographic Indicators Initially Selected as Covariates and Studies Discussing them as Risk Factors*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Operational definition</th>
<th>Social inequalities possibly manifested as risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social Disadvantage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Employment level</td>
<td>PUNEMP = Unemployment Rate (Persons 15 and Over)</td>
<td>Birken, et al., 2006; Brownell et al., 2010; Faelker et al., 2000; Gagné &amp; Hamel, 2009; Lee, 2009; McDonell &amp; Skosireva, 2009; Soubhi et al., 2004;</td>
</tr>
<tr>
<td>• Education level</td>
<td>PNOUNIVD = Persons 25 and Over Without a University Degree as a Percentage of Total Persons 25 and Over</td>
<td>Birken, et al., 2006; Brownell et al., 2010; Faelker et al., 2000; McDonell &amp; Skosireva, 2009; Soubhi et al., 2004;</td>
</tr>
<tr>
<td>• Family status</td>
<td>PLPF = Total Lone Parent Families as a Percentage of Total Census Families</td>
<td>Brownell et al., 2010; Ernst, 2000; Ernst, 2001; Faelker et al., 2000; Gagné &amp; Hamel, 2009; McDonell &amp; Skosireva, 2009; Soubhi et al., 2004;</td>
</tr>
<tr>
<td><strong>Housing Quality</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Rented dwellings</td>
<td>PRENTED = Total Occupied Rented Dwellings as a Percentage of Total Dwellings (note: one dwelling = one household in the census)</td>
<td>Birken, et al., 2006; Ernst, 2000; Ernst, Meyer, &amp; Depanfilis, 2004; Shenassa et al., 2004;</td>
</tr>
<tr>
<td>• Dwelling type</td>
<td>PAPT = Total Apartments (units in buildings under 5 storeys + those in buildings over 5 storeys + duplexes) as a Percentage of Total Dwellings</td>
<td>Ernst, 2000; Garbarino &amp; Crouter, 1978; Zuravin, 1989.</td>
</tr>
<tr>
<td>• Housing in need of major repairs</td>
<td>PMAJORREP = Dwellings in need of major repairs (self-reported)</td>
<td>Ernst, 2001; Ernst et al., 2004; Faelker et al., 2000; Shenassa et al., 2004</td>
</tr>
<tr>
<td><strong>Time living in Neighbourhood and Neighbourhood Stability and Cohesion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Recent Immigrants</td>
<td>PRECIMIG0106 = Percentage of Total Population who Arrived as an Immigrant to Canada in the 2001-2006 Period</td>
<td>Anderson et al., 1998; CIHI, 2008a; Durkin et al., 1994; Flores, Tomany-Korman, &amp; Olson, 2005</td>
</tr>
<tr>
<td>Variable</td>
<td>Operational definition</td>
<td>Social inequalities possibly manifested as risk factors</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Immigrants</td>
<td><strong>PIMIG = Immigrants as a Percentage of the Total Population</strong></td>
<td>Anderson et al., 1998; CIHI, 2008a; Durkin et al., 1994; Flores, Tomany-Korman, &amp; Olson, 2005</td>
</tr>
<tr>
<td>Recent household moves</td>
<td><strong>PMOV5YR = Number of Persons who Moved in the Previous Five Years as a Percentage of the Total Population</strong></td>
<td>Soubhi, Raina, &amp; Cohen, 2001; Ernst, 2000; Lee, 2009; McDonell &amp; Skosireva, 2009;</td>
</tr>
<tr>
<td>Income levels</td>
<td><strong>PLICO = Prevalence of Low Income People before Tax - All persons, Private Households</strong></td>
<td>Many studies, e.g., Birken et al., 2006; Birken et al., 2009; Durkin et al., 1994; Ernst, 2000; Faelker, et al., 2000; McDonell &amp; Skosireva, 2009; Soubhi, et al., 2004</td>
</tr>
</tbody>
</table>
How the Data were Analyzed

The previous section of this chapter discussed the methods and procedures used to coalesce the information required to answer the research questions. This next section discusses the data analysis strategies involved to undertake this retrospective, cross-sectional, ecological study. Secondary data analysis was conducted to develop models predicting injury rates of children living in neighbourhoods with various SES characteristics. Specifically, several types of injury rates were calculated among children 0-6 years and analyzed using descriptive and multivariate techniques. This study aims to build on prior studies of the ecological correlations of childhood injury by accessing data on a population of children residing in Toronto, Ontario and 1. examining whether and to what extent injuries can be predicted by neighbourhood SES characteristics; 2. systematically evaluating the explanatory power of two SES indicators; and, 3. visually depicting the spatial distribution of childhood injuries in map form. Further methodological procedures arising from the data sources and research design are discussed in this chapter.

Ethics

This observational study involved secondary analysis using anonymized aggregate data. The data were aggregated across years and by CT to increase the level of confidentiality as indicated in the applicable confidentiality/non-disclosure agreement. Ethics approval for the study was obtained from the University of Toronto Health Services Research Ethics Board (Appendix D).

Time Period
At the commencement of this project, ED data from fiscal years 2002-2005 inclusive and census data from 2005 were the most recent time periods available for analysis. NACRS prior to 2002 was not used because a) it was in a pilot stage only; and b) ICD coding reflected an earlier iteration (Ministry of Health and Long Term Care, 2007; ONF, 2010). Four years of NACRS data were aggregated to decrease the possible influence of an outlier year of injury occurrence and to increase levels of confidentiality. The rates were re-scaled to be expressed as per 1000 children to make the coefficients easier to interpret. As per discussions on new cases occurring in a population (Coggon, Rose & Baker, 2003; Young, 2005), repeat events of injury are included within the rates and aggregated to the CT level. In other words, rates were calculated per injury rather than per child, because the interest lies in the number of injuries experienced by children, rather than the number of children who experienced injury. The 2.3% of cases that were missing their encrypted health care numbers were included in the aggregate analysis and assumed to be unique individuals.

Quantifying Injury Rates in the Population

The calculation of injury rates for this study can be represented in equation 1 as:

\[
R = \frac{1000}{4N} \sum_{j=1}^{4} I_{j} 
\]  

[1]

Where R represents a rate

I represents the number of injuries in each census tract.

j represents the year

N represents the population of children of the age and CT of interest in 2006.
The sociodemographic data from the Neighbourhood Change CURA and the population denominator data were based on the 2006 census, while injury events were captured from fiscal years 2002/3-2005/6, averaged across years. Hence, the assumption in this study was that the population of children 0-6 and neighbourhood sociodemographic characteristics did not change from 2002/3-2005/6. This assumption appears reasonable because the “Three Cities” data indicates that population characteristics did not change very much throughout that period (Hulchanski, 2010). A methodological paper by Geronimus (1998) also suggests that neighbourhoods characteristics change slowly and that no major difference would be expected between censuses.

The injury rates were age and sex-adjusted where appropriate to eliminate the bias of age or sex in the composition of the populations being compared, therefore providing a more reliable rate than crude rates for comparison purposes. Further description regarding the defined population for this study is provided below:

*Unadjusted rate:* A crude rate. The number of events divided by a denominator that denotes the size of the population. Differences in the size of the populations among different neighbourhoods have not been taken into consideration.

*Adjusted rate:* A summary measure that “adjusts” for the variable of interest in terms of differences among the populations being compared, namely, age-sex structure (see Young, 2006). Toronto’s population was used as the standard in this study for comparison purposes.

*Rounding of Denominator Data*

The population estimates from the census that comprise the denominator data in this study have been rounded randomly up or down to multiples of 5 or 10. One cannot obtain unrounded data from the census. For example, one never sees a count of 3 or 7 children from the census.
However, the random rounding up and down does not display bias (e.g., that counts tend to be rounded down rather than up in small census tracts and up rather than down in large census tracts, which could skew injury rates). The rounding would show a stronger range of variability in small census tracts as opposed to large ones (e.g., rounding down from 7 children to 5, as opposed to rounding from 102 children to 100). There is nothing to indicate that the wider range of variability for rounding small census tracts as opposed to large ones is a problem.

**Missing Data**

The Three Cities in the City of Toronto 1970-2005 analysis is based on census tract 2001 boundaries held constant over time. Three CTs were split into two for the 2006 census and their data are not included for the present analysis. These CTs did not exist when some of the injury data were gathered and the author was unable to calculate an injury rate. Analysis was conducted using listwise deletion. There were also a limited number of CTs whose income data were suppressed by Statistics Canada for the years 1970 or 2005 or both, due to data quality issues or no population at the time. Thus, no SES measures could be calculated. These missing data constituted a total of < 5% of the data set. The suppressed neighbourhood SES categories were very few. When some of the data analysis was repeated with these suppressed SES categories, they were found to be of little consequence to the analysis.

**Ecological Versus Multilevel Analysis**

Multilevel analysis, also known as Hierarchical Linear Modeling (HLM) was investigated as a statistical method for this study. HLM is conceptually similar to Ordinary Least Squares regression but allows researchers to model data that occur at multiple hierarchies without aggregation of micro-level units into macro-level units, or disaggregation of macro-level units.
into micro-level units (O’Connell & McCoach, 2008). HLM was developed to address the unique characteristics of nested data. Such data are hierarchically organized, with information describing more than one micro-level unit (e.g., the individual) coming from more than one macro-level unit (e.g., the neighbourhood), such as children who are nested within families, who are nested within communities (Garson, 2005). The NACRS/CURA data is multilevel, or nested, because children are located within the hierarchical social structure of their neighbourhoods. In other words, the linked NACRS/CURA dataset possesses variables describing individual-level characteristics (e.g., child gender) in addition to variables describing macro-level characteristics (e.g., neighbourhood unemployment levels).

Nested data that represents individuals who are hierarchically organized into neighbourhoods may be disaggregated to the individual level, by repeatedly assigning macro-level observations to individuals. However, when doing so, an assumption of traditional regression models may be violated, namely, the assumption of independence of observations. This assumption may be violated because the observations of any one individual are in some way systematically related to the observations of another individual (Willms, 2002). The presumption is that the responses of individuals from the same macro-level unit would be exposed to similar environments, and therefore be more correlated to each other than the responses of individuals from different macro-level units. Hence, conventional regression techniques would produce standard errors that are too small, and consequently result in a tendency to conclude relationships exist when they really do not (Kim, Solomon, & Zurlo, 2009).

Importantly, multilevel statistical techniques do more than simply disentangle the variables

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12 A more concealed data hierarchy in many datasets is the information repeatedly gathered on the individual: For example, in the NACRS individual-level database some individuals portrayed in the dataset had repeat ED visits, representing observations nested within individuals. Data repeatedly gathered on the individual is hierarchical, because the observations depend on person-level characteristics and are clustered within individuals. Thus, multilevel models may also portray context with respect to temporal settings (Duncan et al., 1998).
describing the nature of the place (contextual effects) from the variables describing the individual (compositional effects) on outcomes. Contextual effects may not be identical for all types of people. Given a set of macro- and micro-level variables that provide the relevant information, multilevel modeling can show how, and for whom, contextual effects matter (Duncan, Jones, & Moon, 1998). In other words, multilevel modeling can assess the cross-level interactive effects of neighbourhood observations and individual observations, thus determining the variance in the effects of individual-level characteristics across different types of neighbourhood characteristics. Thus, of central importance is a rigorous theoretical framework in which the researcher hypothesizes a priori the mediating mechanisms at one level that may influence a characteristic at another level (see McCulloch, 2001). Although HLM represents a useful technique for parsing out the relative contribution of neighbourhood-level effects and individual-level effects, without a rigorous theoretical framework of the pathways involved, the technique is limited to revealing what type of neighbourhoods are associated with certain health and social problems (Joshi, 2001; McCulloch, 2001). Consequently, policy and program implications based on this technique would lack guidance.

Thus, in spite of the hierarchical structure of the original NACRS data set, the lack of theory- and policy-relevant information in the NACRS dataset at the individual level was a key reason why HLM was not chosen as an analytic technique. Typical of Canadian administrative health care data, NACRS data only contains basic individual information, such as age, gender, and encrypted health care numbers. Variables such as socioeconomic status, immigrant status, and household composition are not collected in NACRS, but may later be incorporated with an ecological approach using census data (Cusimano et al., 2010). A lack of individual-level data relating to the outcomes of interest that constrains inferences to the group rather than the
individual level is not uncommon in injury research. Area-based studies on childhood injury have been limited by the need for more detailed data at the individual and family level, which would help explain the variation in injuries at that level (see Shenassa et al., 2004).

Because HLM is designed to estimate the combined effects of neighbourhood-level factors and individual-level effects on health and social outcomes, it promotes an understanding of the influence that context, such as one’s neighbourhood, would have on individual outcomes such as injury. A common application of HLM with respect to health inequities is to determine the proportion of variance that can be explained by individual-level characteristics and the proportion that can be explained by macro-level characteristics such as one’s neighbourhood. Group or context-level variables such as neighbourhood characteristics may help explain differences across contexts in the relationship between individual-level variables and the outcome of interest (O’Connell, Goldstein, Rogers, & Peng, 2008). Given the current lack of individual-level data in the NACRS/CURA dataset, the multi-level hypotheses in this study would be constrained to neighbourhood-level characteristics interacting with individual characteristics with respect to their age, sex, cohort (2002-2005), and possible repeat ED visits. For example, cross-level interactive effects may be tested in the NACRS dataset, given a hypothesis that boys fall more than girls in socioeconomically declining areas, and girls fall more than boys in socioeconomically improving areas. However, there appears to be a lack of theory or literature to justify testing cross-level hypotheses with respect to the individual-level variables available in the data set.

In addition, the census-tract level analysis did not exhibit interactions between age or gender and neighbourhood context variables that would indicate that a detangling of the relative contribution of the higher-level (contextual) characteristics from individual (compositional)
characteristics would help explain injury rates. The main objectives of this study relate to the neighborhood-level risk factors that are significant predictors of child injury. The analysis for this study was ecological, meaning the unit of analysis is not at the individual level but at the neighborhood level. Thus, inferences must be limited to the neighborhood (ecological) level, rather than making inferences about individuals’ risk (Freedman, 1999). Ecological studies can be conducive to building knowledge about the relationship between environmental factors and injury, to identifying whether and to what extent various groups are likely to benefit from targeted strategies, and to evaluating universal injury prevention policies (Stevenson & McClure 2005). An ecological study is a suitable preliminary means to assess to what extent certain neighbourhoods should be targeted for additional intervention, to identify risk and protective factors, and identify to what extent certain neighbourhoods or communities display these factors (Laflamme et al., 2009). The study of large populations and the frequent use of secondary data afforded by ecological approaches allow researchers to cheaply and quickly study the overall impact of environmental exposure to hazards (Walter, 1991).

An additional challenge when using HLM in neighbourhood-based research is that it is difficult to separate the characteristics of inhabitants from the social and physical characteristics of areas they live in (e.g., Burrows & Bradshaw, 2001). Interactions are modeled between people and their environments, with the presumption that that there is a split between them. However, there is overlap between higher-level (contextual) characteristics and individual (compositional) characteristics, leading to a blurring of conceptual distinctions and confusion over the direction of causation. For example, an individual’s unemployment is partially dependent on area unemployment, a characteristic of the local labour market. Conversely, the local labour market is comprised of individuals (Joshi, 2001). Mitchell (2001) notes, “you
cannot have a deprived place without deprived people” (p. 1359). The presumption of multilevel models in injury research is that injuries are partially problems that reside in the deficiencies of individuals and partly problems that reside in the deficiencies of environments. However, explaining variance in health outcomes by explaining the contribution of neighbourhood-level factors over above individual-level factors may detract from the point that a complex constellation of social and spatial processes consolidate disadvantaged individuals into clusters, and that these individuals are unlikely to be able live anywhere more attractive (see Hulchanski, 2010; Mitchell, 2001). Ecological analyses do not propose to be able to separate individual variation from neighbourhood variation and therefore reflect the complexity of injury etiology by portraying individuals as fused and embedded with the systems and surroundings that they operate in (Mitchell, 2001; Stevenson & McLure, 2005). This interrelationship and interdependence of people and places speak to the importance of considering area-level policy initiatives.

Hierarchical models were initially developed in educational settings, such as students nested within classrooms nested within schools (Raudenbush & Byrk, 2002). Mitchell (2001) argues that the multilevel hierarchies are more fixed and immutable in schools than in neighbourhoods; thus, it is easier to delineate the characteristics of students and schools that are associated with various educational outcomes. Neighbourhoods are characterized by the fluid and chaotic flow of individuals interacting with their neighbourhoods in a codependent relationship. Clearly demarcating the relationship between people and places may be more difficult in a neighbourhood setting than a school setting.
Chapter 4: Results

An Account of the Research

This chapter reports the findings from an exploratory, observational study that evaluates the relationship between neighborhood socioeconomic status and injury in a population of children residing in Toronto, Ontario. The power in this study was deemed suitable to explore these associations, given that the number of cases is well over the minimum of 5 times the number of variables (Norman & Streiner, 2008). Data analysis was undertaken in several steps and is presented in this chapter. All statistical analyses and graphs were generated with the Statistical Package for the Social Sciences 16 (Nie, 2006), while the maps of the spatial distribution of the injury rates were generated with MapInfo Professional 10.5.

First, an exploratory analysis was conducted to assess the normality and collinearity of the data and describe relationships among predictive variables and the outcomes, by means of Pearson’s correlations, Spearman’s correlations, and cross tabulations. Second, ANOVA models were built based on the research objectives and the results of the exploratory data analysis. Prior to interpreting the ANOVAs, checks for violations in assumptions were conducted, namely, homogeneity of variance and normal distribution of the dependent variable as defined by the different levels (Norman & Streiner, 2008). Third, multiple regression models were built. The census tracts that have displayed mixed economic trends or middle income earnings were used as a reference category, with the focus of the study being on the comparison between the categories of neighbourhood displaying the economic extremes. Before interpretation of the results of multiple regression analyses, each model was examined for outliers, influential observations, and violations of the assumptions of the analysis, namely, non-normal distribution of residuals, correlated residuals, unequal variance of the residuals, and a non-linear relationship between the
outcome and predictors. Finally, Poisson regression models were constructed. They were also examined for outliers, influential cases, and violations of the assumptions of the analysis, namely, over-dispersion, and a non-linear relationship between the log odds of the outcome and the predictors. Before interpretation of regression analyses, data were inspected for evidence of collinearity and fortunately no Tolerance levels were $\leq .25$, Variance Inflation Factors were $\geq 4$ or condition indices were $> 30$, which suggested the intercorrelation of independent variables was acceptable (Garson, 2005). A discussion of outliers, influential cases, and the assumptions and rationale for each analysis is included in the discussion of findings for each objective. In an effort to avoid the selective reporting bias that has been discussed in the literature (Macura et al., 2010), non-significant coefficients were included in the final models. Finally, the four outcomes were spatially mapped with neighbourhood income trends. The findings from the data analysis are presented according to the study’s objectives, which are reiterated below.

Guiding Research Objectives:
1. To supplement a research design from the Centre of Urban and Community Studies that explored the relationship in the population between neighbourhood socioeconomic trends and sociodemographic characteristics.
2. To describe injury patterns at the level of neighbourhood income trends (census tract) by overall age categories, age subcategories, and gender for overall injury, falls, burns and poisoning that warranted a visit to the ED among children aged 0-6 in Toronto, ON.
3. To determine the relationship in the population between neighbourhood income trends (a 35 year period) and injury outcomes among children aged 0-6 in Toronto, after adjusting for other sociodemographic characteristics.
4. To determine how accurately injury outcomes can be predicted from a linear combination of
neighbourhood disadvantage indicators including neighbourhood income trends (35 year
period) and neighbourhood income status (one point in time).

5. After including other sociodemographic characteristics, to determine whether and to what
extent neighbourhood socioeconomic trends (35 year period) have predictive power in
explaining variation in injury rates, over and above a more typical measure of SES (one point
in time) among children aged 0-6 in Toronto.

6. To visually compare the distribution of childhood injury outcomes by neighbourhood income
trends.

Exploratory Data Analysis

Data were examined graphically with histograms and boxplots to assess bivariate
relationships, the shape of the distributions, and univariate outliers. The independent variables
were all within range. To further assess normality of the distributions, skewness and kurtosis
statistics were computed. The outcomes with higher base rates that represented overall rates of
injury tended to have good levels of skewness and kurtosis (i.e., ± 1) or at least within the
acceptable range (i.e., ± 2) (George & Mallery, 2005). The variables representing low base rates
and injury subsets tended to be positively skewed and leptokurtic, a common issue that occurs
when modeling rare health events (Krishnan & Morrison, 1995; Drake & Pandey, 1996). In
general, if the distribution of the populations do not appear to be severely skewed, leptokurtic, or
platykurtic (i.e., ± 2), for most purposes the analysis is likely to be valid (George & Mallery,
2005). Because the population is large the impact of a departure from normality is diminished
(Tabachnick & Fidell, 2007); however, non-normal distributions were addressed with analytic
techniques. For any type of distribution, z scores > than 3 or 4 are identifiable as outliers and
their exclusion can increase the normality of the distribution (Stevens, 2002). For the ANOVAs and regression models with injury as the dependent variable, outliers for the data set were identified using a criterion of z scores ±3.29 standard deviations from the mean (Tabachnick & Fidell, 2007).

The injury outcomes generated were compared to NACRS 2002/03 data portraying injury-related ED visits for 0-6 year olds in the Institute for Clinical and Evaluative Sciences’ *Injuries in Ontario* Atlas (Macpherson et al., 2005). The two sets of rates are similar, which increases confidence in the integrity of the data. Descriptive statistics for the variables selected for the main analysis in this study are shown in Table 5.
### Table 5

**Descriptive Statistics for Independent Variables and Rates for Injuries (N = 510)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (%) (S. D.)</th>
<th>Range (%)</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Census Tract Indicator</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Housing needing major repair</td>
<td>7.89 (3.8)</td>
<td>0-27.7</td>
<td>.851</td>
<td>1.722</td>
</tr>
<tr>
<td>% Immigrants 01-06</td>
<td>10.01 (7.6)</td>
<td>0-47.4</td>
<td>1.565</td>
<td>3.273</td>
</tr>
<tr>
<td>% Lone parent families</td>
<td>20.07 (7.5)</td>
<td>0-51.1</td>
<td>.892</td>
<td>1.566</td>
</tr>
<tr>
<td>% Rented</td>
<td>42.08 (22.8)</td>
<td>1-100</td>
<td>.442</td>
<td>-.426</td>
</tr>
<tr>
<td>% Apartment</td>
<td>53.7 (25.66)</td>
<td>1.8-100</td>
<td>-.015</td>
<td>-.821</td>
</tr>
<tr>
<td>% Moved over 5 years</td>
<td>43.51 (11.62)</td>
<td>12.9-82.3</td>
<td>.614</td>
<td>.369</td>
</tr>
<tr>
<td>% Immigrants</td>
<td>48.37 (15.40)</td>
<td>13.5-79.1</td>
<td>-.206</td>
<td>-.843</td>
</tr>
<tr>
<td>% Unemployment</td>
<td>7.62 (2.69)</td>
<td>0-18.8</td>
<td>.772</td>
<td>1.341</td>
</tr>
<tr>
<td>% No university degree</td>
<td>61.53 (16.6)</td>
<td>17.5-92.9</td>
<td>-.421</td>
<td>-.697</td>
</tr>
<tr>
<td>% Low income</td>
<td>23.49 (11.36)</td>
<td>0-73.2</td>
<td>.741</td>
<td>1.048</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Injury Variable 0 - 6 years</strong></th>
<th>Mean Crude Rate per 1000(S.D)</th>
<th>Range</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Injury Rate</td>
<td>81.49 (22.41)</td>
<td>29.49-175.61</td>
<td>.665</td>
<td>1.01</td>
</tr>
<tr>
<td>Fall Rate</td>
<td>37.47 (11.63)</td>
<td>6.41-93.33</td>
<td>.639</td>
<td>1.47</td>
</tr>
<tr>
<td>Poisoning Rate</td>
<td>2.55 (1.94)</td>
<td>0-16.67</td>
<td>1.48</td>
<td>5.68</td>
</tr>
<tr>
<td>Fire And Hot Object/Substance Rate</td>
<td>2.02 (1.62)</td>
<td>0-12.5</td>
<td>1.65</td>
<td>6.59</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Mean Count</th>
<th>Range</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poisoning Count</td>
<td>3.56</td>
<td>0-18</td>
<td>1.18</td>
<td>2.25</td>
</tr>
<tr>
<td>Fire and Hot Object/Substance (Burn) Count</td>
<td>2.83</td>
<td>0-16</td>
<td>1.38</td>
<td>3.06</td>
</tr>
</tbody>
</table>

The majority of independent variables were positively correlated, with all zero-order correlations in the expected direction. Specifically, the Pearson correlations among the census variables ranged from -.25 to .80. A .70 rule of thumb for bivariate correlations was used for identifying collinear variables (Tabachnick & Fidell, 2007), with variables correlating > .50 on more than one potential predictor being scrutinized (George & Mallery, 2005). Spearman’s rank correlation coefficients were used to assess the relationship among the ordinal predictors and covariates. When two covariates were found to be collinear, it was not surprising to find they measured similar concepts. When two covariates were correlated, the one with the strongest...
correlation with the dependent variables and the weakest correlations with the other covariates was retained for the analysis (Tabachnick & Fidell, 2007). Fortunately, there were no variables that were very highly correlated (>0.90), which decreases the occurrence of statistical problems of multicollinearity (Tabachnick & Fidell, 2007). The retained variables conceptually represent causal pathways to child injury, namely, social disadvantage, housing quality, and neighbourhood stability. Table 6 presents the inter-correlation matrix of the covariates initially selected for the analysis.
Table 6
*Pearson Correlations among Continuous Independent Variables (N = 516)*

<table>
<thead>
<tr>
<th></th>
<th>% Immigrant</th>
<th>% Major repair</th>
<th>% Lone Parent</th>
<th>% Rented</th>
<th>% Apartments</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Immigrant</td>
<td>1</td>
<td>.04</td>
<td>.38</td>
<td>.16</td>
<td>.22</td>
</tr>
<tr>
<td>% Major repair</td>
<td>.04</td>
<td>1.00</td>
<td>.50</td>
<td>.43</td>
<td>.30</td>
</tr>
<tr>
<td>% Lone parent family</td>
<td>.38</td>
<td>.50</td>
<td>1.00</td>
<td>.40</td>
<td>.26</td>
</tr>
<tr>
<td>% Rented dwelling</td>
<td>.2</td>
<td>.40</td>
<td>.40</td>
<td>1.0</td>
<td>.80**</td>
</tr>
<tr>
<td>% Apartments</td>
<td>.22</td>
<td>.30</td>
<td>.26</td>
<td>.80**</td>
<td>1.00</td>
</tr>
<tr>
<td>% Moved over last 5 yr</td>
<td>.25</td>
<td>.11</td>
<td>.07</td>
<td>.66</td>
<td>.76</td>
</tr>
<tr>
<td>% Immigrant01-06</td>
<td>1.00</td>
<td>.15</td>
<td>.22</td>
<td>.50</td>
<td>.48</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% Moved over 5 yrs</th>
<th>% Immigrants</th>
<th>% Unemployment</th>
<th>% No university degree</th>
<th>% Low income</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Immigrant 01-06</td>
<td>.61</td>
<td>.73**</td>
<td>.54</td>
<td>.46</td>
</tr>
<tr>
<td>% Major repair</td>
<td>.11</td>
<td>.04</td>
<td>.33</td>
<td>.26</td>
</tr>
<tr>
<td>% Lone parent</td>
<td>.07</td>
<td>.38</td>
<td>.56</td>
<td>.64</td>
</tr>
<tr>
<td>% Rented dwelling</td>
<td>.66</td>
<td>.16</td>
<td>.42</td>
<td>.02</td>
</tr>
<tr>
<td>% Apartments</td>
<td>.76**</td>
<td>.22</td>
<td>.33</td>
<td>-.08</td>
</tr>
<tr>
<td>% Moved over last 5 yr</td>
<td>1.00</td>
<td>.25</td>
<td>.31</td>
<td>-.23</td>
</tr>
<tr>
<td>% Immigrant</td>
<td>.25</td>
<td>1.00</td>
<td>.53</td>
<td>.46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% Immigrants 01-06</th>
<th>% Major repair</th>
<th>% Lone Parent</th>
<th>% Rented</th>
<th>% Apartments</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Unemployment</td>
<td>.54</td>
<td>.33</td>
<td>.56</td>
<td>.42</td>
</tr>
<tr>
<td>% No university degree</td>
<td>.06</td>
<td>.26</td>
<td>.64</td>
<td>.02</td>
</tr>
<tr>
<td>% Low income</td>
<td>.64</td>
<td>.46</td>
<td>.67</td>
<td>.69</td>
</tr>
</tbody>
</table>

**r > .70**
Data Analysis to address Research Objectives

In the following section of the dissertation, statements of the research objectives and questions are followed by the presentation of the analyses utilized to address them. Brief summaries of each analysis are provided as conclusions at the end of each section. The research objectives reflect a cumulative process where the meeting of one objective led to the addressing of a subsequent objective. In Chapter 5, the objectives are further articulated by discussing and linking the findings within the conceptual framework displayed in Chapter 1.

Objective 1

To supplement a research design from the Centre of Urban and Community Studies that explored the relationship in the population between neighbourhood socioeconomic trends and sociodemographic characteristics

Research Questions #1:

Is there a relationship in the population between neighbourhood income trends and neighbourhood sociodemographic characteristics (% housing needing major repair, % low income, % immigrants arriving between 2001-2006, % immigrants, % rented, % moved in last 5 years, % lone parent families, % apartments, % unemployment, and % no university degree)?

The first objective of the present study is to supplement the Neighbourhood Change CURA’s “Three Cities” analysis that demonstrated “who lives where” on the basis of Toronto’s change in the average socioeconomic status of its residents over a 35 year period. To show the distinct neighbourhood profiles of “who lives where,” sociodemographic characteristics from the census were presented for each category of neighbourhood (i.e., improving income, mixed trends, or declining income) in various reports (e.g., Hulchanksi, 2007; Hulchanski, 2010). As
previously discussed in this paper, these reports demonstrated that the “Three Cities” have consolidated along the lines of neighbourhood income and more. Descriptive statistics showed that each of the “Three Cities” had distinct social and physical characteristics (Hulchanksi, 2007, p. 4). For the present study, parametric tests were employed to discover whether these neighbourhood income trends, as defined by the “Three Cities,” are significantly or strongly related to demographic, socioeconomic, and housing characteristics presented in the Neighbourhood Change CURA. If the “Three Cities” distinguishes differences according to demographic, social, and housing characteristics, perhaps the “Three Cities” have associations with injury rates that are worth investigating. As shown by the literature review in this paper, demographic, housing, and socioeconomic characteristics have previously been associated with injury to children. Thus, one-way ANOVAs were performed to evaluate the relationships between the three categories of neighbourhood income trends and demographic, socioeconomic, and housing characteristics. An $\alpha$ level of .05 was used for all statistical tests. Guidelines by Cohen (1988) were used to assess the magnitude of the effect sizes. To satisfy readers who are familiar with the “Three Cities” project, outliers were not removed in order to keep the data in their unadulterated and familiar form. As is common in neighbourhood-based data, several variances were heterogeneous and several populations were skewed. However, ANOVA is robust to violation in assumptions, particularly the normality assumption (Green & Salkind, 2005; Norman & Streiner, 2008). The skewness values were all $< \pm 2$ and the majority of skews were in the positive direction, which increases the integrity of the analysis (George & Mallory, 2005). The Bonferroni test was selected for post-hoc tests of the three groups, based on its flexibility and level of control over the Type 1 error rate (Field, 2009). When the homogeneity of variance assumption was broken, the Games-Howell test was selected for post-hoc
comparisons, due to this test’s generally high performance and flexibility (Field, 2009). The results of the analysis of neighbourhood income trends are presented in Table 7.
Table 7
Overall Means and 95% Confidence Intervals of Pairwise Differences in Mean Changes, Neighbourhood Income Trends (N = 510)

<table>
<thead>
<tr>
<th>Neighbourhood Income Trends</th>
<th>Mean%</th>
<th>SD</th>
<th>Declining</th>
<th>Mixed Trends</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Major Repair</td>
<td>7.89</td>
<td>3.81</td>
<td></td>
<td></td>
<td>.02</td>
</tr>
<tr>
<td>Improving</td>
<td>6.74</td>
<td>3.23</td>
<td>-2.37 to -0.16†</td>
<td>-2.69 to -0.48†</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>8.33</td>
<td>3.67</td>
<td>-0.57 to 1.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>8.00</td>
<td>4.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Low Income</td>
<td>23.49</td>
<td>11.36</td>
<td></td>
<td></td>
<td>.26</td>
</tr>
<tr>
<td>Improving</td>
<td>13.90</td>
<td>8.12</td>
<td>-18.61 to -12.86†</td>
<td>-11.00 to -5.26†</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>22.03</td>
<td>9.69</td>
<td>-9.92 to -5.29†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>29.63</td>
<td>10.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% No university degree</td>
<td>61.53</td>
<td>16.60</td>
<td></td>
<td></td>
<td>.44</td>
</tr>
<tr>
<td>Improving</td>
<td>39.33</td>
<td>10.18</td>
<td>-33.11 to -25.80†</td>
<td>-29.31 to -22.02†</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>64.99</td>
<td>13.28</td>
<td>-6.74 to -0.85†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>68.78</td>
<td>12.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Unemployment</td>
<td>7.62</td>
<td>2.69</td>
<td></td>
<td></td>
<td>.30</td>
</tr>
<tr>
<td>Improving</td>
<td>5.44</td>
<td>1.53</td>
<td>-4.38 to -3.27*</td>
<td>-2.12 to -1.09*</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>7.04</td>
<td>2.22</td>
<td>-2.78 to -1.66*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>9.26</td>
<td>2.57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Lone parents</td>
<td>20.06</td>
<td>7.46</td>
<td></td>
<td></td>
<td>.24</td>
</tr>
<tr>
<td>Improving</td>
<td>13.51</td>
<td>4.35</td>
<td>-11.58 to -8.38*</td>
<td>-7.80 to -4.83*</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>19.82</td>
<td>6.51</td>
<td>-5.29 to -2.05*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>23.49</td>
<td>7.41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neighbourhood Income Trends Group</td>
<td>Mean</td>
<td>SD</td>
<td>Declining</td>
<td>Mixed Trends</td>
<td>η²</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------------------</td>
<td>-----------------------</td>
<td>------</td>
</tr>
<tr>
<td>% Rented</td>
<td>42.08</td>
<td>22.77</td>
<td></td>
<td></td>
<td>.04</td>
</tr>
<tr>
<td>Improving</td>
<td>36.25</td>
<td>18.42</td>
<td>-17.01 to -4.98*</td>
<td>-9.11 to 2.07</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>39.77</td>
<td>21.24</td>
<td>-12.87 to -2.07*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>47.25</td>
<td>25.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Moved last 5 yr</td>
<td>43.51</td>
<td>11.62</td>
<td></td>
<td></td>
<td>.04</td>
</tr>
<tr>
<td>Improving</td>
<td>42.89</td>
<td>11.08</td>
<td>-6.84 to -0.15†</td>
<td>-1.43 to 5.25</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>40.98</td>
<td>11.26</td>
<td>-8.10 to -2.71†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>46.39</td>
<td>11.64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Immigrant</td>
<td>48.37</td>
<td>15.41</td>
<td></td>
<td></td>
<td>.63</td>
</tr>
<tr>
<td>Improving</td>
<td>28.21</td>
<td>8.78</td>
<td>-35.62 to -30.52*</td>
<td>-19.75 to -14.42*</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>45.29</td>
<td>10.13</td>
<td>-18.19 to -13.78*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>61.28</td>
<td>8.87</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Immigrant 01-06</td>
<td>10.01</td>
<td>7.64</td>
<td></td>
<td></td>
<td>.35</td>
</tr>
<tr>
<td>Improving</td>
<td>3.92</td>
<td>2.75</td>
<td>-12.94 to -9.93*</td>
<td>-4.74 to -2.72*</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>7.65</td>
<td>4.69</td>
<td>-18.19 to -13.78*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>15.36</td>
<td>8.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apartments</td>
<td>53.71</td>
<td>25.66</td>
<td></td>
<td></td>
<td>.02</td>
</tr>
<tr>
<td>Improving</td>
<td>49.76</td>
<td>26.16</td>
<td>-16.10 to -1.14†</td>
<td>-8.69 to 6.24</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>50.99</td>
<td>25.34</td>
<td>-13.42 to -1.37†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>58.38</td>
<td>25.14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05 using the Games-Howell procedure for unequal variances.
†p < .05 using the Bonferroni procedure for equal variances.
Table 7 shows that all the one-way ANOVAs display significant differences when used to compare demographic, socioeconomic, and housing characteristics among the three different neighbourhood income trends levels. The 95% confidence intervals for the pairwise differences and the means and standard deviations for the three neighbourhood income trend groups are also reported in Table 7. First, a one-way ANOVA was conducted to compare the effect of neighbourhood income trends on percent housing needing major repair, among the neighbourhood income improvement, mixed trends, or neighbourhood income decline conditions. There was a significant relationship among neighbourhood income trends and percent housing needing major repair in a neighbourhood \( F(2, 507) = 6.10, p < .01 \). The assumption of homogeneity of variance was met so Bonferroni was chosen as a post hoc test. This test indicated that the mean percentage of housing needing repair in the neighbourhood improvement group was significantly lower than the neighbourhood decline group. The mixed trends group mean for housing in need of major repair was significantly higher than the improving condition’s group mean but not significantly different from the declining group’s mean. The strength of the overall relationship was weak, with neighbourhood income trends as measured by \( \eta^2 \) accounting for 2% of the variance in percent needing major repair, suggesting the relationship was likely not clinically significant.

Second, a one-way ANOVA was performed to compare the effect of neighbourhood income trends on poverty levels as measured by the percent of citizens living under the low income cutoff (LICO) in a neighbourhood. There were significant differences in percent living under the LICO depending on the three conditions, \( F(2, 507) = 90.28, p < .01 \). The strength of the relationship as assessed by \( \eta^2 \) was strong, with neighbourhood trends accounting for 26% of the variance in the LICO. This strong effect size was not surprising given that LICO is a direct
measure of SES, as is neighbourhood income trends. The Bonferroni procedure for equal variances indicated that there were significant differences among all pairwise comparisons, with the mean percentage of individuals living under the LICO for the improving neighbourhoods condition being significantly lower than the mean percentage for the mixed trends condition and the declining trend condition. The mixed trends condition, not surprisingly, had a significantly lower mean percentage of individuals living under the LICO than the declining trend condition. In other words, the declining neighbourhoods condition had the highest percentage of poor people.

Third, a one-way ANOVA was used to test for differences in educational level among the three neighbourhood income trend groups. As measured by percent of individuals in the neighbourhood with no university degree, there were significant differences in educational level among the three groups of neighbourhoods, $F(2, 507) = 200.84, p < .01$. To assess further the differences among means, the Bonferroni procedure for equal variances was employed. There was a significant difference among all the pairwise comparisons, with the mean score of percent with no university degree in the improving condition being significantly lower than the mean score in both the mixed trends condition and the declining trend condition. In other words, the declining income trends condition had the highest proportion of people at an educational disadvantage. Not surprisingly, the mixed trends condition had a significantly lower mean score than the declining trend condition. As assessed by $\eta^2$, the strength of the relationship was strong, 44% of the variance in percent no university degree being explained by the income trends categories.

Fourth, a one-way ANOVA was conducted to compare the effect of neighbourhood income trends on the unemployment rate in improving income trends, mixed income trends, and
declining income trend conditions. There was a significant association of neighbourhood income trends with unemployment $[F(2, 507) = 107.09, p < .01]$. Levene’s test indicated the homogeneity of variance assumption was not fulfilled. Post hoc comparisons using the Games-Howell test for unequal variances indicated that the mean percentage of unemployed for the improving income trends condition was significantly lower than the mixed income trends and the declining income trends condition. The mixed trends condition was significantly lower in unemployment than the declining trends condition. The $\eta^2$ was large, with 30% of the variance in unemployment being explained by differences among neighbourhood income trends.

Fifth, a one-way ANOVA was conducted to evaluate the effect of neighbourhood income trends on percent lone parent households in a neighbourhood. The results indicated that the three categories of neighbourhood income trends had a differential association with the percent of lone parent households, $[F(2, 507) = 77.67, p < .01]$. The magnitude of the effect as assessed by $\eta^2$ was strong, with 24% of the variance in percent lone parenthood being accounted for by neighbourhood income trends. To assess further the difference among the groups, pairwise comparisons were conducted among the three means, using the Games-Howell procedure, the test that does not require equal population variances. Based on the results of that test, neighbourhoods with increasing income trends had a significantly lower average level of lone parents than those with mixed income trends. Neighbourhoods with declining income trends had significantly higher average levels of lone parenthood than both improving income neighbourhoods and mixed trends neighbourhoods.

Sixth, a one-way ANOVA was conducted to compare the effect of neighbourhood income trends on percent of rented housing, in conditions of improving, mixed trends, or declining average neighbourhood income. There was a significant effect of neighbourhood
income trends for the three levels \([F(2, 507) = 9.89, p < .01]\). Post hoc comparisons, again using the Games-Howell test for unequal variances, suggested the mean percentage of rented housing in improving income trends neighbourhoods was significantly lower than the declining income trends condition and the mixed trends condition. Comparisons between the mixed income trends condition and the declining income trends condition revealed that the mean percentage of rented housing was significantly lower in the mixed trends condition. In summary, the declining neighbourhoods condition had the highest percentage of rented housing. The strength of the relationship as assessed by \(\eta^2\) was small, with income trends accounting for 3% of the variance in rented housing.

Seventh, a one-way ANOVA was employed to test for differences among the three levels of neighbourhood income trend on the percent of individuals who moved residence in the last 5 years. There was a significant effect of neighbourhood income trends on percent moved in the last 5 years in the three categories \([F(2, 507) = 11.78, p < .01]\). Post hoc comparisons using the Bonferroni method for equal variances indicated that the mixed trend group had significantly lower levels of mobility than the declining income trend group, but was not significantly different from the improving income trend group. However, the declining income trends group had significantly higher levels of mobility than the improving income trend group. The magnitude of the effect was weak, with neighbourhood income trends accounting for 4% of variance in neighbourhood mobility.

Eighth, a one-way ANOVA was conducted to evaluate the relationship between neighbourhood income trends and percent immigrants (foreign born individuals) in a neighbourhood. The ANOVA was significant, \(F(2, 507) = 432.45, p < .01\). The magnitude of the effect as measured by \(\eta^2\) was strong, with 63% of the variance in percent of immigrant being
accounted for by the neighbourhood income trends factor. Post hoc tests were again conducted using Games-Howell, a test that does not assume equal variances among the three groups. There was a significant difference in the means between the group with improving neighbourhood income trends and the group with declining income trends, with the group that had improving neighborhood income trends having a lower mean level of immigrants than the declining trends group. The group that had mixed trends had a mean level of immigrants significantly lower than the declining trend condition and significantly higher than the improving trends condition.

Ninth, a one-way ANOVA was performed to test for differences in percent of recent immigrants (arriving between 2001-2006) among the three levels of income trends. There was a significant effect of income trends on % recent immigrants \( F(2, 507) = 141.77, p < .01 \). Again, the homogeneity of variance assumption was broken and Games-Howell post hoc tests were found appropriate to assess the pairwise differences among means. There was a significant difference among all the pairwise comparisons, with the mean percentage for the improving condition being significantly lower than the mean percentage for both the mixed trends condition and the declining trend condition. The mixed trends condition had a significantly lower mean percentage than the declining trend condition. In summary, the declining neighbourhoods condition had the highest proportion of recent immigrants. The strength of the relationship as assessed by \( \eta^2 \), was strong, with income trends accounting for 36% of the variance in recent immigration.

Finally, a one-way ANOVA was conducted to compare the effect of neighbourhood income trends on percent apartments in improving income trends, mixed income trends, and declining income trends groups. There was a significant effect of neighbourhood income trends on the % apartments, \( F(2,507) =5.83, p < .01 \). Bonferroni’s test was selected as appropriate,
because the variances were homogeneous, according to Levene’s test. Bonferroni’s test indicated that there were significant differences among two of the three mean comparisons. The improving neighbourhood category had significantly less apartments than the declining neighbourhood category. The mixed trends category had significantly fewer apartments than the declining neighbourhood category. However, the relationship between improving neighbourhoods and the mixed trends neighbourhood were not significant at p < .05. The magnitude of the effect as assessed by $\eta^2$ was weak, with 2% of the variance in the dependent variable being accounted for by neighbourhood income trends factor.

*Summary of results for Objective 1*

The results of Objective 1 corroborate the relationship among neighbourhood income trends and neighbourhood sociodemographic characteristics that was found in the Neighbourhood Change CURA study (Hulchanski, 2010). Neighbourhood-level sociodemographic characteristics are relevant to the neighbourhood-level study of injury because they are an indicator of neighbourhood quality that affects all children and families in the neighbourhood, despite individual-level child and family characteristics. Differential exposures to levels of neighbourhood quality may have been associated with widening neighbourhood income inequalities.

Measures of effect size that were related to neighbourhood income trends ranged from 2% to 63%. These measures may be thought of as the correlation between the neighbourhood income trends factor and the dependent variables. The wide range of effect sizes indicates that some of the observed differences among means may be more clinically significant than others. The range of effect size values were corroborated by Spearman’s $\rho$, which was used to assess the relationship among the ordinal predictors and the covariates (Tabachnick & Fidell, 2007). Some
of the covariates initially shown in Table 4 possess different properties than the neighbourhood income trends variable. By incorporating information on the change in the Toronto neighbourhood average individual income over time, the neighbourhood income trends variable may represent a configuration of elements that cannot be described merely as a composite of its sociodemographic parts. For example, in declining, transitional neighbourhoods there may be a decreasing reliance among parents on informal and formal supports due to the neighbourhood’s deteriorating networks and growing anomie (Furstenberg, 1993). Such neighbourhood transitions may be related to levels of child safety. Thus, further investigation is warranted regarding the independent contribution of sociodemographic variables to injury outcomes.

The means in Table 7 may differ slightly from other sources due to issues intrinsic to using census data, such as data suppression, rounding, and weighting. However, the sociodemographic census variables listed in Tables 4 and 6 are featured in a U of T Cities Centre Report using 2001 data and very similar means for each income trend category were obtained there (Hulchanski, 2007). Therefore, confidence is bolstered in the integrity of the dataset. The completion of Objective 1 provided a segue for Objective 2.

**Objective 2**

To describe injury patterns at the neighbourhood (census tract) level by overall age categories, age subcategories, and gender for overall injury, falls, burns and poisoning that warranted a visit to the ED in Toronto, ON. This objective encompasses research questions numbered 2, 3, and 4, which will be discussed in sequence.

Objective 2 of this dissertation was to examine the ecological distribution of injury rates by overall age categories, subcategories, and gender. Multivariate Analysis of Variance (MANOVA) was considered as an analytic strategy to meet the objective. However, because
many of the dependent variables were positively correlated greater than .70 the power of MANOVA would be compromised (Tabachnick & Fidell, 2007). Moreover, grouping of dependent variables, as one does with a MANOVA, should have a theoretical or empirical rationale, which not apparent in this case. Rather, the tests of the outcome data were heuristic in this exploratory observational study, thereby providing a guide in the investigation of the injury problem. Hence, as is common in research, one-way ANOVAs were employed for each dependent variable in spite of the increase risk for Type 1 error (Field, 2009).

The results for Objective 2 are presented in summary form in the text due to their length. They are displayed in three phases, constituting research questions 2, 3 and 4. First, injury patterns by broad overall categories are presented. Second, the results pertaining to gender are presented. Finally, findings broken down by different age categories are presented. A detailed breakdown of 95% confidence intervals of pairwise differences in mean changes of all injury types and subcategories can be seen in Appendix E. Summaries of one-way ANOVAs for the overall injury outcomes are shown in Table 8.

*Research Questions #2:*

*Is there a relationship in the population between neighbourhood income trends and the four overall injury outcomes, namely, any adjusted rate overall, adjusted fall rate overall, adjusted poisoning rate overall, and adjusted burn rate overall?*
Table 8  
*Grand Means of Pairwise Differences in Mean Changes, Overall Injury Categories (N = 510)*

<table>
<thead>
<tr>
<th>Neighbourhood Income Trends</th>
<th>Grand Mean</th>
<th>SD</th>
<th>F Test</th>
<th>η2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Rate Overall</td>
<td>83.66</td>
<td>23.03</td>
<td>23.12†</td>
<td>.09</td>
</tr>
<tr>
<td>Fall Rate Overall</td>
<td>38.74</td>
<td>12.37</td>
<td>34.25*</td>
<td>.12</td>
</tr>
<tr>
<td>Poisoning Rate Overall</td>
<td>2.6</td>
<td>1.93</td>
<td>7.46*</td>
<td>.03</td>
</tr>
<tr>
<td>Burn Rate Overall</td>
<td>2.05</td>
<td>1.62</td>
<td>3.60*</td>
<td>.01</td>
</tr>
</tbody>
</table>

*p < .05 using the Games-Howell procedure for unequal variances.
†p < .05 using the Bonferroni procedure for equal variances.

As summarized in Table 9, one-way ANOVAs were conducted to evaluate the relationships between neighbourhood income trends and the four overall injury outcomes. As previously discussed in this paper, three levels constitute the neighbourhood income trends of the “Three Cities” (improving neighbourhoods, mixed-trends neighbourhoods, and deteriorating neighbourhoods). The results indicated all the F tests were significant; however, not every pairwise comparison reached significance (see Appendix D). Effect sizes for overall injury and falls were medium and for poisoning and burns they were small. Follow up tests, as shown in Appendix D., showed that with the exception of the burn outcome, the pattern was for the declining income trends neighbourhoods to have the lowest mean injury rates and the mixed trends neighbourhoods to have the highest mean injury rates. Based on the results of the analyses, the declining income trends category appears to have some unique properties in comparison to the mixed trends and improving income trends categories.

*Research Questions #3: Is there a relationship in the population between neighbourhood income trends and injury rates, namely, boys adjusted injury rate overall, girls adjusted injury rate overall, boys adjusted fall rate overall, girls adjusted fall rate overall, boys adjusted poisoning
rate overall, girls adjusted poisoning rate overall, boys adjusted burn rate overall, and girls
adjusted burn rate overall?

Table 9
Summary of Grand Means and Standard Deviation and F values for Injury Rate by Gender
(N =510)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Mean</th>
<th>SD</th>
<th>F Value</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Injury Rate Boys</td>
<td>94.70</td>
<td>30.25</td>
<td>19.48*</td>
<td>.07</td>
</tr>
<tr>
<td>Any Injury Rate Girls</td>
<td>72.41</td>
<td>23.35</td>
<td>14.7*</td>
<td>.06</td>
</tr>
<tr>
<td>Fall Rate Boys</td>
<td>43.50</td>
<td>15.50</td>
<td>25.13*</td>
<td>.09</td>
</tr>
<tr>
<td>Fall Rate Girls</td>
<td>33.28</td>
<td>12.67</td>
<td>20.86*</td>
<td>.08</td>
</tr>
<tr>
<td>Poisoning Rate Boys</td>
<td>2.96</td>
<td>2.63</td>
<td>1.75</td>
<td>.01</td>
</tr>
<tr>
<td>Poisoning Rate Girls</td>
<td>2.05</td>
<td>2.22</td>
<td>4.17*</td>
<td>.02</td>
</tr>
<tr>
<td>Burn Rate Boys</td>
<td>2.27</td>
<td>2.24</td>
<td>1.00</td>
<td>.00</td>
</tr>
<tr>
<td>Burn Rate Girls</td>
<td>1.66</td>
<td>1.84</td>
<td>.942</td>
<td>.00</td>
</tr>
</tbody>
</table>

*p < .05 using the Games-Howell procedure for unequal variances

Summary of Results for Research Questions #3

Table 9 displays a summary of the analysis in the form of the grand means, omnibus
tests, and effect sizes. A detailed table of means for each neighbourhood income category, 95%
confidence intervals of pairwise differences in mean changes, and report of the findings can be
found in Appendix D. Table 9 and Table 10 display the same basic patterns. Effect sizes were
medium for overall injuries and falls, and small for burns and poisoning. Generally, significant
results are found for overall injury, falls, and poisoning, but results for burn injuries seldom
reached significance.

Injury outcomes for boys and girls generally displayed significant relationships with
neighbourhood income trends. When significant results were obtained, Appendix D shows the
declining income trends condition had the lowest mean injury rates. The pattern was for the declining income trends neighbourhoods to have the lowest mean injury rates and the mixed trends neighbourhood to have the highest mean injury rates. Based on the results of the pairwise tests, the declining income trends category appears to have some unique properties in comparison to the mixed trends and improving income trends categories (See Appendix D).

The injury rates for boys were consistently higher than that for girls, a finding that is congruous with other research (i.e., Kohen, Soubhi, & Raina, 2000; Macpherson et al., 2005). Injury rates did not appear to differ across neighbourhood income categories for one gender but not the other (See Appendix D). If such an interaction had been present, it may call for further investigation with respect to why and to what extent neighbourhood income category exerts a differential effect on one gender but not the other.

Research Questions #4

Is there a mean difference in injury rates for the four different injury types and three different age groups, among the three populations: Improving Income Trends, Mixed Income Trends, and Declining Income Trends?
Table 10

Grand means and Standard Deviations and F Values for Injury Outcomes Stratified by Age (N = 510)

<table>
<thead>
<tr>
<th>Neighbourhood Income Trends</th>
<th>Mean</th>
<th>SD</th>
<th>F test</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Rate Overall age 0-1</td>
<td>81.74</td>
<td>28.33</td>
<td>12.34</td>
<td>.05</td>
</tr>
<tr>
<td>Any Rate Overall age 2-4</td>
<td>92.50</td>
<td>30.32</td>
<td>24.24</td>
<td>.09</td>
</tr>
<tr>
<td>Any Rate Overall age 5-6</td>
<td>144.20</td>
<td>56.12</td>
<td>11.67</td>
<td>.04</td>
</tr>
<tr>
<td>Fall Rate Age 0-1</td>
<td>40.15</td>
<td>16.76</td>
<td>15.77</td>
<td>.06</td>
</tr>
<tr>
<td>Fall Rate Age 2-4</td>
<td>41.00</td>
<td>15.18</td>
<td>29.5</td>
<td>.11</td>
</tr>
<tr>
<td>Fall Rate Age 5-6</td>
<td>65.92</td>
<td>31.40</td>
<td>15.63</td>
<td>.06</td>
</tr>
<tr>
<td>Poisoning Rate Age 0-1</td>
<td>3.48</td>
<td>3.47</td>
<td>2.22</td>
<td>.01</td>
</tr>
<tr>
<td>Poisoning Rate Age 2-4</td>
<td>2.90</td>
<td>2.93</td>
<td>4.27</td>
<td>.02</td>
</tr>
<tr>
<td>Poisoning Rate Age 5-6</td>
<td>2.04</td>
<td>4.27</td>
<td>1.24</td>
<td>.01</td>
</tr>
<tr>
<td>Burn Age 0-1</td>
<td>3.91</td>
<td>3.97</td>
<td>1.66</td>
<td>.01</td>
</tr>
<tr>
<td>Burn Age 2-4</td>
<td>1.48</td>
<td>1.89</td>
<td>.498</td>
<td>.00</td>
</tr>
<tr>
<td>Burn Age 5-6</td>
<td>1.12</td>
<td>2.35</td>
<td>2.47</td>
<td>.01</td>
</tr>
</tbody>
</table>

Summary of Results for set of Research Questions # 4

Table 10 displays a summary of the analysis in the form of the grand means, omnibus tests, and effect sizes for the injury rates for different ages and income trend categories. The results are summarized for the set of research questions that assess the difference in means amongst overall injuries, falls, poisoning, and burn injuries by age group. The age groups are categorized into 0-1 year olds, 2-4 year olds, and 5-6 year olds. A detailed table of means for each neighbourhood income category, 95% confidence intervals of pairwise differences in mean changes, and report on the findings can be found in Appendix D.
Significant results tended to occur for overall injuries and fall injuries but not poisoning and burn injuries. The pattern of results in Table 10 is similar to those presented in Tables 8 and 9. Generally, the declining income trends group displayed the lowest mean injury rates (See Appendix D). The effects sizes ranged from small to medium, with smaller effects being shown for burn and poisoning outcomes. The very low rate of poisoning among 5 to 6 year olds is corroborated by Agran et al．’s (2003) breakdown of injury causes by age. The more mature 5 to 6 year olds appear less vulnerable to consuming poisonous substances than younger children.

For overall injuries and falls, the older children had the highest rates. This result is consistent with the literature that shows a positive relationship between child age and injury (e.g., Faelker et al., 2000; Oliver & Kohen, 2010; Kohen et al., 2000).

**Summary of results of Objective 2**

Objective 2 constituted Research Questions 2, 3, and 4. Generally, the declining income trends group displayed the lowest mean injury rates. As can be seen in Appendix D, the significant differences were most often found between the declining income trends groups and the mixed trend group or the declining income trend group and the improving income trend group. The declining income trends neighbourhoods appears to have some unique properties in comparison to the other two neighbourhood types. Results tended to be significant for overall injuries and fall injuries but not poisoning and burn injuries. Low base rates of the two latter injury types may explain these non-significant results. Differences among groups are hard to identify when an event seldom occurs.

Multiple testing increases the chances of finding anomalies in the results that would not generalize to other jurisdictions or time periods. Although adjustments have been made for
inflated Type 1 error, some of the significant results for Objective 2 may have occurred by chance.

According to guidelines by Cohen (1988), effect sizes related to the neighbourhood income trends concept were generally small. Therefore, there is justification to add covariates that represent other sociodemographic characteristics into multivariate models to assess their independent contribution to injury rates. Thus, the next research objective is as follows:

**Objective 3**

To determine the relationship in the population between neighbourhood income trends (a 35 year period) and injury outcomes among children aged 0-6 in Toronto, after adjusting for other sociodemographic characteristics. The research questions are:

**Research Questions #3**

Do the neighbourhood income trends variables add anything to the prediction equation for overall injury, fall injuries, poisoning, and burn injuries, after adjustment for other demographic measures, namely, % Housing needing major repair, % Immigrant from 2001-2006, % Lone parent family, % Apartments, % Unemployment, % No university degree?

Hierarchical ordinary least squares (OLS) multiple linear regression analyses were conducted to determine if the addition of the information regarding neighbourhood income trends improved the prediction of injury beyond that accounted for by variation in other predictors of injury. Because past research and theory indicates that the covariates retained from Table 4 are predictors of injury, there is justification for entering them into statistical models first, then adding neighbourhood income trends as a new predictor (Field, 2009). First, overall injury was assessed as an outcome. Outliers for the data set were assessed using a criterion of ± 3.29 standard deviations from the mean. This assessment left 485 cases in the data set.
Regression diagnostics were conducted, including a histogram, scatterplot and p-p plot of the standardized residuals. These diagnostics displayed that the assumptions of constant variance, linearity and normality were met. An examination of standardized residuals prompted the removal of 4 cases that had scores $> \pm 3.29$. The Durbin Watson statistic of 1.63 indicated the residuals of the model were independent. The cutoff criterion for cases considered to be influential was Cook’s distance $> 1$ (Field, 2009). According to this criterion there were no influential cases. Mahalanobis distance was assessed with a $p < .001$ criterion (Tabachnick & Fidell, 2007) and leverage values were computed with $(3k + 1)/n$ where $k$ was the number of predictors and $n$ the number of observations (Stevens, 2002). According to these criteria 3 more cases were deleted leaving 478 cases in the data set. The findings of the analysis are displayed in Table 11.
Table 11

Summary of Hierarchical Multiple Regression Analyses for Variables predicting Overall Injury Rate per 1000 (N = 510)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Step 1</th>
<th></th>
<th></th>
<th>Step 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE B</td>
<td>β</td>
<td>r_{az,b}</td>
<td>b</td>
<td>SE B</td>
</tr>
<tr>
<td>Constant</td>
<td>69.26</td>
<td>3.94</td>
<td>62.75</td>
<td>6.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Needing major repairs</td>
<td>191.22</td>
<td>28.57</td>
<td>.29**</td>
<td>.30</td>
<td>161.01</td>
<td>29.14</td>
</tr>
<tr>
<td>% Immigrant 01-06</td>
<td>-165.41</td>
<td>16.50</td>
<td>-.48**</td>
<td>-.42</td>
<td>-126.85</td>
<td>20.18</td>
</tr>
<tr>
<td>% Lone parent family</td>
<td>-33.46</td>
<td>19.96</td>
<td>-.10</td>
<td>-.08</td>
<td>-20.79</td>
<td>19.95</td>
</tr>
<tr>
<td>% Apartments</td>
<td>-2.93</td>
<td>4.14</td>
<td>-.03</td>
<td>-.03</td>
<td>-5.84</td>
<td>4.15</td>
</tr>
<tr>
<td>% Unemployment</td>
<td>-4.81</td>
<td>45.91</td>
<td>-.01</td>
<td>-.01</td>
<td>33.73</td>
<td>46.22</td>
</tr>
<tr>
<td>% No university</td>
<td>39.96</td>
<td>7.13</td>
<td>.30**</td>
<td>.25</td>
<td>47.63</td>
<td>8.75</td>
</tr>
<tr>
<td>Improving neighbourhood</td>
<td>1.73</td>
<td>3.12</td>
<td>.03</td>
<td>.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining neighbourhood</td>
<td>-9.63</td>
<td>2.35</td>
<td>-.21**</td>
<td>-.19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: $R^2 = .36$ for Model 1: $\Delta R^2 = .02$ (p < .01). **p < .001

The results of set 1 indicated that the 6 covariates accounted for a significant level of injury variability, $R^2 = .36$, adjusted $R^2 = .36$ $F(6, 471) = 45.02$, p < .001. The percent dwellings in need of major repairs of contributed most highly to the injury rate ($t = 6.69$, p < .001), while percent individuals with no university degree in the census tract also contributed to the injury rate ($t = 5.60$, p < .001). Immigrants arriving between 2001 and 2006 were a protective factor ($t = -10.03$, p < .001). As shown in set 2, the neighbourhood income trends accounts for a significant proportion of the injury variance after adjustment for the covariates, $R^2$ change = .02, $F(2, 469) = 8.37$, p < .001. The addition of the neighbourhood income trends variable in the second set did not change the significance of the covariates at the p < .05 level. The second set
indicated that neighbourhoods that were declining in terms of average income tended to have significantly lower injury rates in comparison to the mixed-trends neighbourhoods that had not changed very much in terms of average income (t = -4.09, p < .001). Neighbourhoods that were improving in terms of average income had overall injury rates that were not significantly different from neighbourhoods that have not changed very much in terms of average income. The adjusted $R^2$ value of .38 suggested that more than a third of the injury variability is predicted by the sociodemographic covariates and neighbourhood income trends. The removal of outliers and the addition of the second block of variables did not change the significance of the individual predictors. However, neighbourhood income trends contributed very modestly to the predictive power of the model.

Second, a hierarchical OLS multiple regression analysis was conducted to predict the fall injury rate from known predictors of injury and neighbourhood income trends. Outliers for the entire data set were again assessed using a criterion of $\pm 3.29$ standard deviations from the mean (Stevens, 2002). This assessment left 486 cases in the data set. Regression diagnostics were conducted, including a histogram, scatterplot and p-p plot of the standardized residuals. These diagnostics displayed that the assumptions of constant variance, linearity and normality were met. An examination of standardized residuals prompted the removal of 3 cases that had scores $> \pm 3.29$. The Durbin Watson statistic of 1.70 indicated the residuals of the model were independent. The cutoff criterion for cases considered to be influential was Cook’s distance $> 1$ (Field, 2009). According to this criterion there were no influential cases. Mahalanobis distance was assessed with a $p < .001$ criterion (Tabachnick & Fidell, 2007) and leverage values were computed with $(3k + 1)/n$ where $k$ was the number of predictors and $n$ the number of
observations (Stevens, 2002). According to these values 3 more cases were deleted leaving 480 cases in the data set. The findings of the analysis are displayed in Table 12.

Table 12

<table>
<thead>
<tr>
<th>Summary of Hierarchical Multiple Regression Analyses for Variables Predicting Average Fall Injury Rate per 1000 children 0-6, 2002/3-2005-6 (N = 510).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
</tr>
<tr>
<td>Factor</td>
</tr>
<tr>
<td>Constant</td>
</tr>
<tr>
<td>% Needing major repairs</td>
</tr>
<tr>
<td>% Immigrant 01-06</td>
</tr>
<tr>
<td>% Lone parent family</td>
</tr>
<tr>
<td>% Apartments</td>
</tr>
<tr>
<td>% Unemployment</td>
</tr>
<tr>
<td>% No university</td>
</tr>
<tr>
<td>Improving neighbourhood</td>
</tr>
<tr>
<td>Declining neighbourhood</td>
</tr>
</tbody>
</table>

Note: $R^2 = .31$ for Model 1: $\Delta R^2 = .03$ (p < .01). ***p < .001, **p <.01, *p < .05.

The results of step 1 indicated that the 6 covariates accounted for a significant level of injury variability, $R^2 = .31$, adjusted $R^2 = .30$, $F(6, 473) = 35.62, p < .001$. The percent of dwellings in need of major repairs of contributed most highly to the injury rate ($t = 6.22, p < .001$), while percent individuals with no university degree in the neighbourhood also contributed to the injury rate ($t = 3.50, p < .001$). Immigrants arriving between 2001 and 2006 were a protective factor ($t = -9.54, p < .001$). As shown in step 2, neighbourhood income trends accounts for a significant proportion of the injury variance after adjustment for the effects of the
covariates, $R^2$ change = .03, $F (2, 471) = 11.09, p < .001$. The addition of the neighbourhood income trends variable in the second set did not change the significance of the covariates at the $p < .05$ level. The results from the second set of variables indicated that neighbourhoods that were declining in terms of average income tended to have significantly lower injury rates in comparison to neighbourhoods that had not changed very much in terms of average income ($t = -4.46, p < .001$). Neighbourhoods that were improving in terms of average income had overall injury rates that were significantly higher than neighbourhoods that have not changed very much in terms of average income ($t = 2.04, p < .05$). The adjusted $R^2$ value of .33 suggested that a third of the injury variability is predicted by the sociodemographic covariates and neighbourhood income trends. However, neighbourhood income trends contributed modestly to the predictive power of the model. The removal of outliers and influential cases and the addition of the second block of variables did not change the significance of the individual predictors.

For the third analysis, a Poisson regression was conducted to determine if the addition of the information regarding neighbourhood income trends improved the prediction of poisoning injuries beyond that accounted for by differences in sociodemographic characteristics. Initially, a hierarchical ordinary least squares multivariate regression analysis was conducted to determine the answer. However, regression diagnostics indicated a violation in assumptions, including heteroscedasticity. Because the data did not appear well estimated by OLS regression, Poisson regression was conducted using count data. This analytic approach was chosen because it is appropriate for non-normally distributed count outcomes, and a viable alternative to dividing data into binary outcomes in efforts to conduct logistic regression, which would result in the loss of information and may weaken statistical power (Anderson, Agran, Winn, & Tran, 1998; Gardner, Mulvay, & Shaw, 1995).
The 2006 census population was the offset, providing some measure of a unit’s exposure. The poisoning counts represented the total number of poisonings over four years (2002-2006) in each neighbourhood. Thus, the results of the analysis should be interpreted as the number of poisonings over four years per population size. The total counts over four years served as the outcome, rather than using averaged, rounded counts that represent one year. As previously mentioned in Chapter 3, the 2006 census population was assumed to represent the population over the four study years. This analytic strategy was chosen because the event of interest had low counts. If the counts were averaged and rounded to represent one year there was concern they may decrease the variability and accuracy in the analysis. In addition, aggregating counts increased confidentiality levels of the data.

In order to preserve power when the injury of interest was rare, the first step of the analysis required examining bivariate relationships between the covariates and the outcome variable. Only covariates with significant relationships were used in the final models in a conservative approach. Outliers for the data set were assessed using a criterion of ± 3.29 standard deviations from the mean. Residual values were graphed to explore outliers and leverage values were computed as (3k + 1)/n where k was the number of predictors and n the number of observations (Stevens, 2002). The cutoff criterion for cases considered to be influential was Cook’s distance > 1. According to this criterion there were no influential cases. The exclusion of outliers and influential cases identified according to these values left 479 cases in the data set. As is not uncommon with hospital and neighbourhood-based data (Hutcheson & Sofroniou, 1999), the assumption of the Poisson distribution of equal mean and variance was violated. Thus, adjustments were made to address heterogeneity in the model, namely, scaling the parameters and rerunning the Poisson models while obtaining robust standard errors for the
Poisson regression coefficients. Moreover, the analysis was repeated using negative binomial regression as another method to deal with the overdispersion in the model. The same predictors were significant with the models generated by negative binomial regression and the directions of influence were the same, but the model fit was worse than the Poisson regression according to Akaike’s information criterion (AIC). Hence, the negative binomial regression models are not reported. The final Poisson models are displayed in Table 13.

Table 13

Summary of Poisson regression Analyses for Variables Predicting Poisoning Count aggregated over 2002/3-2005/6 (N = 510)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Step 1</th>
<th>Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE b</td>
</tr>
<tr>
<td>Constant</td>
<td>-4.96</td>
<td>.13</td>
</tr>
<tr>
<td>% Needing major repairs</td>
<td>4.19</td>
<td>.99</td>
</tr>
<tr>
<td>% Immigrant 01-06</td>
<td>-2.48</td>
<td>.46</td>
</tr>
<tr>
<td>% Lone parent family</td>
<td>-.04</td>
<td>.70</td>
</tr>
<tr>
<td>% No university degree</td>
<td>.41</td>
<td>.27</td>
</tr>
<tr>
<td>Improving neighbourhood</td>
<td>.05</td>
<td>.12</td>
</tr>
<tr>
<td>Declining neighbourhood</td>
<td>-.18</td>
<td>.07</td>
</tr>
</tbody>
</table>

Note: $AIC$ for Model 1: 1987.06, $AIC$ for Model 2: 1984.71. ***p<.001, **p < .01, *p < .05.

The Poisson regression coefficient can be interpreted similarly to that of OLS multiple regression. However, Poisson regression models the log of the expected count as a linear function of the predictors, rather than modeling a linear relationship between a dependent variable and the predictors. The Exp(B) represents the change in the odds ratio corresponding to a one-unit change in the predictor variables. The first Poisson regression model generated to predict poisoning from the covariates was statistically significant with likelihood ratio $\chi^2 =$
57.58, df = 4 yielding p-value < .001. The predictors percent housing needing major repairs and percent immigrants from 2001-2006 were each statistically significant. The Wald $\chi^2$ indicated the relative influence of the entered variables; thus, housing needing repairs had the greatest influence on poisoning injuries, followed by immigration levels. The expected log count for a one-unit increase in percent housing needing major repairs was 4.19. If a neighbourhood was expected to increase its percent in need of major repairs by 1 unit, the difference in the logs of the expected counts would be expected to increase by 4.19 units, while holding the other variables in the model constant. The expected log count for a one-unit increase in immigration was -2.48. If a neighbourhood was to decrease its level of immigrants by 1 unit, the difference in the logs of the expected counts would be expected to decrease by 2.48 units.

The second model also demonstrated that the relationship between poisoning and the predictors was significant ($\chi^2 = 62.61$, df = 6, p < .001). The same individual predictors were significant and results were in the same direction as in the first model. The second model displayed the estimated Poisson regression coefficients that compared declining income trends neighbourhoods to mixed income trends neighbourhoods (the reference category), holding the other variables in the model constant. The difference in the logs of expected counts is expected to be -0.18 units lower for declining income trends neighbourhoods when compared to mixed income trends neighbourhoods. When comparing the models with and without the neighbourhood income trends variable, the fit of the model was essentially the same according to AIC. Neighbourhood income trends added little to the predictive power of the model.

Finally, a Poisson regression was conducted to determine if addition of the information regarding neighbourhood income trends improved the prediction of burn injuries beyond that accounted for by differences in sociodemographic characteristics. To determine the answer, a
hierarchical ordinary least squares multivariate regression analysis was conducted with burn rates as the outcome. However, regression diagnostics indicated a violation in assumptions, including heteroscedasticity. Because the data did not appear well estimated by OLS regression, Poisson regression was conducted again, this time using count data of burns.

The Poisson regression regarding burns was conducted using the same assumptions as for the poisoning analysis. Thus, the results should be interpreted as the number of burns over four years per population size. In order to preserve power when the injury of interest was rare, the first step of the analysis required examining bivariate relationships between the covariates and the outcome variable. Only covariates with significant relationships were used in the model in a conservative approach. Outliers for the data set were assessed using a criterion of ± 3.29 standard deviations from the mean. Residual values were graphed to explore outliers and leverage values were computed as $(3k + 1)/n$ where $k$ was the number of predictors and $n$ the number of observations (Stevens, 2002). The cutoff criterion for cases considered to be influential was Cook’s distance > 1. According to this criterion there were no influential cases. The exclusion of outliers and influential cases identified according to these values left 479 cases in the data set. As with the poisoning outcome, the assumption of the Poisson distribution of equal mean and variance was violated. Thus, adjustments were made to address heterogeneity in the model, namely, scaling the parameters and rerunning the Poisson models while obtaining robust standard errors for the Poisson regression coefficients. The analysis was repeated using negative binomial regression as another possible method to address the overdispersion in the model. The same predictors were significant as in the Poisson regression when models were generated with negative binomial regression, but according to Akaike’s information criterion
(AIC), the model fit was poorer. Hence, the negative binomial models are not reported. The final Poisson models are displayed in Table 14.

Table 14

Summary of Poisson regression Analyses for Variables Predicting Burn Count aggregated over 2002/3 – 2005/6 (N = 510)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Step 1</th>
<th></th>
<th></th>
<th>Step 2</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE b</td>
<td>Exp(B)</td>
<td>Wald χ2</td>
<td>b</td>
<td>SE b</td>
<td>Exp(B)</td>
</tr>
<tr>
<td>Constant</td>
<td>-5.43</td>
<td>.16</td>
<td>0.00</td>
<td>1214.13</td>
<td>-5.55</td>
<td>.23</td>
<td>0.00</td>
</tr>
<tr>
<td>% Needing major repairs</td>
<td>2.7</td>
<td>1.22</td>
<td>14.88</td>
<td>4.9*</td>
<td>2.17</td>
<td>1.24</td>
<td>8.76</td>
</tr>
<tr>
<td>% Immigrant 01-06</td>
<td>-.38</td>
<td>.73</td>
<td>1.468</td>
<td>.27</td>
<td>-.25</td>
<td>.73</td>
<td>0.78</td>
</tr>
<tr>
<td>% Lone parent family</td>
<td>-.28</td>
<td>1.69</td>
<td>0.76</td>
<td>.03</td>
<td>.89</td>
<td>1.87</td>
<td>2.44</td>
</tr>
<tr>
<td>% No university degree</td>
<td>.70</td>
<td>.26</td>
<td>2.01</td>
<td>7.11**</td>
<td>.84</td>
<td>.32</td>
<td>2.32</td>
</tr>
<tr>
<td>Improving neighbourhood</td>
<td>-1.10</td>
<td>.07</td>
<td>1.11</td>
<td>2.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining neighbourhood</td>
<td>.05</td>
<td>.12</td>
<td>1.05</td>
<td>.17</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: AIC for Model 1: 1799.79, AIC for Model 2: 1801.49. **p < .01, *p < .05.

The first Poisson regression model generated to predict burns from the covariates was statistically significant with likelihood ratio χ2 = 19.70, df = 4, yielding p-value < .01. The predictors percent housing needing major repairs and percent with no university degree were each made a statistically significant contribution to the equation. The second model, including the primary variables, was also significant with likelihood ratio χ2 = 21.59, df = 6, yielding p-value < .01. The second model demonstrated that percent housing needing major repair was no longer significant at p < .05 although it approached significance (p = .08). Moreover, it showed the estimated Poisson regression coefficient that compared declining income trends neighbourhoods to mixed income trends neighbourhoods (the reference category), holding the
other variables in the model constant. When comparing the first and second models, the fit was essentially the same according to AIC. Thus, the addition of the information on neighbourhood income trends did not add to the explanatory power of the model.

**Summary of results for Objective 3**

**SUMMARY OF FINDINGS FOR OVERALL INJURY**
Due to the direction of the regression coefficients, the results suggest that high rates of recent immigrants are related to lower rates of overall injury. High rates of housing in need of major repair and high rates of unemployment are related to higher rates of overall injury. The coefficients for the OLS regressions equation that reached significance appear large due to the rescaling of the dependent variable but the standardized betas do not indicate a problem.

Overall, neighbourhood income trends made a unique contribution to the allover injury rate, adjusting for the sociodemographic variables used in the model. However, the effect size of the covariates was much larger when compared to that of neighbourhood income trends.

**SUMMARY OF FINDINGS FOR FALLS**
Due to the direction of the regression coefficients, the results suggested high rates of housing in need of major repair and high rates of unemployment appear positively related to overall injury. High rates of recent immigrants are related to lower rates of fall injury. The coefficients for the regression equation that reach significance appear large due to the rescaling of the dependent variable, but the standardized betas do not indicate a problem. Overall, neighbourhood income trends made a unique contribution to the fall injury rate, controlling for the sociodemographic variables used in the model. However, the effect size of the covariates was much larger when compared to that of neighbourhood income trends. The results for falls
were similar to the results for overall injury, likely due to the high number of falls that constitute overall injury.

**SUMMARY OF FINDINGS FOR POISONING**

The direction of the B coefficients for percent immigrant from 2001-2006 and percent housing in need of major repair are consistent with the overall injury and fall analysis. The b coefficient and Exp (B) indicate a large influence of housing in need of repair on poisoning injuries. In summary, the results suggest that neighbourhoods with high levels of immigrants afford a protective factor against injury for children while housing in need of major repair contributes strongly to injury. The addition of the neighbourhood income trends variable in the second set did not change the significant covariates to non-significant. The results from the second set of variables indicated that neighbourhoods that were declining in terms of average income tended to have significantly lower odds of injury in comparison to the mixed trends neighbourhoods that had not changed very much in terms of average income.

**SUMMARY OF FINDINGS FOR BURNS**

The first model yielded only two significant covariates, percent needing major repairs and percent with no university degree. The second model that included the neighbourhood income trends predictor demonstrated that percent needing major repairs was no longer significant at the .05 level. The addition of neighbourhood income trends did not contribute to the fit of the model according to AIC, nor did the coefficients for neighbourhood income trends reach significance. Although these models have little predictive power, they are informative for exploratory purposes.
Conclusion and next steps:
The general patterns were that neighbourhood income trends, although showing significant associations, added little to the predictive power of the models as measured by $R^2$ change and AIC. For the variables analyzed in Objective 3, interaction variables were added as a separate block. The interaction variables did not account for a significant proportion of the injury variance, after controlling for the effects of neighbourhood income trends and other sociodemographic characteristics, and were therefore excluded from the final models. The effect sizes of the covariates were much larger than those of neighbourhood income trends. In an effort to further explore these findings, a sensitivity analysis was performed using a one-point-in-time measure of SES derived from 2006 census data. Thus, efforts to assess relationship between income distribution and injury in Toronto are enhanced by providing an assessment of the relative power of these two primary variables (neighbourhood income trends versus. neighbourhood income status). The operationalization of these two primary variables was shown in Table 2. The next two research objectives are addressed simultaneously via linear regression models juxtaposing the effect of two primary variables on the outcome.

Objective 4
To determine how accurately injury outcomes can be predicted from a linear combination of sociodemographic characteristics including covariates and neighbourhood income trends (35 year period) and covariates and neighbourhood income status (one point in time).

Research Questions #4: How well are overall injury, fall, burn, and poisoning rates predicted by a linear combination of sociodemographic characteristics and neighbourhood income trends, and a linear combination of sociodemographic characteristics and neighbourhood income status?
**Objective 5**

After including other sociodemographic characteristics, to determine whether and to what extent neighbourhood socioeconomic trends (35 year period) have predictive power in explaining variation in injury rates, over and above a more typical neighbourhood income status measure of SES (one point in time) among children aged 0-6 in Toronto.

*Research Question #5: Is neighbourhood income trends or neighbourhood income status the better predictor of overall injury, fall, burn and poisoning injuries?*

*Exploratory Data Analysis for Neighbourhood Income Status*

Spearman’s correlations revealed that the neighbourhood income trends predictor and the neighbourhood income status predictor were significantly correlated ($\rho = .73, p < .01$, two tailed test). There is substantial overlap between neighbourhood income trends and neighbourhood income status. Although the neighbourhood income trends variable has unique properties by incorporating longitudinal information on the change in the Toronto neighbourhood average individual income, it is similar to the one-point-in-time SES measure. Thus, to avoid possible redundancy between these two predictors, the focus of research objectives 4 and 5 was on examining the independent effect of these two neighbourhood socioeconomic status measures on injury, as opposed to including them in one model. If the explanatory power of one of the socioeconomic status measures is as strong as, or stronger than, the conventional covariates such as social disadvantage, housing quality, and neighbourhood stability, there is justification to collect and analyze these socioeconomic data in administrative data systems. A depiction of the significant relationship between neighbourhood income trends and neighbourhood income status is shown in Figure 3.
As can be seen in Figure 3, there are no neighbourhoods that are improving in terms of average income status that are in the low income category, and no neighbourhoods that are declining in terms of average income status are in the high income category. However, there is substantial overlap between improving income trends neighbourhoods and high income neighbourhoods, and between declining income trends neighbourhoods and low income neighbourhoods. Mixed trends neighbourhoods that have changed little over the years in terms
of income status appear more diverse than the other two categories. Although the majority of them are middle income, there are many that are low income. These low income neighbourhoods appear to have entrenched, long term, low income status.

For the analyses of overall injury conducted with neighbourhood income trends as the primary variable, and with neighbourhood income status as the primary variable, outliers for the data set were assessed using a criterion of ± 3.29 standard deviations from the mean. Regression diagnostics were conducted for both analyses, including a histogram, scatterplot and p-p plot of the standardized residuals. These diagnostics indicated that the assumptions of constant variance, linearity and normality were met. The examination of standardized residuals prompted the removal of cases that had scores > ± 3.29. The Durbin Watson statistics for both models indicated the residuals were independent. The cutoff criterion for cases considered to be influential was Cook’s distance > 1 (Field, 2009). According to this criterion there were no influential cases. Mahalanobis distance was assessed with a p < .001 criterion (Tabachnick & Fidell, 2007) and leverage values were computed with (3k + 1)/n where k was the number of predictors and n the number of observations (Stevens, 2002). There were two influential cases (using leverage or Mahalanobis distance) in the neighbourhood income trend analysis that were not outliers in the neighbourhood income status analysis, and vice versa. These 4 cases were deleted to ensure equivalent populations and direct comparison of the two analyses. These deletions left 474 cases for analyses. For the comparison of each analysis, all the predictors were forced into the model simultaneously. Table 15 presents the results of the multiple regression analyses for the model including neighbourhood income trends and covariates and the model including neighbourhood income status and covariates.
Table 15

Multiple Regression Analyses to Compare Mean Overall Injury Rate Regressed on Neighbourhood Income Trends and Covariates and Mean Overall Injury Rate Regressed on Neighbourhood Income Status and Covariates (N = 510)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE B</td>
</tr>
<tr>
<td>Constant</td>
<td>62.78</td>
<td>5.91</td>
</tr>
<tr>
<td>% Needing major repairs</td>
<td>158.92</td>
<td>29.58</td>
</tr>
<tr>
<td>% Immigrant 01-06</td>
<td>-127.02</td>
<td>20.27</td>
</tr>
<tr>
<td>% Lone parent family</td>
<td>-19.30</td>
<td>20.42</td>
</tr>
<tr>
<td>% Apartments</td>
<td>-5.79</td>
<td>4.23</td>
</tr>
<tr>
<td>% Unemployment</td>
<td>24.70</td>
<td>47.43</td>
</tr>
<tr>
<td>% No university</td>
<td>48.46</td>
<td>8.94</td>
</tr>
<tr>
<td>Improving / High income</td>
<td>1.70</td>
<td>3.14</td>
</tr>
<tr>
<td>Declining / Low income</td>
<td>-9.71</td>
<td>2.38</td>
</tr>
</tbody>
</table>

Note: Model 1 = Neighbourhood Income Trends model (Improving/Declining). Model 2 = Neighbourhood Income Status model (High/Low).

*** p < .001, ** p < .01, * p < .05.

The multiple regression model including all six covariates and neighbourhood income trends (Model 1) was significant $R^2 = .39$, adjusted $R^2 = .38$ [$F$, (8, 465) = 36.58, p < .001]. As shown in Table 16, the percentage of housing in need of major repair and the percentage of individuals without a university degree had significant positive regression weights, suggesting that neighbourhoods with a higher percentage of housing in need of major repair and a higher percentage of individuals without a university degree tended to have higher injury rates. The percentage of recent immigrants had a significant negative weight, indicating that
neighbourhoods with a higher level of recent immigrants tended to have lower injury rates. Neighbourhoods that were declining in terms of average income tended to have significantly lower injury rates in comparison to mixed trends neighbourhoods that had not changed very much in terms of average income). Neighbourhoods that were improving in terms of average income had overall injury rates that were not significantly different than mixed trends neighbourhoods that have not changed very much in terms of average income.

The results of the multiple regression analysis predicting overall injury from neighbourhood income status and the six covariates (Model 2) were also significant $R^2 = .37$, adjusted $R^2 = .36 \ [F, (8, 465) = 34.06, p < .001]$. The significance of the results was similar to that of Model 1. However, the significance level of coefficients representing neighbourhoods with low income status was $p < .05$, while the significance level of coefficients representing declining income trends was $p < .005$. Model 1 had 2% more explanatory power than Model 2. The $R^2$ of Model 1 indicates that 39% of the variance in injury can be accounted for by its linear relationship with the predictor variables. In summary, neighbourhood income trends contributed more predictive power to injury rates than neighbourhood income status, but the effect was modest.

Second, two standard multiple regression analyses were performed with fall injury rate as the dependent variable. Outliers for the data sets were assessed using a criterion of $\pm 3.29$ standard deviations from the mean. Regression diagnostics were conducted for both analyses, including a histogram, scatterplot and p-p plot of the standardized residuals. These diagnostics showed that the assumptions of constant variance, linearity and normality were met. The examination of standardized residuals prompted the deletion of cases that had scores $> \pm 3.29$. The Durbin Watson statistics for both models indicated the residuals were independent. The
cutoff criterion for cases considered to be influential was Cook’s distance > 1 (Field, 2009). According to this criterion there were no influential cases. Mahalanobis distance was assessed with a p < .001 criterion (Tabachnick & Fidell, 2007) and leverage values were computed with \((3k + 1)/n\) where \(k\) was the number of predictors and \(n\) the number of observations (Stevens, 2002). There were four influential cases (using leverage or Mahalanobis distance) that were not equivalent in each dataset in terms of their status as influential cases. These 4 cases were deleted to ensure equivalent populations and direct comparison of the two analyses. All the deletions left 480 cases for analyses. For the comparison of each analysis with the other, all the predictors were forced into the model simultaneously. The results of the two analyses can be seen in Table 16.
Table 17
Multiple Regression Analyses to Compare Average Fall Injury Rate Regressed on Neighbourhood Income Trends and Covariates and Average Fall Injury Regressed on Neighbourhood Income Status and Covariates, 2002/3-2005/6 (N = 510)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Model 1</th>
<th></th>
<th></th>
<th>Model 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE B</td>
<td>β</td>
<td>r_{az,b}</td>
<td>b</td>
<td>SE B</td>
</tr>
<tr>
<td>Constant</td>
<td>30.17</td>
<td>3.17</td>
<td></td>
<td></td>
<td>30.09</td>
<td>3.66</td>
</tr>
<tr>
<td>% Needing major repairs</td>
<td>75.95</td>
<td>15.85</td>
<td>.22***</td>
<td>.22</td>
<td>94.12</td>
<td>15.50</td>
</tr>
<tr>
<td>% Immigrant 01-06</td>
<td>-59.51</td>
<td>10.87</td>
<td>-.33***</td>
<td>-.25</td>
<td>-71.87</td>
<td>10.36</td>
</tr>
<tr>
<td>% Lone parent family</td>
<td>-10.48</td>
<td>10.87</td>
<td>-.06</td>
<td>-.04</td>
<td>-15.60</td>
<td>10.88</td>
</tr>
<tr>
<td>% Apartments</td>
<td>-1.48</td>
<td>2.26</td>
<td>-.03</td>
<td>-.03</td>
<td>.41</td>
<td>2.26</td>
</tr>
<tr>
<td>% Unemployment</td>
<td>11.79</td>
<td>25.03</td>
<td>.02</td>
<td>.02</td>
<td>-3.31</td>
<td>24.91</td>
</tr>
<tr>
<td>% No university</td>
<td>19.60</td>
<td>4.76</td>
<td>.28***</td>
<td>.19</td>
<td>21.66</td>
<td>5.51</td>
</tr>
<tr>
<td>Improving / High income</td>
<td>3.19</td>
<td>1.70</td>
<td>.11</td>
<td>.09</td>
<td>2.04</td>
<td>1.76</td>
</tr>
<tr>
<td>Declining / Low income</td>
<td>-5.41</td>
<td>1.28</td>
<td>-.23***</td>
<td>-.19</td>
<td>-4.09</td>
<td>1.43</td>
</tr>
</tbody>
</table>

Note: Model 1 = Neighbourhood Income Trends model (Improving/Declining). Model 2 = Neighbourhood Income Status model (High/Low).

*** p < .001, ** p < .01, * p < .05.

The multiple regression model including all six covariates and neighbourhood income trends (Model 1) was significant $R^2 = .33$, adjusted $R^2 = .32 \ [F, (8, 471) = 29.57, p < .001]$. As shown in Table 17, the percentage of housing in need of major repair and the percentage of individuals without a university degree had significant positive regression weights, suggesting that neighbourhoods with a higher percentage of housing in need of major repair and a higher percentage of individuals without a university degree tended to have higher injury rates. The percentage of recent immigrants had a significant negative weight, indicating that neighbourhoods with a high level of recent immigrants tended to have lower injury rates.
Neighbourhoods that were declining in terms of average income had significantly lower injury rates in comparison to mixed trends neighbourhoods that had not changed very much in terms of average income. Neighbourhoods that were improving in terms of average income had overall injury rates that were not significantly different than mixed trends neighbourhoods that have not changed very much in terms of average income.

The results of the multiple regression analysis predicting fall injury from the one point in time measure of neighbourhood income status and the six covariates (Model 2) were also significant $R^2 = .32$, adjusted $R^2 = .31 \ [F, (8, 471) = 27.57, p < .001]$. The significance levels of the results were similar to that of Model 1. However, the significance level of neighbourhoods with low income status was $p < .01$, while the significance level of declining income trends was $p < .005$. Model 1 had 1% more explanatory power than model 2. The $R^2$ of Model 1 indicates that 32% of the variance in injury can be accounted for by its linear relationship with the predictor variables. In summary, neighbourhood income trends contributed more predictive power to injury rates than neighbourhood income status, but the effect was minimal.

Third, two Poisson regression analyses were performed, with poisoning regressed onto neighbourhood income trends and neighbourhood income status respectively. The same covariates were used in both analyses to provide a direct comparison of the predictive power of the two primary variables. The 2006 census population was the offset, providing some measure of a unit’s exposure. The analytic strategy was the same as what was done for the previous Poisson analyses. The 2006 census population was assumed to represent the population over the four study years. Consistent with the previous Poisson analyses, only covariates with significant correlations with the outcome were used in the model in a conservative approach.
Outliers for the data set were assessed using a criterion of ± 3.29 standard deviations from the mean. This criterion left 489 cases in the data set, which represents a large population. Residual values were graphed to explore outliers and leverage values were computed as \( (3k + 1)/n \) where \( k \) was the number of predictors and \( n \) the number of observations (Stevens, 2002). The cutoff criterion for cases considered to be influential was Cook’s distance > 1. According to this criterion there were no influential cases. The exclusion of influential cases identified according to these values left 479 cases in the data set. The assumption of the Poisson distribution of equal mean and variance was violated. Thus, adjustments were made to address heterogeneity, namely, scaling the parameters and rerunning the Poisson models while obtaining robust standard errors for the Poisson regression coefficients. The analysis was also repeated using negative binomial regression as another possible method to address the overdispersion in the model. The negative binomial regression generated the same significant predictor as the Poisson regression models, but according to Akaike’s information criterion (AIC), the model fit was poorer. Hence, the negative binomial models are not reported. The final Poisson models comparing the fit of neighbourhood income trends versus neighbourhood income status are displayed in Table 17.
Table 17

Poisson Regression Analyses to Compare Poisoning Regressed on Neighbourhood Income Trends and Covariates and Poisoning Regressed on Neighbourhood Income Status and Covariates, 2002/3-2005/6 (N = 510)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Model 1</th>
<th>Model 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE b</td>
<td>Exp(B)</td>
</tr>
<tr>
<td>Constant</td>
<td>-5.11</td>
<td>.22</td>
<td>0.01</td>
</tr>
<tr>
<td>% Needing major repairs</td>
<td>3.46</td>
<td>1.00</td>
<td>31.82</td>
</tr>
<tr>
<td>% Immigrant 01-06</td>
<td>-1.71</td>
<td>.60</td>
<td>0.18</td>
</tr>
<tr>
<td>% Lone parent family</td>
<td>-0.30</td>
<td>.70</td>
<td>1.35</td>
</tr>
<tr>
<td>% No university degree</td>
<td>0.62</td>
<td>.36</td>
<td>1.86</td>
</tr>
<tr>
<td>Declining / Low income</td>
<td>-0.18</td>
<td>.07</td>
<td>1.05</td>
</tr>
<tr>
<td>Improving / High income</td>
<td>0.05</td>
<td>.12</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Note: Model 1 = Neighbourhood Income Trends model (Improving/Declining). Model 2 = Neighbourhood Income Status model (High/Low).
Note: AIC for Model 1: 1984.95, AIC for Model 2: 1988.99. ***p < .001, **p < .01, *p < .05.

Model 1 was generated to predict poisoning from a combination of the covariates and neighbourhood income trends. The model was statistically significant with likelihood ratio $\chi^2 = 58.79$, df = 6 yielding $p$-value < .001. The predictors of percent housing needing major repairs and percent immigrants from 2001-2006 were each statistically significant. The Wald $\chi^2$ indicated the relative influence of the entered variables; thus, housing needing repairs had the greatest influence on poisoning injuries, followed by immigration levels. The expected log count for a one-unit increase in percent housing needing major repairs was 3.46. If a neighbourhood was expected to increase its percent in need of major repairs by 1 unit, the difference in the logs
of the expected counts would be expected to increase by 3.46 units, while holding the other variables in the model constant. The expected log count for a one-unit increase in immigration was -1.71. If a neighbourhood was to decrease its level of immigrants by 1 unit, the difference in the logs of the expected counts would be expected to decrease by 1.71 units. The model also displayed the estimated Poisson regression coefficients that compared declining income trends neighbourhoods to mixed income trends neighbourhoods (the reference category), and improving income trends neighbourhoods to mixed income trends neighbourhoods, holding the other variables in the model constant. This comparison indicated that declining income neighbourhoods had a significantly lower count of injury than the reference category ($p < .05$).

The second model, regressing poisoning onto neighbourhood income status and the covariates, also demonstrated that the relationship between poisoning and the predictors was significant ($\chi^2 = 5,879$, df = 6, $p < .001$). The same individual covariates were significant as in the first model and results were in the same direction. The second model displayed the estimated Poisson regression coefficients that compared low income neighbourhoods to medium income neighbourhoods (the reference category), and high income neighbourhoods to medium income neighbourhoods, holding the other variables in the model constant. The SES variables were not significant. When comparing the model with neighbourhood income trends versus neighbourhood income status, AIC indicated that the neighbourhood income trends component of SES had slightly greater explanatory power than the neighbourhood income status component, namely, a 4-unit difference.

Finally, two Poisson regression analyses were performed, with burns as the dependent variable, and neighbourhood income trends and neighbourhood income status as the respective primary variables. The analytic strategy was the same as what was done for the previous Poisson
analyses. The 2006 census population was the offset that provided some measure of a unit’s exposure. As per the previous Poisson analyses, the 2006 census population were assumed to represent the population over the four years of the study. The burn counts represented the total number of burns over the four study years (2002/3-2005/6) in each neighbourhood. Thus, the results of the analysis should be interpreted as the number of burns over four years in the population. Consistent with the previous Poisson analyses shown in this paper, only covariates with significant relationships with the outcome were used in the model. Outliers for the data set were assessed using a criterion of $\pm 3.29$ standard deviations from the mean. This criterion left 489 cases in the data set, representing a large population. Residual values were graphed to explore outliers and leverage values were computed as $(3k + 1)/n$ where $k$ was the number of predictors and $n$ the number of observations (Stevens, 2002). The cutoff criterion for cases considered to be influential was Cook’s distance $> 1$. According to this criterion there were no influential cases. According to leverage values, there were 3 influential cases that were not equivalent in each dataset in terms of their status as influential cases. These 3 cases were deleted to ensure equivalent populations and direct comparison of the two analyses. The seven cases that were deemed influential cases for both datasets were also deleted. The deletions left 479 cases for analyses. For each model, the predictors were forced in simultaneously. The assumption of the Poisson distribution of equal mean and variance was violated. Thus, adjustments were made to address heterogeneity, namely, scaling the parameters and rerunning the Poisson models while obtaining robust standard errors for the Poisson regression coefficients. The analysis was also repeated using negative binomial regression as another possible method to address the overdispersion in the model. The negative binomial regression generated the same significant predictor as the Poisson regression models, but according to Akaike’s information criterion
(AIC), the model fit was poorer. Hence, the negative binomial models are not reported. The final Poisson models comparing the fit of neighbourhood income trends versus neighbourhood income status are displayed in Table 18.

Table 18

Poisson Regression Analyses to Compare Burns Regressed on Neighbourhood Income Trends and Covariates and on Neighbourhood Income Status and Covariates, 2002/3-2005/6 (N = 510)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Model 1</th>
<th></th>
<th></th>
<th>Model 2</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-5.55</td>
<td>.23</td>
<td>0.00</td>
<td>573.29</td>
<td>-5.26</td>
<td>.26</td>
<td>-0.01</td>
<td>417.90</td>
</tr>
<tr>
<td>% Needing major repairs</td>
<td>2.17</td>
<td>1.24</td>
<td>8.76</td>
<td>3.08</td>
<td>2.69</td>
<td>1.21</td>
<td>14.66</td>
<td>4.94**</td>
</tr>
<tr>
<td>% Immigrant 01-06</td>
<td>-.25</td>
<td>.73</td>
<td>0.78</td>
<td>.12</td>
<td>-.36</td>
<td>.73</td>
<td>.70</td>
<td>.24</td>
</tr>
<tr>
<td>% Lone parent family</td>
<td>.89</td>
<td>1.87</td>
<td>2.44</td>
<td>.23</td>
<td>-.81</td>
<td>1.83</td>
<td>.44</td>
<td>.20</td>
</tr>
<tr>
<td>% No university degree</td>
<td>.84</td>
<td>.32</td>
<td>2.32</td>
<td>6.79**</td>
<td>.49</td>
<td>.37</td>
<td>1.63</td>
<td>1.80</td>
</tr>
<tr>
<td>Declining / Low income</td>
<td>-.10</td>
<td>.07</td>
<td>1.11</td>
<td>2.08</td>
<td>.04</td>
<td>.09</td>
<td>1.04</td>
<td>.18</td>
</tr>
<tr>
<td>Improving / High income</td>
<td>.05</td>
<td>.12</td>
<td>1.05</td>
<td>.17</td>
<td>-.11</td>
<td>.13</td>
<td>.90</td>
<td>.71</td>
</tr>
</tbody>
</table>

Note: Model 1 = Neighbourhood Income Trends model (Improving/Declining). Model 2 = Neighbourhood Income Status model (High/Low).

Note: AIC for Model 1: 1801.49, AIC for Model 2: 1802.68. **p < .01, *p < .05.

Model 1 was generated to predict burns from a combination of the covariates and neighbourhood income trends. The model was statistically significant with likelihood ratio $\chi^2 = 21.60$, df = 6 yielding $p$-value < .01. Only the predictor of percentage of individuals in a CT with no university degree was significant at the .01 level; however, the percentage of housing in a CT in need of major repair approached significance ($p = .08$). The very low rates of burn injuries across all CTs likely influenced the results. The Wald $\chi^2$ indicated the relative influence of the entered variables; thus, individuals without a university education in the CT had the
greatest influence on poisoning injuries, followed by housing in need of repair. The model also displayed the estimated Poisson regression coefficients that compared declining income trends neighbourhoods to mixed income trends neighbourhoods (the reference category), and improving income trends neighbourhoods to mixed income trends neighbourhoods, holding the other variables in the model constant. This comparison indicated that none of the neighbourhood income trends coefficients were significant.

Model 2 was generated to predict burns from a combination of the covariates and neighbourhood income trends. The model was statistically significant with likelihood ratio $\chi^2 = 17.90$, df = 6 yielding $p$-value < .01. The only significant coefficient in the model was the percent of housing needing major repair. Although percent with no university degree was a significant coefficient in Model 1 it was not in this case ($p = .18$). The second model displayed the estimated Poisson regression coefficients that compared low income neighbourhoods to medium income neighbourhoods (the reference category), and high income neighbourhoods to medium income neighbourhoods, holding the other variables in the model constant. The SES variables were not significant. When comparing the model with neighbourhood income trends versus neighbourhood income status, the one-unit difference in AIC values indicated that the neighbourhood income trends component of SES had roughly equivalent explanatory power to the neighbourhood income status component. The low rates of burn injuries likely influenced the amount of variation in the CTs and impacted the results. Although this model had little predictive power, it is informative for exploratory purposes.

**Summary of results for Objectives 4**

Overall injury outcomes and fall outcomes were predicted accurately from a linear combination of sociodemographic characteristics, namely, the neighbourhood income trends and
covariates and neighbourhood income status and covariates models. The adjusted $R^2$ of the OLS models ranged from .31 to .38, which represented a sizable proportion of the variance. The omnibus tests for all four outcomes were significant, but the models with burns and poisoning as the outcome did not have as many significant individual predictors as overall injury and falls. The significance of the individual covariates generally reflected the findings of Objective 3. The poisoning and burn models were more informative for exploratory than predictive purposes. With the exception of the model regressing poisoning on neighbourhood income trends and covariates, the primary variables for these two outcomes did not research significance.

**Summary of results for Objective 5**

The socioeconomic trends and socioeconomic status variables were significant predictors of injury rates for overall injury and falls. Socioeconomic trends possessed slightly more explanatory power than socioeconomic status for all four outcomes. The model regressing poisoning on neighbourhood income trends and covariates showed that the declining trends neighbourhoods had a significant negative relationship with poisoning. Otherwise, socioeconomic trends were not a significant predictor of poisoning. Socioeconomic status was not a significant predictor of poisoning or burns. In most cases, the difference in the fit of the socioeconomic trends models versus the socioeconomic status models was minimal. However, collecting and analyzing the socioeconomic trends variable in administrative data systems in lieu of the socioeconomic status variable has some justification, because the two variables require roughly equivalent effort to calculate from census data.

The sensitivity analysis performed with the neighbourhood income status variable indicated that the results were robust. Overall, the results for the neighbourhood income trends analysis and the neighbourhood income status analysis were similar. Table 19 summarizes the
differences in predictive power of the neighbourhood income trends variable versus the more
typical neighbourhood income status (SES) models.

Table 19
*Predictive Power of Neighbourhood Income Trends vs. Neighbourhood Income Status (N = 510)*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Neighbourhood Income Trends</th>
<th>Neighbourhood Income Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Injury (Adjusted $R^2$)</td>
<td>.38</td>
<td>.36</td>
</tr>
<tr>
<td>Falls (Adjusted $R^2$)</td>
<td>.32</td>
<td>.31</td>
</tr>
<tr>
<td>Poisoning (AIC)</td>
<td>1984.95</td>
<td>1988.99</td>
</tr>
<tr>
<td>Burns (AIC)</td>
<td>1801.49</td>
<td>1802.68</td>
</tr>
</tbody>
</table>

**Objective 6**

The final research objective investigates to what extent the results from research objectives 3, 4, and 5 are consistent with the statistical outputs when spatially depicted. This objective is accomplished by mapping the distribution of childhood injuries by neighbourhood income trends.

Geographic Information Systems (GIS) were engaged to accomplish this objective. GIS, a spatial analysis program, has seldom been used in child welfare-related studies to depict a visual image of children’s safety and well-being. However, GIS has potential to help researchers and practitioners understand the burden of injury. The analyses may be done in a simple form to show spatial relationships among variables that can help practitioners with service planning and that are policy-relevant. A map is a novel approach that often has a greater impact for audiences than a written presentation of data (Cusimano et al., 2007).

In this dissertation, the mapping was done to clarify and communicate the analyses. The Neighbourhood Change CURA study identified and communicated a clustering of socio-economic trends as the “Three Cities” within Toronto in map form (Hulchanski, 2010).
“Three Cities,” namely, the improving income trends, declining income trends, and mixed trends neighborhood were defined and superimposed on the injury data. In the present analysis, the injury data were classified in the maps using quantiles, which is useful to show spatial clusters. The quantile method is also useful because the data classification system is intuitive to understand. An equal number of observations was placed in each class and mapped by neighbourhood income trends. The bottom class is the bottom 25% of CTs ranked by injury rate and so on, making 4 groups (quartiles). The maps for each injury outcome are presented and discussed sequentially, commencing with overall injury in Figure 4.

Mean Annual Number of Injuries Per 1,000 Children Age 0 to 6 Years by census tracts

- 0 to 67
- 67 to 83
- 83 to 99
- 100 to 191

Injury Rate Not Available

Change in the Census Tract Average Individual Income as a percentage of the Toronto CMA Average, 1970-2005

- City #1: Increase of 20% or More
  (100 Census Tracts, 19% of the City)
- City #2: Increase or Decrease is Less Than 20%
  (208 Census Tracts, 40% of the City)
- City #3: Decrease of 20% or More
  (206 Census Tracts, 40% of the City)
- City #0: Not Classified, Income Not Available
  (13 Census Tracts, 1% of the City)

Figure 4

Source:
(1) National Ambulatory Care Reporting System (NACRS), 2002/3 - 2005/6
(2) Child population data from Statistics Canada, Census Tract Profile Series 2006
Mapping: University of Toronto Cities Centre
Figure 4 presents a map of the distribution of overall injury per 1,000 children. ED visits for injuries do not appear uniformly distributed across Toronto. The concentration of injury in the city appears to be higher in the western, southern, and southwestern parts of the city than in other areas. Figure 5, denoting the falls outcome, displays accordant results.
Child Injury Rates from a Fall 2002-2006 by Neighbourhood and the Three Cities of Toronto 1970-2005

Change in the Census Tract Average Individual Income as a percentage of the Toronto CMA Average, 1970-2005

City #1: Increase of 20% or More
   (100 Census Tracts, 19% of the City)

City #2: Increase or Decrease is Less than 20%
   (208 Census Tracts, 40% of the City)

City #3: Decrease of 20% or More
   (206 Census Tracts, 40% of the City)

City #0: Not Classified, Income Not Available
   (13 Census Tracts, 1% of the City)

Figure 5

Source:
(1) National Ambulatory Care Reporting System (NACRS), 2002/3 - 2005/6
(2) Child population data from Statistics Canada, Census Tract Profile Series 2001
Mapping: University of Toronto Cities Centre
Examination of the map of the distribution of falls in Figure 5 reveals that the
neighbourhood distribution of falls is clustered in a pattern similar to overall injury. Many of the
tracts with high rates of falls had high rates of overall injury; however, the rates for falls are not
as concentrated as for overall injuries. The fall results echo those of the previously conducted
regression analyses, which indicate that falls constitute much of overall injury. Figure 6,
denoting poisoning injury, shows a different pattern of results.

Mean Annual Number of Injuries from Poison Per 1,000 Children Age 0 to 6 Years by census tracts

- 0 to 1.2
- 1.3 to 2.3
- 2.4 to 3.8
- 3.9 to 9.6

Change in the Census Tract Average Individual Income as a percentage of the Toronto CMA Average, 1970-2005

City #1: Increase of 20% or More
(100 Census Tracts, 19% of the City)

City #2: Increase or Decrease is Less than 20%
(208 Census Tracts, 40% of the City)

City #3: Decrease of 20% or More
(206 Census Tracts, 40% of the City)

City #0: Not Classified, Income Not Available
(13 Census Tracts, 1% of the City)

Source:
(1) National Ambulatory Care Reporting System (NACRS), 2002/3 - 2005/6
(2) Child population data from Statistics Canada, Census Tract Profile Series 2005
Mapping: University of Toronto Cities Centre

Figure 6
Poisoning as reflected in the ED data (Figure 6) does not appear to follow the pattern of overall injuries and falls. The rates of poisoning were calculated using a small number of cases. Rates were calculated using a count of 1,829 poisoning events averaged over four years. As previously indicated in this paper, examination of the histogram for the rates of poisoning were skewed with a high number of neighbourhoods with no poisoning events (12%) and the majority (91%) with under 8 counts. Low base rates may explain the lack of variation observed. Differences among groups are hard to identify when an event seldom occurs. There was a low number of counts used to calculate the rates. There are a small amount of tracts with the highest rate of poisoning, (3.9 - 9.6 per 1000), but the majority of tracts had a rate less than or equal to 3.8 per 1000. The map of the distribution of poisoning is congruent with the results from the regression models and ANOVAs that indicated that poisoning did not have a strong relationship with neighbourhood income trends.
Burns, as displayed in Figure 7, were the least common of the four outcomes. The rates were calculated using 1,456 counts of burns averaged over the four years. As previously discussed in this paper, the histogram of the distribution of burns was positively skewed and leptokurtic. Low base rates may explain the lack of variation observed. There were many neighbourhoods with no burn events (14%) and the majority of cases (91%) had under 7 events. Differences among groups are hard to identify when an event seldom occurs. A low number of counts was used to calculate the rates. There are a small amount of neighbourhoods with the highest rate of burns (4.9 - 9.4 per 1000), but the majority had rates of 4.8 or less per 1000. Burns as reflected in the ED data does not appear to follow any particular pattern. The map of the distribution of burns is congruent with the regression and ANOVA results that indicated that relationship between burns and neighbourhood income trends was weak.

Summary of Findings

This cross-sectional, ecological, retrospective study identified the extent to which neighbourhood socioeconomic trends are related to intentional and unintentional overall injuries, falls, burns, and poisonings, using Toronto, Ontario as a case study. Neighbourhood socioeconomic trends had relationships of varying strength with the other neighbourhood disadvantage indicators that were used as covariates in this study. For overall injury and falls, effect sizes pertaining to neighbourhood income trends were medium, and for burns and poisoning the effect sizes were small.

When multivariate regression models were employed, the effect sizes of the covariates were stronger than that of neighbourhood income trends. For overall injuries, falls, and poisonings, there were positive and statistically significant coefficients for the percent of housing needing major repair and percent of individuals in a neighbourhood with no university degree.
For overall injuries, falls, and poisonings, a high concentration of recent immigrants served as a protective factor. For overall injuries, falls, and poisonings, the neighbourhood income trend variable showed a negative and statistically significant coefficient for the declining income trends level. The models for burns did not have much explanatory power but are interesting for exploratory purposes.

A sensitivity analysis was performed, regressing the injury outcomes onto a one-point-in-time SES measure that was similar to but different from the neighbourhood income trends measure. The results were similar using the former measure, however, the latter measure had slightly more explanatory power. The additional explanatory power of the neighbourhood income trends variable was not large.

GIS mapping was conducted to overlay injury rates with the neighbourhood income trend indicator. For overall injuries and falls, ED visits did not appear uniformly or randomly distributed across Toronto. The concentration of overall and fall injury appears higher in the western, southern, and southwestern parts of the city than in other areas. This pattern was not evident for poisoning and burn injuries.
Chapter 5: Discussion and Conclusion

This thesis situated the problem of child injury within an ecological model. Consequently, this thesis sought to answer the broad research question, is there a relationship between neighbourhood socioeconomic status and childhood injury among children 0-6? The broad question was divided into six objectives, which were examined in turn. Based on the analyses of city-wide, population-based, cross-sectional data, this study had three main conclusions with respect to the relationship between socioeconomic characteristics and injury:

1. Neighbourhood socioeconomic trends were significantly related to ED injury visits in children age 0-6. The declining income trends group of neighbourhoods had the lowest mean rates.

2. Other economic and sociodemographic measures were more important than neighbourhood socioeconomic change in explaining injury ED visits. Neighbourhood socioeconomic change only explained a small portion of the association between neighbourhood characteristics and injury ED visits.

3. Neighbourhood socioeconomic change had slightly more power than a more conventional one-point-in time socioeconomic status measure.

This chapter contextualizes each conclusion with theoretical considerations, explanations for results, comparisons with other research, and implications for research, policy, and practice. Next, the strengths and limitations of the study are discussed. Finally, a set of broader implications is proposed. Concluding comments close the thesis.

Conclusion 1:
Neighbourhood socioeconomic trends had a significant independent contribution to injury rates.
The declining income trends group had the lowest mean rates.
The results of the ANOVAs indicated that neighbourhood socioeconomic trends had a significant relationship with child injury outcomes. The lowest mean injury rates occurred among the declining income trends category. The effect sizes showed that the strength of the relationships were small to medium, indicating the clinical significance of the results may be small. There was substantial heterogeneity among the dependent variables in the dataset, as shown by overdispersion and unequal variances, which is not unusual in neighbourhoods effects research (O’Campo et al., 2000; Small & Feldman, 2011) and hospital-based data (Hutcheson & Sofroniou, 1999). The heterogeneity among and within neighbourhood income categories indicates further examination can occur at the local level.

Some further examination of this sort has occurred. Within each of the “Three Cities” variation in housing and socioeconomic characteristics was previously identified by the Neighbourhood Change CURA, according to sociodemographic and housing qualities (type of housing, age of housing, family type, income, education, and immigration status) (Hulchanski, 2008). Thus, the CURA subdivided each of the “Three Cities” into logical groupings according to these unique sociodemographic and housing qualities in a cluster analysis (Hulchanski, 2008). The results show that the improving income trends category can be divided into 2 subcategories, the mixed trends category can be divided into 3 subcategories, and the declining income trends category can be divided into 4 subcategories, thus comprising 9 subcategories in all (Hulchanski, 2008). This finding indicates that dividing the “Three Cities” into subcategories may illuminate significant differences within each of the “Three Cities”. In the present study, the mean injury scores of each of these subcategories have been explored in a preliminary subanalysis for significant differences (not shown). This preliminary subanalysis indicates that 2 of the subcategories for the declining income trends category have injury rates significantly lower than
the other 7 subcategories. These 2 declining income subcategories have unique income, education, family type, and housing profiles, although they are both neighbourhoods with declining income trends. Although a full report would entail presenting many mean rates and significance levels, the preliminary subanalysis indicates thus far that dividing the “Three Cities” into more finely grained subcategories may help explain the differences in injury rates. The subanalysis indicates there are subcategories of neighbourhood with significantly lower mean levels of injury than other neighbourhood categories. This finding deserves further exploration to examine what processes and characteristics engender low injury rates in certain subcategories of neighbourhoods, and whether it is practical to target the subcategories of neighbourhoods with high injury rates for intervention. The neighbourhood-level influences on injury risk may be subtle and difficult to transfer into informed prevention efforts. Efficient use of resources may be to target the neighborhoods with high rates of injury regardless of their income status.

The declining income trends group of neighbourhoods had the lowest mean rates of the three neighbourhood categories, although the effect sizes were small. The possibility that disadvantaged neighbourhoods have protective or mediating factors at the ecological level in Toronto cannot be discounted. Among residents 12 years old and over, a study by CIHI (2006) has noted that the most socioeconomically disadvantaged neighbourhoods in Toronto were associated with significantly less self-reported injuries than those in other neighbourhoods. This result was unique among Canadian cities, although Vancouver was found to duplicate this result to some extent (CIHI, 2006). Another study noted a negative association between material deprivation and unintentional injury among 0-14 years olds in Toronto. This negative association was not apparent other Ontario cities (Lee, 2009). In addition, an area-based study that profiled 0 - 20 year olds (CIHI, 2008a) demonstrated there are variations among Canadian
cities in the degree of the gap in injury hospitalization rates associated with unequal SES. Toronto had little variation by SES in comparison to the Canadian average, while some other Canadian cities had marked gaps in comparison to the Canadian average. The results of these three studies, although not considering the exact age groups and injury outcomes as the present study, buttress the findings in the present study that the neighbourhood income trends and neighbourhood income status did not contribute highly to variation in injury rates in Toronto.

The contextualization of the results of this study among the other Canadian studies that exist suggests SES-related injury gaps do not operate the same across Canada. These Canadian findings are consistent with recent research that suggests whether and to what extent neighbourhoods influence health risk depends on a unique blend of individual, neighbourhood, and city level conditions (Small & Feldman, 2012). Within a regression framework and an ecological model, such individualized representations would entail a focus on the interplay among individual, neighbourhood, and city level characteristics. This study presents Toronto as a case study with a unique set of properties, rather than as a representative city in Canada (Small & Feldman, 2012).

Although more Canadian studies on the topic are needed, the studies that exist suggest that SES-related disparities in child injury urgently require further focus and investigation. As discussed in the literature review of this paper, studies indicate that the Prairie Provinces may be driving Canada’s SES gradient in injury outcomes. This possibility requires further investigation and possible priority intervention in the prairies in order to help equalize injury outcomes for children residing there.

The results that support Conclusion 1 are visually depicted in maps according to objective 6. Mapping the rates of child injury can help health and social service professionals examine
whole neighbourhoods and communities. The identification of areas with high and low rates can illuminate further areas of discussion about whether the presence or absence of certain neighbourhood services contributes to various health and social problems (Ernst, 2000). For example, pinpointing the location of hospitals and clinics, and stratifying analyses by geographical distance to these services, may demonstrate whether SES-related gradients exist within each distance stratum. If differential access is related to residence location, future research and practice efforts can address this inequity.

**Conclusion 2**

*Other economic and sociodemographic measures were more important than neighbourhood socioeconomic change in explaining injury ED visits.*

There were several covariates that were included in the regression models as traditional predictors for injury. Explanation for the effects of following significant covariates are summed up and discussed in the following section: Recent immigrants, housing in need of major repair, and low education.

**Recent Immigrants**

After controlling for other neighbourhood characteristics, a negative relationship between recent immigrant status and three of the four outcomes (overall injuries, falls, and poisoning) was found in this study. Two recent studies that investigated the neighbourhood-level association between socioeconomic status and injury found Toronto had a significant inverse relationship between injury rates and immigrant/minority status, stronger than that of other Canadian cities (CIHI, 2006; Lee, 2009), although Vancouver was found to duplicate this result to some extent (CIHI, 2006). The negative relationship found in this study persists in spite of the fact that the “Three Cities” data indicate that neighbourhoods with a high level of recent immigrants are
associated with high levels of social and economic disadvantage. Some ecological studies suggest that in spite of a high degree of disadvantage, many immigrant communities appear to possess protective factors. For example, Hispanic immigrant communities in the USA, in spite of high poverty levels, have been found to have lower rates of child injury than other communities in similar conditions (Anderson et al., 1998; Durkin et al., 1994). Community norms and values that promote social cohesion and group affinity among immigrant and minority communities may ecologically affect health and social outcomes (Galster & Santiago, 2006). If recent immigrants are grouped in enclaves, the cultural norms and expectations of the group may serve as a protective factor, regardless of one’s own personal characteristics. For example, group cohesion and social support in some communities of recent immigrants may contribute to child safety, even though the community lacks economic resources and is in social transition. The presence of group cohesion and social supports dovetail with the contribution of community characteristics to lowering injury risk, proposed in the ecological model shown in Chapter 1. Thus, the possibility that improving and mixed income trends neighbourhoods have isolating features and deficits that promote injury at the ecological level cannot be discounted.

An alternate explanation for the negative relationship between recent immigrants and injury is that it is an artifact of individual characteristics. For example, a large body of literature documents the “healthy immigrant effect” whereby healthy and skilled individuals self-select to emigrate on the basis of their ability to withstand adaptation to a new country. In a related process, the recipient country screens out potential immigrants who do not possess high levels of health, education, and other desirable characteristics (Ali, McDermott & Gravel; Kennedy, McDonald, & Biddle, 2006). Thus, individuals who likely have high levels of personal resources and low levels of risk-taking behaviour are selected as immigrants. These traits may somehow
positively affect their levels of child supervision and coping ability. Indeed, individual-level research has found that immigrant and minority children of certain backgrounds possess lower levels of injury than the majority (Kennedy & Rodriguez, 1999; Jain, Khoshnood, Lee & Concato, 2001; Vaughn et al., 2004). Dovetailing with this research is the finding that a greater level of acculturation among immigrant or minority parents and families, in comparison to low acculturation, has been linked to declines in positive health behaviour and health status, including rates of unintentional child injuries (e.g., Hernandez & Charney, 1998; Kennedy & Rodriguez, 1999). Although acculturation is a complex, multidimensional concept that is hard to operationalize, the causal pathway purported for this finding is that when immigrants assimilate into the dominant culture, their health and safety behaviour begins to reflect the dominant group, thereby muting the healthy immigrant effect (e.g., Hernandez & Charney, 1998; Kennedy & Rodriguez, 1999). If the negative relationship found in this study is simply attributable to the aggregation of the individual characteristics of recent immigrants, the high representation of recent immigrants in certain areas would be responsible for the observed low injury rates, rather than representing the characteristics inherent to the neighbourhood. Thus, this study’s analysis of neighbourhood-level data would reflect an ecologic bias.

The explanation for the finding of the negative relationship between recent immigration and injury has a caveat. Recent immigrant communities are not monolithic. Due to variability in country of origin, reason for migration, level of discrimination, and level of acculturation, the nature of social processes in immigrant enclaves varies. Thus, levels of group cohesion and social support may vary. In addition, some immigrant parents’ ability to cope with and supervise children on an individual level may be influenced by contextual community characteristics, making the relationship between individual-level and group-level influences complex. The
integration of macro- and micro-level processes and systems is challenging on a theoretical and practical level. The variation found in health and social outcomes among various categories of immigrant appears related to the substantial heterogeneity in immigrant communities (Osypuk, Diez Roux, Hadley, & Kandula, 2009). There is a wide array of social and economic factors that frame individual choices and circumstances in the theoretical model presented in Chapter 1. Further understanding of the perceptions and processes particular to given communities, and their relationship with injury, require in-depth qualitative research methods.

An additional, less uplifting explanation for the negative relationship between the proportion of recent immigrants and injury may be that recent immigrants experience barriers to the Canadian health care system, such as cultural unfamiliarity, fear of blame, or lack of insurance, and thus avoided ED treatment for their children’s injuries. This study cannot identify injuries treated outside of the hospital system, and hence cannot explore in depth this particular explanation regarding differential access. Varying thresholds for referral to the ED among parents and neighbourhood-based health care providers, on the basis of cultural or other characteristics, cannot be discerned in this study. Research is needed on the extent to which one’s decision to seek ED treatment for an injured child is related to individual or neighbourhood characteristics and broader policies, as per the contributors to injury outlined in the ecological model shown in Figure 1.

The contention that recent immigrants’ differential access to care arises due to a lack of health insurance deserves exploration. A strength of the NACRS is reflected in its ability to capture of almost the entire Ontario population due to universal provision of provincial health insurance, which should mute the influence of economic barriers. One exception is the three-month waiting period for health insurance for recently landed immigrants. Hence, the negative
relationship between recent immigration and injury may reflect differential access on the basis of payment responsibility. A brief examination of payment responsibility in the NACRS database suggests that injury visits paid for by residents of other countries is estimated at less than 0.5% of overall visits. The information provided by this examination indicates that recent immigrants without provincial health insurance undergo few ED visits. Again, it is difficult to determine if this lack of utilization is due to differential access on the basis of culturally-related barriers or a true lack of injury.

The extent to which results regarding immigration in this population-based study in Toronto will generalize to other times and locations is unclear. Many immigrant communities in Canada are socioeconomically disadvantaged, which makes it difficult to parse out the influence of immigrant status versus socioeconomic status. Results from Toronto may not generalize to other cities in Ontario. A report by Toronto Public Health (2008) proposes that although Toronto possesses a high degree of income inequality, it also has a variety of equalizing properties protective to its population’s health, which may be somehow related to the “healthy immigrant” effect, a degree of neighbourhood mixing, and the availability of established social services. As previously mentioned in this paper, Toronto is known to have a high degree of universal children’s safety programs, which could exert an equalizing effect across Toronto. Results could be biased towards the null due to these Toronto characteristics.

*Housing in Need of Major Repair*

In Toronto, levels of housing in need of major repair varied little among the three neighbourhood income categories. This result is explained by age of housing insofar as the declining income trends areas actually possess a large amount of rental housing that was built during the postwar boom (Toronto Tower Renewal, 2011). Although in need of amenities such
as proximate community services, transit access, and energy efficiencies, these buildings seldom require major repairs yet (Hulchanski, 2010). The findings from this study indicate that citizens in the declining income trends neighbourhoods do not appear more likely than those in other neighbourhoods to suffer adverse exposure to physical hazards arising from housing in need of repair. The more peripheral postwar declining income trends neighbourhoods have newer housing stock, while the mature, established, and central improving and mixed trends neighbourhoods are characterized by older homes that have required repair. This study corroborated the findings of the Neighbourhood Change CURA report that the need for major housing repairs is similar across Toronto, regardless of neighbourhood income status (Hulchanski, 2010). Thus, it is not surprising that housing in need of repair offers a unique contribution to the injury rate, independent of neighbourhood income trends.

In this study, a very strong relationship was found between housing in need of major repair and three of the four injury outcomes (overall injury, falls, and poisoning) while controlling for other predictors of injury. A strong positive bivariate relationship can be seen in the scatterplots depicting the relationship between housing in need of repair and for outcomes of overall injury, falls, and poisoning. This study previously discussed the importance of housing quality to the injury prevention effort. Other studies have found evidence of a strong and independent contribution of housing problems when studying the relationship between the environment and injury risk (e.g., McDonell & Skosireva, 2009; O’Campo et al., 2000; Reading et al., 2005; Shenassa et al. 2004). Housing may be a mediator between individual and social determinants of health that deserves further investigation into causal pathways (e.g., see Shenassa et al. 2004; Dunn 2003, Dunn, Hayes, Hulchanski, Hwang, & Potvin, 2006). The strong relationship between housing in need of major repair and injury found in this study
suggests that further investigation is warranted into targeting and alleviating housing hazards as an injury risk factor, especially because this finding is consistent with previous results. Further research using different populations and methodologies can confirm the benefits of targeting neighbourhoods with high levels of housing in need of major repair for interventions and investment, to decrease the burden of injury and other poor outcomes.

Low Education

The relationship between injury and low education, as measured by the level of individuals with no university degree, showed some significant positive trends in this study. Past research has specified low educational attainment in a variety of ways (e.g., high school diploma vs. no high school diploma; university degree vs. no university degree), and in combination with the variety of injury definitions presented, this result is difficult to clearly compare with the literature. Low levels of education in a neighbourhood may systematically influence social norms and values about safety and prevention. However, there is some evidence that the geographical clustering of various types of children and families, as opposed to the forces of neighbourhood upon children and families, may explain this relationship (Meritt, 2009; Reading et al., 2008). Morrongiello & Dayler (1996) suggest that low levels of formal education may impact knowledge of child development and preventative behaviour, which may increase injury risk. In any event, the relationship found between low education and injury indicates the importance of capacity-building in terms of local access to training and educational opportunities.

Conclusion 3

Neighbourhood socioeconomic trends had slightly more power than a more conventional one-point-in time socioeconomic status measure
When models were compared, the socioeconomic trends models had slightly better fit than the socioeconomic status models for all four outcomes. The importance of the difference in model fit is prone to subjective evaluation, but the differences appear small. The results of the Spearman’s correlation and model comparisons according to $R^2$ and AIC indicate that the neighbourhood income trends variable operated in similar ways to the neighbourhood income status variable. As shown in Table 2, the income trends variable captured the trends over time in Toronto neighbourhoods according to the change in average individual income. Hence, this variable may be reflecting small but important differences from the more conventional one-point-in time SES measure. The difference in explanatory power between the income trends models versus the income status models indicates that the encroachment of social and economic change upon neighbourhoods may exert slightly different forces upon families than neighbourhoods with entrenched socioeconomic standing. Ethnographic research from the USA suggests that families residing in transitional, economically declining neighbourhoods collectively adapted to and challenged the decreasing resources and growing anomie in their environments in order to safeguard their children, while families residing in neighbourhoods of entrenched poverty resorted to more individualized and harsh discipline strategies (Furstenberg, 1993). The measure of neighbourhood socioeconomic transition in this study may capture slightly different properties than the measure of neighbourhood socioeconomic status.

According to the results of Conclusion 3, there is justification for calculating and using the neighbourhood income trends variable in research using administrative data sets. Both the neighbourhood income trends and neighbourhood income status variable require little effort to calculate from census data. The neighbourhood income trends measure performs as well if not slightly better than a more conventional measure of neighbourhood income status as an
explanatory measure for injury. With reference to conceptualizing the relationship between income and health outcomes, Raphael et al. (2003) suggest that researchers “measure income more than once to gain a broader perspective” as has been undergone in this study (p. 12). In summary, researchers should carefully consider the quality of their socioeconomic status measures when predicting injury outcomes.

Strengths of the Study

Methodological Strengths

This study had strengths that deserve mention. Although the neighbourhood is an important environment that has policy and practice implications in its potential to affect all residents residing in it, there is little knowledge of how varying neighbourhood characteristics influence injury risk for young children in Canada. Results with different external causes of injury were reported in this study, according to assertions in the literature that the association with neighborhood socioeconomic status is contingent on the external cause (Gagné & Hamel, 2009; Hippisley-Cox et al., 2002; Lyons, Lo, Heaven, & Littlepage, 1995). This study represented a large population with public health insurance, who sustained medically attended injuries recorded using standard protocols. Moreover, the use of administrative health data circumvents the problems of recall bias in self-report (Harel, Overpeck, Jones, and Scheidt, 1994).

GIS Mapping

This study was original of its use of GIS mapping to portray childhood injury at the neighbourhood level. As previously mentioned in this paper, a map often has a greater impact than a written description (Cusimano et al., 2007). Ernst (2000) suggests that GIS mapping is an
important exercise to help social workers understand the level and nature of resources available in given neighbourhoods, such as parks, community agencies, and transportation systems. Hence, they can assist families to choose functional neighborhoods and advocate to improve existing neighborhoods in terms of the supports and infrastructure needed (Ellen & Turner, 1997; Ernst, 2000). Simply put, mapping geographical spatial patterns in studies of the relationship between income inequality and health outcomes may starkly illustrate the income-contingent benefits and drawbacks of living in certain areas. Consequently, public policy debate can be stimulated (Dunn, Schaub, & Ross, 2007).

**Young Children**

The study of young children as opposed to older children contributes to this study’s strengths, due to decreased likelihood of two threats to internal validity. First, reverse causality problems where poor health leads to downward social mobility and consequent residence in a declining or poor neighbourhood is unlikely with young children. Reverse causality is not a strong consideration in this short-term, retrospective study. Rather, reverse causality may be more relevant for longitudinal studies given that the negative effects of serious childhood injuries on families’ social and economic mobility may take time (Scott, 2009).

Second, the study of young children, who cannot play sports or participate in independent extracurricular activities, implies that the potentially confounding impact of sport and recreational injury has little relevance to this study. Among older children and adolescents, there is evidence that the association between SES and sport and recreation injuries is different than the relationship between SES and other types of injuries (Faelker et al., 2000; Potter et al., 2005; Williams, Currie, Wright, Elton, & Beattie, 1997). Children and adolescents from well-off families have more exposure to sport and recreation than those who are less privileged because
well-off families can afford to provide these pastimes (Faelker et al., 2000; Potter et al., 2005; Williams, Currie, Wright, Elton, & Beattie, 1997). Unfortunately, given current data collection and coding practices, it may be difficult to distinguish a sport and recreation injury from another type of injury (Britton, 2005; Finch & Boufous, 2008). These measurement issues indicate it is beneficial that the increased risk of sports and recreational injury among the more privileged groups has little relevance to this study.

**Use of Raw Measures**

The raw sociodemographic measures used from the census are more easily understood for hypothesis generation of the causal pathway between neighbourhood characteristics and injury than composite measures (Thanigasalam, 2001; Pickett & Pearl, 2001). For example, the use of the raw measure of the level of housing in need of repair revealed its very strong positive association with injury. If the housing variable was combined into a composite measure of economic or physical deprivation, such a strong relationship may be muted. Use of raw measures is harmonious with the exploratory goals of the study. According to Last (2001), exploratory research entails searching for patterns, suggestions, or hypotheses, while explanatory research attempts to test hypotheses and provide explanations regarding why relationships exist. Because there is a lack of research on the specific topic and the specific location, the aims of this study were largely exploratory, but it also sought to develop some understanding of the potential mechanisms that explain the results.

**Limitations of the Study**

This study had seven key limitations that will be discussed in the following section. These limitations expand upon the more general limitations regarding the use of ecological designs, administrative health data, census data, and traditional regression analysis with spatial
data that have already been covered in the introductory chapter. Some of the following
limitations have already been touched upon in the conclusions and implications sections in the
present chapter. The seven limitations are the cross-sectional design, selection effects, a time lag
between the data sets used, the lack of spatial analysis, characteristics of outliers, low base rates,
and the variables available. These limitations are discussed in turn.

Cross-sectional Design

A major limitation of this study’s cross-sectional study design is the inability to discern
the temporal order and direction of causation between the exposure and outcome. The literature
review previously discussed the general limitations of cross-sectional designs. The level of this
study’s cross-sectional, ecological design on the traditional research evidence hierarchy is low.
Thus, the causal interpretations provided by this study are limited. Longitudinal studies can
avoid this limitation by ascertaining the degree of exposure prior to the outcome. When and if
long-term temporal data of the NACRS and census are available, they can provide more robust
evidence of causal factors.

Selection Effects

Selection effects reflect variation in rates associated with the characteristics of people who
consolidate in certain types of neighbourhood, rather than the effects of neighbourhood
characteristics on people (Bergström & van Ham, 2010). Variation in injury risk among
neighbourhoods may be explained by geographical clustering of similar types of children and
families. A possible selection effect for this study is related to the characteristics that would
entail less use of the ED of children from declining and low income neighbourhoods, in

14 “Selection effect” may be a misnomer, given the evidence (e.g., Bunting, Walks, & Filion, 2004; Hulchanski,
2010) that individuals who lack economic and other resources do not “select” to reside in certain neighbourhoods,
but rather have little choice on where to live.
comparison to children from more privileged areas. Thus, the injury outcome variables may actually measure something other than injury. For example, these measures may reflect that parents and/or care providers in low socioeconomic status neighbourhoods may have different injury thresholds than those more well-off neighbourhoods for referral to the ED. In fact, if parents who consolidate in certain neighbourhoods have a higher perception of culpability for an injury than those in other neighbourhoods, their willingness to attend the ED may be affected. Thus, their unobserved characteristics may lead to bias. Although not a characteristic intrinsic to their residents, postwar urban sprawl and long travel times in declining and low income areas may also act as a disincentive by residents to attend EDs, in comparison to those living in the more accessible and high income central areas of Toronto.

Some authors suggest that a way to circumvent selection-related bias is to study severe injuries such as those requiring hospitalization, which will provide a more consistent injury threshold across communities than more minor injuries (Jolly, Moller, & Volkmer, 1993; Reading et al., 1999). Others argue that a bias regarding hospitalization is still possible because hospital admission may reflect medical care providers’ belief in a given parent’s functionality and ability to follow treatment and care instructions (Anderson et al., 1998; Williams et al., 1997). The possibility of different injury thresholds due to selection effects is difficult to rectify. The nature of the administrative health data used in the study contributes to selection bias and denotes the importance of studying area-based variation in childhood injury with varied data sources and study designs.

Another, less contentious, possible selection effect is selective survival. Only survivors can be captured in cross-sectional studies (Kleinbaum, 2002). The threat of this selection effect to the internal validity of this study has already been discussed: Only children who attended the
ED can be included in this study. If children from a particular neighbourhood category were more likely to die from injury without attending hospital than those in others, the study’s results would be biased in a conservative direction.

*Time Lag between Data Sets*

The sociodemographic data and the population denominator data used in this study were based on the 2006 census. Injury events were captured from the fiscal years of the NACRS from 2002/3 to 2005/6. Thus, the assumption made in this study was that the population of children aged 0-6 and neighbourhood sociodemographic characteristics did not change from the 2002/3 to 2005/6 fiscal years. As discussed in the methodology section of this paper, it is plausible that neighbourhood characteristics change slowly (Geronimus & Bound, 1998; Hulchanski, 2010) and thus the time lag between the census data and the injury data would be inconsequential. The expectation is that the overall ecological characteristics of the neighbourhoods changed minimally over the study period. Nonetheless, the possibility exists that the 2006 census data do not accurately characterize the neighbourhoods of children experiencing injury in the earlier years of NACRS data, such as 2002/3.

Given that the expectation is that the overall ecological characteristics of the neighbourhoods changed minimally over the study period, what is perhaps the main conceptual problem regarding time in this study is that the dataset does not reveal how long individuals have been exposed to their neighbourhoods. Exposure to a neighbourhood over time may influence risk for childhood injury (Tienda, 1991). Although the children represented in the study were young and presumably would not experience the substantial cumulative effects of neighbourhood, the influence of cumulative neighbourhood conditions on parents in ways that would mediate or transmit neighbourhood effects to their children is unknown. The analysis of
this study essentially represents a snapshot of the association between neighbourhood SES and child injury outcomes.

*Lack of Spatial Analysis*

As previously discussed in this paper, this study used a traditional analytic approach, assuming independence among spatial units (CTs). However, it is sometimes the case in spatial data that the values of a variable in adjacent spatial units are correlated. In other words, the data deviates from a random pattern and violates the assumption of independence. If this assumption is violated, traditional analytic approaches such as regression analysis may produce standard errors that are too small, and consequently inflate the Type I error rate (Freisther et al., 2008). Although the results of this study generated some very small p-values that would be likely to remain significant even if autocorrelation was present, an Exploratory Spatial Data Analysis (ESDA) would enhance the traditional regression analysis in this study. ESDA represents the first step in a spatial analysis by detecting possible autocorrelation among spatial units. If spatial autocorrelation is detected, advanced procedures such as Spatial Random Effects Panel models or Generalized Least Squares models can control for correlated measurement error among units close together in space (Coulton et al., 2007). In the future, the limitation represented by this study’s traditional analytic approach can be addressed with these spatially-based procedures.

*Low Rates*

The low base rates found in this study for burns and poisoning are heartening and reflect the improvement in childhood injury rates in Canada. For example, poisoning deaths and hospitalizations dropped by half (46%) for children aged 1 to 4 in Canada between 1994 and 2003 inclusive, while children of the same age group had a 32% decline in burns during the same
period (SKC, 2006). In spite of analytic techniques in this study to address the low numbers of
burns and poisonings, such as aggregation of four years of data, the burn and poisoning
outcomes may have low power to detect a significant effect. Regardless, this preliminary study
offers insight into the injury outcomes that require priority attention and those that need to be
explored through further research.

Outliers

As previously discussed in this paper, outliers were detected by applying exploratory data
analysis techniques and removed according to pre-set criteria. After these procedures, a
substantial number of cases were left from each neighbourhood income category. When some of
the analyses were undertaken with outliers included, their effect on the performance of the
regression models was negligible. Although the exact number of outliers removed depended on
the particular analysis undertaken, an example from the neighbourhood income trends vs. SES
comparison is that there were about 1% of the subsample removed for the improving income
trends group, 6% of the subsample removed from the mixed income trends group, and 9% of the
subsample removed from the declining income trends group. There were consistently more
outliers removed from the mixed income trends and declining income trends categories than
from the improving income trends category, with the declining income trends category having
the highest number. In sum, the improving income trends category was smaller and more
homogeneous than the other two categories. The greater heterogeneity of mixed income trends
and declining income trends neighbourhoods has been previously identified within the
Neighbourhood Change CURA analysis (Hulchanski, 2008).

In the present study, a subanalysis of outliers (not shown) indicates that the univariate
and multivariate outliers were significantly different from the other cases on the basis of recent
immigrant status. The level of recent immigrants was higher among multivariate outliers than the other cases, and lower among univariate outliers of the outcome than the other cases. For the multivariate outliers, a general profile of high neighbourhood disadvantage was present, however, the injury rates were lower on average than the other cases. In contrast, the univariate outliers for the outcome variables appeared to have high mean injury rates, but did not have high profiles of disadvantage in comparison to the other cases. The deletion of the outliers limits the study’s generalizability to certain mixed income trend and declining income trend neighbourhoods, such as those with typical profiles of disadvantage but with high injury rates, and neighbourhoods with high profiles of disadvantage but with low injury rates. However, given the size of the dataset, the results remain applicable to a wide range of neighbourhoods.

After completion of quantitative analyses, the in-depth qualitative comparison of the extreme cases for risk factors and resiliency can provide insight into the development of models and theory that delineate the connections between neighbourhood and injury. Ethnographic analysis within neighbourhoods with extreme scores on injury can elucidate how families negotiate injury risks and protective factors (see Coppedge, 1999).

Available Data

The variables in this study were hypothesized to represent levels of economic and social transition and impoverishment working at the neighbourhood level, as per the theoretical model in Figure 1. These variables were accessed via the census, and thus had the advantage of being inexpensive, available, and linkable to other data sets. Moreover, census data have been found to be robust in terms of their relationship with social indicators in neighborhoods as defined by their inhabitants (Coulton, Korbin, Chow, & Su, 2001). The census variables for this study were selected based on prior research, theory, and typical model building techniques. A theoretical
assumption for regression is that no relevant variables are omitted from the model. However, for this and the many other studies using census data to predict health outcomes, other variables may also be linked to injury patterns if they were collected and available. Due to the complexity of ecological models, researchers and program designers have often isolated the indicators in an ecological model in order to target their relationship to an outcome (Corse, Schnid, & Trikett, 1990; Garbarino, 1988). The integration of multiple indicators to account for contextual complexity remains theoretically and practically challenging given the data usually available (Frohlich et al., 2007). For example, the data available in this study do not account for sources of resiliency, which will be discussed as follows.

The focus on injury and the encroachment of social and economic decline upon successively larger areas of Toronto draws attention to neighbourhoods’ challenges and deficits. Given this study’s results that neighbourhood socioeconomic decline does not pose a significant risk to childhood injury, there may be unmeasured sources of resiliency, such as collective strength, support, or cohesion in declining neighbourhoods, that deserve attention. To buttress this resiliency contention, Soubi et al. (2004) found measures of neighbourhood of cohesion, as reported by parents in Canada, showed small protective effects against injury in early childhood. There is a need to identify potential measures of strength, cohesion, and support at the neighbourhood level and to make them accessible to researchers and practitioners. Considering the influence of empowering and positive factors such as community strength, cohesion, and social support within ecological models such as the one used to frame this study can balance the focus on deficits and disparities that are common in the dominant risk-based approach. Practice implications include building on identified strengths, cohesion, and supports at the neighbourhood level.
Recommendations for Research, Policy, and Practice

The relevance of the findings to future research, policy, and practice have been discussed according to the main conclusions of this study and the strengths and limitations of the design. The theoretical orientation and results of this study also suggest certain research, policy, and practice recommendations related to the use of ICD codes and the predilections that may be introduced as a result of their classification systems. These recommendations are discussed as follows.

Future Research

In this study, the continuum of intent in the ecological model shown in Figure 1 provided a rationale for combining ED injuries of unintentional, intentional, and undetermined intent into a set of comprehensive injury outcomes. Although presenting rates of injury without specification of intent has been done before (CIHI, 2006; CIHI, 2008a; Macpherson et al., 2005), this is the first known study to provide an explicit theoretical rationale for combining the intent categories for data analysis. In addition, basing this study on ED visits rather than on substantiated child welfare cases, the latter which comprise the most severe forms of neglect and intentional injury, allows the less severe cases and rarely reported cases that may be based on temporary, short-term lapses in supervision and social and economic hardship to be measured (English et al., 2005). Low base rates for burn and poisoning outcomes also warranted the combining of intentional, unintentional, or undetermined intent injuries. Although there are no universal guidelines to group ICD-10 codes, the approach to grouping ICD codes in this study is somewhat unconventional. For example, Christoffel and Gallagher (2006) recommend that for fatal injuries researchers adhere to the traditional coding categorizations of intentional, unintentional, and undetermined intent, in order to provide consistent comparisons of death
across jurisdictions (see Centers for Disease Control and Prevention, 1997). As previously shown in this paper by a discussion of the literature, the three intent categories have an arbitrary nature; however, they break the occurrence of injury into manageable pieces.

A nod to these conventional intent categories could occur in the future, which could further test the theory presented in this paper. Although the vast majority of injuries are coded as unintentional, the present study could be replicated with outcomes divided according to the more typical categories of intentional, unintentional, and undetermined intent. More specific injury categories such as these may be more sensitive to neighbourhood-based variation than broad-based injury categories. With adjustments to address low base rates, potential interactions on the basis of intent may be examined. Previous research has found caregivers in low-SES areas have been found culpable due to “intentional” harm (e.g., child abuse) more often than those in higher-SES areas (Birken et al., 2009; Coulton, Korbin, Chan, & Su, 2007; Merritt, 2009), but the causes of this phenomenon are debatable. Future investigations, leapfrogging off of the present study, can further this discussion.

The ICD-10 category of undetermined intent must be approached thoughtfully. Past research and coding conventions have assumed a division between intentional and unintentional injuries. Therefore, injuries of undetermined intent, also receiving their own set of ICD codes, have represented a wild card and bugbear for researchers. Although reabstraction studies suggest a reasonable degree of accuracy for the injury mechanisms and diagnoses selected for this study (CIHI, 2008b; Gibson et al., 2008), the background research presented in this paper indicates that “intentional” injuries are commonly misclassified in health care settings. The review of reabstraction studies for the NACRS provided little insight into the level of miscoding of intent categories. Future research can examine these data quality issues via qualitative interviewing of
health care workers, hospital coding technicians, and health information specialists to gather more information on the pitfalls and benefits of current ICD coding standards and functions. Injuries coded with undetermined intent highlight the potentially arbitrary nature of coding classifications and the challenges in health care settings of unequivocally determining intent. For the present study, the merging of intentional, unintentional, and undetermined intent injuries helped to moderate these somewhat artificial distinctions, which was addressed with the ecological model of childhood injury presented earlier in this paper.

In order to circumvent the pitfalls of secondary analysis of administrative health data that have beset this topic area, researchers could take advantage of natural experiments, interventional research, and qualitative studies wherever possible, to augment and compare with the results that already exist. In addition, the lack of information about the specific physical sequelae of child abuse, related to the narrow ICD code definitions of child abuse, indicate that it is important to access child abuse and neglect data gathered from social service agencies to examine the extent to which physical injury can be ascertained.

**Future Policy**

The policy implications of this work are tentative due to being an ecological study of one city, studying injury outcomes among young children. General conclusions must be drawn cautiously, due to the exploratory nature of this study and many others like it. Advocating for overarching policy changes as a result of this project would be premature. More research on the topic is needed in different settings with different methodologies to corroborate the results in this thesis. A balance must be struck between the universal and the particular when deciding whether certain place-based associations between income status and health outcomes are should justify attention from policy-makers and program developers (Coppedge, 1999). Recent studies into the
place-based relationship between income distributions and health suggest that aiming for generalizable, sweeping conclusions about the extent of health inequality on the basis of income inequality is unrealistic (Small & Feldman, 2012). Rather than aiming for universal statements, researchers and policy makers may embrace the nuanced ways in which income distributions in certain places are associated with certain poor outcomes and not others. Research and policy must not simply consider how widespread a relationship is, but also the conditions under which the relationship appears or does not (Small & Feldman, 2012). This preliminary study contributes to a body of research offering insight into conditions under which the relationship between socioeconomic status and health and social outcomes holds. Moreover, it offers insights into which cities and neighborhoods need to be further evaluated for the nuances that contribute to risk and protective factors for injury. Although this study has illuminated some neighbourhood-level associations with injury risk, there is wide variation in rates among different neighbourhoods.

The results of the present study may inform the increasing opportunity to address local differences in injury patterns and severity. In 2009 the Pascal report was released in Ontario and endorsed a model for integrated service provision, which would provide families with public health services, family support programming, and links to broader supports such as housing, recreation, employment, and income assistance, with reflections of the unique needs of individual neighbourhoods. The optimal lead for service system planning and management was identified in the report as the municipal authorities. As part of the move towards integrated service provision, Toronto’s Children’s Services Division has the responsibility to research and promote linkages between direct service providers and health, housing, and job training (City of Toronto, 2010). The Division has thematically grouped various outcomes, including safety
(injury hospitalizations, child abuse and neglect, and offenses against children) (City of Toronto, 2011). Thus, the municipal government appears positioned to address the relationships found in this thesis between housing in need of repair and injury and low education and injury.

An upcoming review of the known impact of injury prevention initiatives that address the determinants of health indicates that countries such as Canada and the USA, that have fairly decentralized governments, have policy environments favourable to municipal intervention, while countries with more centralized governments have policy environments favourable to interventions at a broader state level (Hyndman, 2012). The state of the research currently is unable to assess whether and under what conditions municipal vs. provincial/statewide injury prevention interventions are more effective (Hyndman, 2012), but it appears that due to the Canadian policy context and the unique injury characteristics of Toronto, the municipal government is optimally situated to tailor injury prevention initiatives to the unique needs of the city’s neighbourhoods.

**Practice Implications**

Practice implications of the arbitrary nature of the distinctions among intentional, unintentional, and undetermined intent injuries include the need for health care providers and health records personnel to be reflective about defining intent. Boiler plating of injury classifications among these professionals must be discouraged. Rather than falling into prescriptive practice and routine behaviours, they should be afforded adequate training and resources to record the nature of injuries reflectively, and have input on the basis of their experience into the next iteration of ICD codes. Thus, trends in coding and opportunities for improvement of clinical documentation and communication can be identified. Gibson et al. (2008) and Lorenzoni, Da Cas, and Aparo (2000) have made similar general recommendations in
terms of increasing the quality of ICD coding. A corollary of improved screening and reflective practice regarding intent is that there is added responsibility on professionals such as social workers, nurses, physicians, health care administrators, and lawyers to address intentional injury once it is identified. Refinements in practice are already occurring, in the form of screening programs in health care settings designed to accurately identify “intentional” injuries such as those resulting from violence (e.g., O’Campo, Kirst, Tsamis, Chambers, & Ahmad, 2011; Registered Nurses Association of Ontario, 2005).

However, these programs are not designed to take into account resource levels or fiscal efficiencies outside of the health care system (O’Campo et al., 2011; Registered Nurses Association of Ontario, 2005). Research that documents professionals’ concerns about inadequate or inefficient intervention resources once they do code abuse stresses the importance of advocating for sufficient resources for victims of intentional injury (Rovi & Johnson, 2003).

**Conclusion**

The findings of this study demonstrate the conditional nature of childhood injury, which has also been found in other studies. Much of the challenge for researchers and practitioners in the injury field is to comprehensively address the complexity of injury. A conceptualization and explanation of injury phenomena that is all-encompassing and complete would be prohibitively complex, and difficult to transfer into prevention policies and programs (Volpe, 2004). Although the glimpse of the injury problem provided by ecological studies such as this one is partial and conditional, it can focus the attention of service providers onto social and economic factors outside the individual and family that may contribute to child injury. Indeed, calls for parents by researchers to supervise children vigilantly have often been found to be ideologically-driven and unrealistic given the ongoing demands of daily life, especially when living in poverty.
environments (Roberts, 1996). Mapping the area variation in injury rates can drive policy imaginations in regards to how to address injury risk related to the social determinants of health, by acknowledging that health is a holistic construct that arises from contextual and material conditions. Attention to these factors decreases the focus upon the characteristics and culpability of individual families relating to injury, and more upon the socioeconomic challenges and constraints faced by an increasing proportion of the population. The current culture of parenting that places the burden of responsibility for child safety onto individual parents can informed by studies such as this one that have a wider purview.
References


Hemenway, David. 2009. *While we were sleeping: Success stories in injury and violence prevention.* Berkeley, CA: University of California.


## Appendix A
### Search Strategy

<table>
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<tr>
<th>Database</th>
<th>Search Terms</th>
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<td>PsycINFO 1980 +</td>
<td>(DE=(<em>communities</em> or <em>social environments</em> or <em>neighborhoods</em>)) and(DE=(<em>injuries</em> or <em>burns</em> or <em>head injuries</em> or <em>spinal cord injuries</em> or <em>wounds</em> or <em>accidents</em> or <em>falls</em> or <em>safety</em>)) (Copy Query)</td>
</tr>
<tr>
<td></td>
<td>Date Earliest to 2009</td>
</tr>
<tr>
<td></td>
<td>Range: Limited Age is Neonatal (birth-1 mo) or Infancy (2-23 mo) or Preschool Age (2-5 yrs)</td>
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<tr>
<td>MEDLINE 1996 +</td>
<td>child$.mp. or exp Battered Child Syndrome/ or exp Child Abuse/ or exp Child Health Services/ or exp Child, Preschool/ or exp Child Welfare/ or exp Child/ or exp Child Development/</td>
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<tr>
<td></td>
<td>and accident prevention/ or safety/ or Wounds and Injuries&quot; or injury prevention.mp</td>
</tr>
<tr>
<td></td>
<td>and exp Poverty/ or exp Residence Characteristics/ or neigbo*rhood.mp. or exp Socioeconomic Factors/ or exp Social Environment/</td>
</tr>
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|                   | limit search to ("newborn infant (birth to 1 month)" or "infant (1 to 23 months)" or "preschool child (2 to 5 years)"
<p>| EMBASE            | Community and child/ or infant/ or preschool child/ or child abuse/ or child behavior/ and injury or accident prevention |
| Database contains 1980 - 2009 |                                                                                     |
| All EBM Reviews - Cochrane DSR, ACP Journal Club, DARE, and CCTR | Accident Prevention |
|                   | Child abuse                                                                  |
| ASSIA (applied social | (kw= (infan* or child* or minor* or toddler* or baby* or                                      |
| Database starts from 1991 |                                                                                     |</p>
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<th>Database</th>
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<tr>
<td>Social Work Abstracts 1980-2009</td>
<td>infant or child* or minor* or toddler* or baby or babies and (abuse or maltreat* or neglect* or harm or physical abuse or sex abuse or witness* or child protect* or child welfare or threat or danger or accident prevention or injury prevention) and (community or neighborhood) {Including Limited Related Terms}</td>
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<td>Social Sciences Abstracts Database starts 1984</td>
<td>((Housing or Housing policy or Neighbourhood or Affordable housing or Economics / social aspects or Social problem[s] or public welfare) &lt;in&gt; Keyword AND &lt;br&gt;Date: between 1995 and 2009) And ((Infants/Care) Or (child protection) Or ((Child abuse or Child abuse / prevention or Children s accidents / prevention or Child welfare or Social work with children) &lt;in&gt; Keyword AND &lt;br&gt;Date: between 1995 and 2009)) And ((Child abuse or Child abuse / prevention or Children s accidents / prevention or Child welfare or Social work with children) &lt;in&gt; Keyword AND &lt;br&gt;Date: between 1995 and 2009)</td>
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<td>Social Service Abstracts Date 1995 to 2010</td>
<td>KW=((socioeconomic factors or social environments) or neighborhood* or community*) and KW=((neglect* or maltreat*) or (harm or abuse* or wound*) or (accident* or injur*)) and KW=((child* or children) or (toddler* or baby or babies) or (infant* or minor*))</td>
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<td>CINAHL 1982+</td>
<td>s25  S21 not S24</td>
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<td>S23  (MH &quot;War+&quot;) or (MH &quot;War Crimes+&quot;) or (MM &quot;Chemical Warfare&quot;)</td>
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<td>S22  (MM &quot;Developing Countries&quot;)</td>
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<td>S21  S13 and S20</td>
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<td>S20  S14 or S15 or S16 or S17 or S18 or S19</td>
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<td>S19  &quot;location&quot;</td>
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<td>S18  (&quot;neighborhood&quot;) or (MH &quot;Domain I: Environmental Domain (Omaha)+&quot;)</td>
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<td>S17  neighbourhood</td>
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<td></td>
<td>S15  (MH &quot;Epidemiological Research+&quot;)</td>
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<td></td>
<td>S14  (MM &quot;Prevalence&quot;) or (MH &quot;Cross Sectional Studies&quot;) or (MM &quot;Registries, Trauma&quot;) or (MH &quot;Surveys+&quot;)</td>
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<td>Topic</td>
<td>Description</td>
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<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>S13</td>
<td>S5 and S11</td>
</tr>
<tr>
<td>S12</td>
<td>S5 and S11</td>
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<tr>
<td>S11</td>
<td>S6 or S7 or S8 or S9 or S10</td>
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<tr>
<td>S10</td>
<td>(MH &quot;Child Safety+&quot;)</td>
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<tr>
<td>S9</td>
<td>(MH &quot;Community Health Nursing+&quot;) or (MH &quot;Community Health Services+&quot;) or (MM &quot;Community Networks&quot;)</td>
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<tr>
<td>S8</td>
<td>&quot;injury prevention&quot;</td>
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<tr>
<td>S7</td>
<td>(MM &quot;Community Programs&quot;)</td>
</tr>
<tr>
<td>S6</td>
<td>(MM &quot;Early Childhood Intervention&quot;) or (MH &quot;Early Intervention+&quot;) or (MM &quot;Nursing Interventions&quot;) or (MM &quot;Crisis Intervention&quot;) or (MM &quot;Intervention Trials&quot;) or (MM &quot;Crisis Intervention (Iowa NIC)&quot;)</td>
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<td>S5</td>
<td>S3 NOT S4</td>
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<td>S4</td>
<td>(MH &quot;Violence+&quot;) or (MM &quot;Intimate Partner Violence&quot;)</td>
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<td>S2</td>
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<td>(&quot;Wounds and injuries&quot;) or (MH &quot;Wounds and Injuries+&quot;)</td>
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**Caredata (social work):** AKA Social Care Online 1990s+
- (topic="socioeconomic groups" or topic="community development" or topic="communities") and (topic="emergency health services" or topic="child abuse" or topic="child neglect") and (topic="pre-school children" or topic="young people" or topic="vulnerable children" or topic="children" or topic="babies")

**ERIC:**
- Database: ERIC
- Publication Date: 1995-2010
- Education Level: Postsecondary Education
- Query: KW=((socioeconomic influence) or (socioeconomic background)) or (social environment)) or KW=(neighbo*rhood* or communit*) and KW=(accident* or safety or negligence) or KW=((child abuse) or (child neglect) or injur*) and KW=((preschool children) or (young children) or (child neglect) or (child abuse) or (child neglect) or (young children) or (infant)) or KW=(child or children or toddler) or

**Digital Dissertations @ Scholars Portal:**
- Database: Digital Dissertations @ Scholars Portal
- Query: ((socioeconomic influence) or (socioeconomic background) or (social environment)) or (neighbo*rhood* or communit*) and DE=(accident* or safety or negligence) or DE=(child abuse) or (child neglect) or injur*) and DE=((preschool children) or (young children) or (infant) or
DE=(child or children or toddler*)

Second search:
Query: DE=((preschool child*) or (young child*) or infan*) or DE=(child* or children or toddler*) and (socioeconomic or hous* or neighbo?rhood) or communit* and DE=(accident* or neglect* or injur*)

1995-2010

<table>
<thead>
<tr>
<th>Government Documents</th>
<th>Statistics Canada</th>
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<td>Public Health Agency of Canada</td>
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<td>Index term: prevention or evaluation or effectiveness</td>
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<td>Not adolescent or teen or youth</td>
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</table>
Change in Average Individual Income, City of Toronto, 1970 to 2005

Average Individual Income from all sources, 15 Years and Over, Census Tracts

Source: Statistics Canada, Census 1971, 2006

Cities Centre
Greater Toronto Urban Observatory

1970 to 2005
CHANGE

Change in the Census Tract Average Individual Income as a percentage of the Toronto CMA Average, 1970-2005

- Increase of 20% or More (100 Census Tracts, 19% of the City)
- Increase or Decrease is Less than 20% (208 Census Tracts, 40% of the City)
- Decrease of 20% or More (206 Census Tracts, 40% of the City)

Note: Census Tract 2001 boundaries shown. Census Tracts with no income data for 1970 or 2005 are excluded from the analysis. There were 527 total census tracts in 2001.
### Appendix C
Framework for Injury Classification, ICD 10

<table>
<thead>
<tr>
<th>Cause</th>
<th>Unintentional</th>
<th>Intentional</th>
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<tr>
<td>Cut/pierce</td>
<td>W25-29</td>
<td>X99</td>
</tr>
<tr>
<td>Drowning/submersion</td>
<td>W65-74</td>
<td>X92</td>
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<tr>
<td>Falls</td>
<td>W00-19</td>
<td>Y01</td>
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<tr>
<td>Fire</td>
<td>X00-09</td>
<td>X76</td>
</tr>
<tr>
<td>Hot object/substance</td>
<td>X10-19</td>
<td>X77</td>
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<tr>
<td>Poisoning</td>
<td>X40-49</td>
<td>X85-89</td>
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<tr>
<td>Struck by object or person</td>
<td>W20-22, W50-52</td>
<td>Y00, Y04</td>
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<td>Suffocation</td>
<td>W75-84</td>
<td>X91</td>
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<td>V30-V79 (.4-.9), V83-86 (.0-.3)</td>
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<td></td>
<td>V12-V14 (.3-.9), V19 (.4-.6)</td>
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</tr>
<tr>
<td></td>
<td>V02-04 (.1-.9), V09 (.2)</td>
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<tr>
<td>• Occupant</td>
<td>V30-79 (.4-.9) V83-86 (.0-.3)</td>
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</tr>
<tr>
<td>• Pedal Cyclist</td>
<td>V10-11, V12-14 (.0-.2)</td>
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<tr>
<td>• Pedestrian</td>
<td>V02-04 (.1-.9), V09 (.2)</td>
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</table>

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15 Source: Christoffel & Gallagher (2006).
Appendix D

University of Toronto
Office of the Vice-President, Research
Office of Research Ethics

PROTOCOL REFERENCE #21673

Dr. David Hulchanski
Faculty of Social Work
246 Bloor Street W
Toronto, ON M5S 1A1

Ms. Tanya Morton
Faculty of Social Work
246 Bloor Street W
Toronto, ON M5S 1A1

November 17, 2008

Dear Dr. Hulchanski and Ms. Morton:

Re: Your research protocol entitled “Childhood Injury: A Study of Neighbourhood Correlates in Toronto, ON” by Prof. D. Hulchanski (supervisor), Ms. T. Morton (PhD candidate)

ETHICS APPROVAL

Original Approval Date: December 17, 2007
Expiry Date: December 16, 2009
Continuing Review Level: 1*
Renewal: 1 of 4

We are writing to advise you that the Health Sciences Research Ethics Board has granted annual renewal of ethics approval to the above referenced research study through the REB’s expedited process. Please note that all protocols involving ongoing data collection or interaction with human subjects are subject to re-evaluation after 5 years. Ongoing projects must be renewed prior to the expiry date.

Any changes to the approved protocol or consent materials must be reviewed and approved through the amendment process prior to its implementation. Any adverse or unanticipated events should be reported to the Office of Research Ethics as soon as possible.

Best wishes for the successful completion of your project.

Yours sincerely,

Marianna Richardson
Research Ethics Coordinator

*See Continuing Review Guidelines on the Office of Research Ethics website -

Appendix E

Table 20
Grand Means and 95% Confidence Intervals of Pairwise Differences in Mean Changes, Overall Injury Categories

<table>
<thead>
<tr>
<th>Neighbourhood Income Trends</th>
<th>Mean</th>
<th>SD</th>
<th>Declining</th>
<th>Mixed Trends</th>
<th>$\eta^2$</th>
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</thead>
<tbody>
<tr>
<td>Any Rate Overall</td>
<td>83.66</td>
<td>23.03</td>
<td>2.76 to 15.75†</td>
<td>-12.10 to 0.93</td>
<td>.09</td>
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<td>Improving</td>
<td>85.20</td>
<td>21.02</td>
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<td>-2.86 to 4.23</td>
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<td>90.78</td>
<td>24.30</td>
<td>5.78 to 11.18*</td>
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<td>Declining</td>
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<td>Fall Rate Overall</td>
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<td>.12</td>
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<td>11.80</td>
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<tr>
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<td></td>
</tr>
<tr>
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<tr>
<td>Poisoning Rate Overall</td>
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<td></td>
<td></td>
<td>.03</td>
</tr>
<tr>
<td>Improving</td>
<td>2.51</td>
<td>2.07</td>
<td>-0.80 to 0.03</td>
<td>-0.98 to -.09*</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>2.99</td>
<td>2.11</td>
<td>0.24 to 0.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>2.26</td>
<td>1.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burn Rate Overall</td>
<td>2.05</td>
<td>1.62</td>
<td></td>
<td></td>
<td>.01</td>
</tr>
<tr>
<td>Improving</td>
<td>1.68</td>
<td>1.38</td>
<td>-0.80 to 0.03</td>
<td>-0.98 to -.09*</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>2.21</td>
<td>1.81</td>
<td>-0.24 to 0.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>2.07</td>
<td>1.49</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05 using the Games-Howell procedure for unequal variances.
†p < .05 using the Bonferroni procedure for equal variances.
One-way ANOVAs were conducted, as shown in Table 20, to evaluate the relationships between neighbourhood income trends and the four overall injury outcomes. As previously mentioned in this paper, three levels constitute neighbourhood income trends (improving neighbourhoods, mixed-trends neighbourhoods, and deteriorating neighbourhoods). First, a one-way ANOVA was conducted to test for variation in the overall childhood injury rate among the three levels of neighbourhood income trend. The strength of the relationship between neighbourhood income trends and the adjusted rate of overall injury, as assessed by $\eta^2$, was medium, with neighbourhood income trends accounting for 9% of the variance of the any adjusted injury rate. The ANOVA was significant \( F(2, 500) = 23.12, p < .01 \). Levene’s test for equality of variances indicates variances did not differ significantly from each other \( p > .05 \). Follow-up tests were conducted to evaluate pair-wise differences among the means. Post hoc comparisons were conducted with the Bonferroni test. The results displayed that declining income trend neighbourhoods had a significantly lower mean overall injury rate than both the mixed income trends neighbourhoods and the improving income trends neighbourhoods. The comparison between improving and mixed income trends neighbourhoods was not significant in terms of mean overall rates.

Second, a one-way ANOVA was conducted on the relationship between neighbourhood income trends and fall rates. The ANOVA was significant \( F(2, 504) = 34.25, p < .01 \). Follow-up tests were conducted to evaluate pair-wise differences among means. The strength of the relationship between neighbourhood income trends and the overall fall rate, as assessed by $\eta^2$, was medium, with neighbourhood income trends accounting for 12% of the variance of the adjusted fall rate. Based on the results of Levene’s test, there was no assumption the variances were homogenous and post hoc comparisons were conducted with the Games-Howell test. The
declining income trends condition displayed a significantly lower mean than both the improving income trends condition and the mixed trends condition. However, the improving income trends condition and the mixed income trends condition were not significantly different from each other in terms of mean fall rates.

Third, a one way ANOVA was conducted to compare the relationship between the three levels of neighbourhood income trends and the overall poisoning rate. As assessed by $\eta^2$, the magnitude of the effect was small, with neighbourhood income trends accounted for 3% of the variance in the adjusted poisoning rate. The ANOVA was significant $[F(2, 504) = 7.46, p < .01]$. Levene’s test for equality of variances indicates variances for differ significantly from each other ($p < .01$). Therefore, follow up tests were conducted using Games-Howell and revealed that there was a significant difference between the mixed income trends and the declining income trends conditions only, with the mixed income trends group having the higher mean. Comparisons between the improving trends group and the other two groups did not reach significance.

Finally, a one-way ANOVA was conducted to assess the relationship between neighbourhood income trends and the overall burn rate. The strength of the relationship between neighbourhood income trends and the overall burn rate, as assessed by $\eta^2$, was low. Neighbourhood income trends accounted for just 1.4% of the variance of the burn rate. The overall F test was significant $[F = (2, 503) = 3.60, p < .05]$. Follow-up tests using the Games-Howell test, a test that does not assume equal variances among groups, demonstrated that the mixed income trends group had a significantly higher mean than the improving income trends group. Comparisons between the declining group and the other two groups were not significant.

Summary of results for Research Questions #2
All of the injury outcomes displayed a significant overall relationship with neighbourhood income trends, but as would be expected, not every pairwise comparison reached significance. The number of outliers removed for the one-way ANOVA analyses ranged between 3 and 7. Analyses were repeated with and without outliers. The removal of outliers changed the overall results of one analyses. Removing outliers changed the significance of the results for the burn outcome. The overall F test was non-significant when outliers were included, but it reached significance when the 4 outliers for this analysis were excluded. In the latter case, the pairwise comparison between the improving income trends neighbourhoods and the mixed trends neighbourhood reached significance. However, the order of the mean scores did not change, with the improving income trends category having the lowest burn rate and the mixed trends category having the highest rate.

In summary, injury outcomes displayed a significant relationship with neighbourhood income trends. With the exception of the burn outcome, the pattern was for the declining income trends neighbourhoods to have the lowest mean injury rates and the mixed trends city to have the highest mean injury rates. Based on the results of the analyses, the declining income trends category appears to have some unique properties in comparison to the mixed trends and improving income trends categories.

Research Questions #3: Is there a relationship in the population between neighbourhood income trends and injury rates, namely, boys adjusted injury rate overall, girls adjusted injury rate overall, boys adjusted fall rate overall, girls adjusted fall rate overall, boys adjusted poisoning rate overall, girls adjusted poisoning rate overall, boys adjusted burn rate overall, and girls adjusted burn rate overall?
Table 21
*Grand Means and 95% Confidence Intervals of Pairwise Differences in Changes in Means, Injury Rate by Gender*

<table>
<thead>
<tr>
<th>Neighbourhood Income Trends</th>
<th>Mean</th>
<th>SD</th>
<th>Declining</th>
<th>Mixed Trends</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Injury Rate Boys</td>
<td>94.70</td>
<td>30.25</td>
<td></td>
<td></td>
<td>.07</td>
</tr>
<tr>
<td>Improving</td>
<td>96.54</td>
<td>29.57</td>
<td>3.13 to 19.34*</td>
<td>-15.59 to 2.21</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>103.23</td>
<td>33.17</td>
<td>11.15 to 24.71*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>85.29</td>
<td>24.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Injury Rate Girls</td>
<td>72.41</td>
<td>23.35</td>
<td></td>
<td></td>
<td>.06</td>
</tr>
<tr>
<td>Improving</td>
<td>73.29</td>
<td>20.55</td>
<td>1.23 to 13.13*</td>
<td>-11.47 to 1.45</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>78.30</td>
<td>25.62</td>
<td>6.76 to 17.61*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>66.11</td>
<td>20.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Rate Boys</td>
<td>43.50</td>
<td>15.50</td>
<td></td>
<td></td>
<td>.09</td>
</tr>
<tr>
<td>Improving</td>
<td>47.15</td>
<td>15.10</td>
<td>5.18 to 13.48*</td>
<td>-4.82 to 4.27</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>47.43</td>
<td>16.77</td>
<td>6.16 to 13.04*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>37.83</td>
<td>12.36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Rate Girls</td>
<td>33.28</td>
<td>12.67</td>
<td></td>
<td></td>
<td>.08</td>
</tr>
<tr>
<td>Improving</td>
<td>36.84</td>
<td>12.98</td>
<td>4.29 to 11.31*</td>
<td>-2.81 to 4.89</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>35.80</td>
<td>13.83</td>
<td>3.96 to 9.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>29.04</td>
<td>9.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poisoning Rate Boys</td>
<td>2.96</td>
<td>2.63</td>
<td></td>
<td></td>
<td>.01</td>
</tr>
<tr>
<td>Improving</td>
<td>3.08</td>
<td>2.81</td>
<td>-0.40 to 1.14</td>
<td>-0.92 to 0.72</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>3.18</td>
<td>2.87</td>
<td>-0.13 to 1.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>2.70</td>
<td>2.26</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As shown in Table 21, a one-way ANOVA was first conducted to assess the relationship among neighbourhood income trends on injury rates for boys. There was a significant relationship with neighbourhood income category and the injury rate for boys \(F(2, 504) = 19.48, p < .01\]. The strength of the relationship between neighbourhood income trends and the adjusted rate of overall injury for boys, as indicated in Table 9, was medium. As assessed by \(\eta^2\), neighbourhood income trends accounted for 7% of the variance of the boys overall injury rate. Follow-up tests were conducted to evaluate pair-wise differences among the means. Levene’s test for equality of variances indicates variances differed significantly from each other; therefore, post hoc comparisons were conducted with the Games-Howell test. These comparisons revealed the declining neighbourhood trends category had a significantly lower mean rate than the mixed
trends neighbourhood income category and the improving neighbourhood income category. The improving neighbourhood trends category and the mixed neighbourhood trends category did not appear significantly different in terms of overall injury rates for boys.

Second, a one-way ANOVA was used to test for differences in the overall injury rate for girls among the three categories of neighbourhood income trend. The ANOVA was significant \( F(2, 503) = 14.7, p < .01 \). The strength of the relationship between neighbourhood income trends and the adjusted rate of overall injury for girls, as assessed by \( \eta^2 \), was medium, with neighbourhood income trends accounting for 6% of the variance of the girls overall injury rate. Follow-up tests were conducted to evaluate pairwise differences among the means. Levene’s test for equality of variances indicates variances for this outcome differ significantly from each other. Therefore, post hoc comparisons were performed with the Games-Howell test again. The post hoc comparisons revealed the declining neighbourhood trends category had a significantly lower mean girls’ overall injury rate than the mixed trends neighbourhood income category and the improving neighbourhood income category. The comparisons between the improving neighbourhood trends category and the mixed neighbourhood trends category were not statistically significant.

Third, a one-way ANOVA was conducted to compare the relationship between the three levels of neighbourhood income trends and the fall rate for boys. There was a significant relationship between neighbourhood income trends and the fall rate of boys \( F(2, 502) =25.13, p < .01 \). The effect size, as assessed by \( \eta^2 \), was medium, with neighbourhood income trends accounting for 9% of the variance for the overall boys fall injury rate. Levene’s test for equality of variances indicates variances differ significantly from each other. Thus, the Games-Howell follow-up test for unequal variances revealed there were significant differences between
improving income trends neighbourhoods and declining income trends neighbourhoods, with the declining neighbourhoods having the lowest mean rate. Comparisons between the mixed trends neighbourhoods and declining trends neighbourhood indicated the declining trends neighbourhood also had a significantly lower rate than the mixed trends neighbourhoods. The comparisons between the mixed trends and improving trends group were not significant.

Fourth, a one-way ANOVA was conducted to evaluate the relationship between neighbourhood income trends and girls’ fall outcomes. The ANOVA for the fall rate for girls was significant, \([F (2, 503) = 20.86, p < .01]\). The effect size, as assessed by \(\eta^2\), was medium, with neighbourhood income trends accounting for 8% of the variance for the overall girls fall injury rate. Levene’s test for equality of variances indicates variances differ significantly from each other. Thus, follow up tests as per Games-Howell revealed there were significant differences between the improving income trends neighbourhoods and declining income trends neighbourhoods, and the mixed trends neighbourhoods and declining trends neighbourhoods. The declining income trends group showed the lowest rate of injuries in comparison to the mixed trend and the improving trend group. There were no significant differences between the mixed trends and the improving trends groups.

Fifth, a one-way ANOVA was used to assess the relationship among the different levels of neighbourhood income trends and the rate of poisoning for boys. The relationship was not statistically significant \([F (2, 501) = 1.75, p > .05]\). The strength of the relationship between neighbourhood income trends and the adjusted rate of overall poisoning for boys, as assessed by \(\eta^2\), was small, with neighbourhood income trends accounting for less than 1% of the variance of the boys poisoning rate. Follow up tests were not conducted.
Sixth, a one-way ANOVA was used to test for girls’ poisoning rate differences among three neighbourhood income trend conditions. The ANOVA for the adjusted poisoning rate for girls was significant \( [F (2, 503) = 4.17, p < .01] \). The strength of the relationship between neighbourhood income trends and the adjusted rate of overall poisoning for girls, as assessed by \( \eta^2 \), was small, with neighbourhood income trends accounting for 2% of the variance of the girls poisoning rate. Levene’s test for equality of variances indicated variances differ significantly from each other \( (p < .01) \). Follow-up tests using Games-Howell indicated that the declining trends condition was significantly lower in terms of mean girls’ poisoning rates than the mixed trends condition. The improving trends condition did not differ significantly from the mixed trends and declining trends conditions.

Finally, one-way ANOVAs were used to assess the relationship between neighbourhood income trends and burn outcomes for boys and girls, respectively. There was no significant effect of neighbourhood income trends on burn outcomes for boys \( [F (2, 501) = 1.00, p > .05] \). In addition, the relationship among neighbourhood income trends and burn rate for girls was not significant \( [F (2, 498) = 0.942, p > .05] \). Therefore, follow-up tests were not conducted. The effect sizes were negligible.

**Summary of Results for Research Questions #3**

The same basic patterns can be seen in the two tables. Specifically, significant results are found for overall injury, falls, and poisoning, but results for burn injuries seldom reached significance. For overall injury and falls, the declining neighbourhood trends group appears significantly different from the improving neighbourhood trends group and the mixed trends group. However, the improving trends group and the mixed trends group appear to be more
similar to each other than the declining trends group. The declining trends group appears to have unique characteristics in comparison to the other income trend groups.

The number of outliers removed for these analyses ranged from 3 to 9 data points. Analyses were repeated with and without outliers. The removal of outliers did not change the overall results except for the boys poisoning outcomes. Including the 6 outliers changed the results for the boys poisoning outcome because the F test became significant at the .05 level when the outliers were included. Only the pairwise comparison between the mixed trends and declining trends condition was significant when outliers were included, with the declining trends condition having the lowest boys mean poisoning rate. However, the order of the mean injury rates remained the same, with the declining income category displaying the lowest mean rate, and the mixed trends category having the highest mean rate.

In summary, injury outcomes for boys and girls displayed generally significant relationships with neighbourhood income trends. When significant results were obtained, the declining income trends condition had the lowest mean injury rates. The pattern was for the declining income trends neighbourhoods to have the lowest mean injury rates and the mixed trends neighbourhood to have the highest mean injury rates. Based on the results of the pairwise tests, the declining income trends category appears to have some unique properties in comparison to the mixed trends and improving income trends categories.

The injury rates for boys were consistently higher than that for girls, a finding that is congruous with other research (i.e., Kohen, Soubhi, & Raina, 2000; Macpherson et al., 2005). Injury rates do not appear to differ across neighbourhood income categories for one gender but not the other. If such an interaction had been present, it may call for further investigation with
respect to why and to what extent neighbourhood category exerts a differential effect on one gender but not the other.

Research Questions #4

Is there a mean difference in injury rates for the four different injury types and three different age groups, among the three populations: Improving Income Trends, Mixed Income Trends, and Declining Income Trends?

Table 22

Grand means and 95% Confidence Intervals of Pairwise Differences in Changes in Means,

Injury Outcomes Stratified by Age

<table>
<thead>
<tr>
<th>Neighbourhood Income Trends</th>
<th>Mean</th>
<th>SD</th>
<th>Declining</th>
<th>Mixed Trends</th>
<th>( \eta^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Rate Overall age 0-1</td>
<td>81.74</td>
<td>28.33</td>
<td>-5.24 to 9.10</td>
<td>-19.00 to -3.43*</td>
<td>.05</td>
</tr>
<tr>
<td>Improving</td>
<td>78.01</td>
<td>24.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>89.23</td>
<td>31.27</td>
<td>6.51 to 19.78*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>76.08</td>
<td>25.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Rate Overall age 2-4</td>
<td>92.50</td>
<td>30.32</td>
<td>4.09 to 20.35*</td>
<td>-16.60 to 1.19</td>
<td>.09</td>
</tr>
<tr>
<td>Improving</td>
<td>94.29</td>
<td>29.74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>102.00</td>
<td>32.82</td>
<td>13.21 to 26.65*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>82.07</td>
<td>24.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Rate Overall age 5-6</td>
<td>144.20</td>
<td>56.12</td>
<td>6.68 to 38.73*</td>
<td>-18.19 to 16.57</td>
<td>.04</td>
</tr>
<tr>
<td>Improving</td>
<td>153.03</td>
<td>58.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>153.84</td>
<td>61.52</td>
<td>10.93 to 36.09*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>130.32</td>
<td>45.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Rate Age 0-1</td>
<td>40.15</td>
<td>16.76</td>
<td></td>
<td></td>
<td>.06</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>------------------------</td>
<td>---------</td>
<td>--------</td>
<td>------------------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>Improving</td>
<td>40.14</td>
<td>15.45</td>
<td>0.20 to 8.85*</td>
<td>-9.37 to .25</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>44.70</td>
<td>18.82</td>
<td>5.23 to 12.93*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>35.62</td>
<td>13.77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Rate Age 2-4</td>
<td>41.00</td>
<td>15.18</td>
<td>.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving</td>
<td>45.55</td>
<td>15.77</td>
<td>6.20 to 14.82*</td>
<td>-3.80 to 5.29</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>44.80</td>
<td>15.35</td>
<td>6.48 to 13.04*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>35.04</td>
<td>12.58</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall Rate Age 5-6</td>
<td>65.92</td>
<td>31.40</td>
<td>.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving</td>
<td>77.63</td>
<td>35.31</td>
<td>10.64 to 29.51*</td>
<td>-1.11 to 19.03</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>68.67</td>
<td>33.12</td>
<td>4.32 to 17.90*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>57.56</td>
<td>24.81</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poisoning Rate Age 0-1</td>
<td>3.48</td>
<td>3.47</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving</td>
<td>3.20</td>
<td>3.46</td>
<td>-1.7 to .36</td>
<td>-1.00 to .96</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>3.88</td>
<td>3.70</td>
<td>-.15 to 1.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>3.22</td>
<td>3.19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poisoning Rate Age 2-4</td>
<td>2.90</td>
<td>2.93</td>
<td>.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving</td>
<td>2.84</td>
<td>3.17</td>
<td>-.050 to 1.21</td>
<td>-1.164 to .27</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>3.33</td>
<td>3.24</td>
<td>0.33 to 1.75*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>2.49</td>
<td>2.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poisoning Rate Age 5-6</td>
<td>2.04</td>
<td>4.27</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving</td>
<td>1.72</td>
<td>3.95</td>
<td>-1.25 to 1.00</td>
<td>-1.93 to .55</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>2.41</td>
<td>4.88</td>
<td>-0.45 to 1.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>1.84</td>
<td>3.74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burn Age 0-1</td>
<td>3.91</td>
<td>3.97</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>------</td>
<td>------</td>
<td>-----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving</td>
<td>3.26</td>
<td>3.64</td>
<td>-1.93 to 0.41</td>
<td>-2.03 to 0.32</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
<td>4.03</td>
<td>4.37</td>
<td>-1.04 to 0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declining</td>
<td>4.12</td>
<td>3.69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burn Age 2-4</td>
<td>1.48</td>
<td>1.89</td>
<td>.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving</td>
<td>1.43</td>
<td>2.05</td>
<td>-0.54 to 0.59</td>
<td>-0.75 to 0.44</td>
<td></td>
</tr>
<tr>
<td>Mixed Trends</td>
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<td>2.01</td>
<td>-0.25 to 0.61</td>
<td></td>
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</tr>
<tr>
<td>Declining</td>
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<td>1.69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burn Age 5-6</td>
<td>1.12</td>
<td>2.35</td>
<td>.01</td>
<td></td>
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</tr>
<tr>
<td>Improving</td>
<td>0.66</td>
<td>2.10</td>
<td>-1.25 to 0.01</td>
<td>-1.19 to 0.12</td>
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</tr>
<tr>
<td>Mixed Trends</td>
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<td>2.52</td>
<td>-0.66 to 0.48</td>
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<tr>
<td>Declining</td>
<td>1.28</td>
<td>2.28</td>
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</table>

Table 22 displays the results to the set of research questions that assess the difference in means amongst overall injuries, falls, poisoning, and burn injuries by age group. The age groups are categorized into 0-1 year olds, 2-4 year olds, and 5-6 year olds. First, a one-way ANOVA was performed to examine the association among neighbourhood income trends and overall injury to children aged 0 to 1 year. There was a significant association among neighbourhood income trends and overall injuries to 0 to 1 year olds, for the three conditions \( F(2, 502) = 12.34, p < .001 \). Post hoc comparisons using the Games-Howell test indicated that the mean rate for the improving income trends category was significantly lower than the mixed trends category. In addition, the declining trends category displayed a mean significantly lower than the mixed trends category. The effect size, as estimated by \( \eta^2 \) was small, with 5% of the variance in the overall 0-1 year old injury rate being accounted for by the neighbourhood income trends.
Second, a one-way ANOVA was performed on the same outcome, but for children aged 2 to 4 years, with neighbourhood trends as the factor. Rates of overall injury varied significantly across the three neighbourhood categories, $F(2, 503) = 24.24, p < .001$. For the one-way ANOVA, $\eta^2 = .09$, representing a medium effect size. Because the variances were deemed heterogeneous according to Levene’s test, post hoc comparisons were performed with the Games-Howell procedure. The results indicated that the declining trends group had a significantly lower mean rate than the improving trends group and the mixed trends group. However, the differences between the improving and mixed trends group was not statistically significant.

Third, a one-way ANOVA was performed to evaluate differences in the overall injury rate for 5 to 6 year olds among the three neighbourhood income categories. There was a significant association among the neighbourhood income categories on overall injuries to 5 to 6 year olds, $F(2, 505) = 11.67, p < .001$. Because Levene’s test indicated that the variances were not homogenous, the Games-Howell post hoc test is presented as an alternative to Bonferroni. The pattern of results is similar to those of the 2 to 4 year olds. Results indicated that the declining trends group had a significantly lower mean rate than the improving trends group and the mixed trends group. However, the differences between the improving and mixed trends group was not statistically significant. For the one-way ANOVA, $\eta^2 = .04$, representing a small effect size.

Fourth, a one-way ANOVA was undertaken to test for fall rate differences among the three neighbourhood income trends groups for 0 to 1 year olds. The ANOVA was significant, $F(2, 502) = 15.77, p < .001$. Equal variances were not assumed based on the results of Levene’s test and post hoc tests were undertaken with the Games-Howell. There was a significant
difference in the means between the declining income trends group and the mixed trends group. There was also a significant difference between the declining trends group and the improving trends group. Again, the declining trends group had the lowest mean fall rate and the mixed trends group the highest. There were no significant differences between the improving trends and mixed trends group. The effect size, as estimated by $\eta^2$ was medium, with 6% of the variance in the 2-4 year old fall rate being accounted for by the neighbourhood income trends.

Fifth, a one-way ANOVA was conducted to evaluate the association among the three categories of neighbourhood income trend and the fall rate for 2 to 4 year olds. Mean fall rates differed significantly across the three categories, $F(2, 501) = 29.50, p < .001$. Based on Levene’s test, there was no assumption variances were equal, and post hoc tests were conducted using the Games-Howell. Based on the results of this test, the declining trends income category had a significantly lower mean fall injury rate than both the improving and mixed trends category. The mixed trends category had the highest mean fall injury rate for 2-4 year olds; however, the mean difference between the mixed trends and improving trends categories was non-significant. The magnitude of the relationship as assessed by $\eta^2$ was medium, with neighbourhood income category accounting for 11% of the variance of the dependent variable.

Sixth, a one-way ANOVA was performed to assess the relationship between neighbourhood income trends and the fall rate for 5 to 6 year olds. There was a significant effect of neighbourhood income category on the 5 to 6 year old fall rate, $F(2, 505) = 15.63, p < .001$. In this analysis, the homogeneity of variance assumption was violated and alternative statistics are presented in the form of the Games-Howell test. This test revealed that the declining trends income category had a significantly lower mean fall injury rate than both the improving and mixed trends category. The mixed trends category had the highest mean fall injury rate for 5 to 6
year olds, but the mean difference between the mixed trends and improving trends categories did not approach significance. The η2 was medium and indicated that 6% of the variance in the 5 to 6 year old fall rate could be explained by neighbourhood income categories.

Seventh, a one-way ANOVA was conducted to compare the relationship among neighbourhood income trends and the poisoning rate for 0 to 1 year olds. There was no significant relationship between neighbourhood income trends in the three categories and the 0 to 1 year old poisoning rate \( [F(2, 504) = 2.22, p = .11] \). These results suggest that neighbourhood income category does not have a relationship with the 0 to 1 year old poisoning rate. Follow up tests were not conducted. Not surprisingly, the magnitude of the effect as assessed by η2 was low, with neighbourhood income trends accounting for 1% of the variance in the dependent variable.

Eighth, a one-way ANOVA was conducted to test for differences in the 2 to 4 year old poisoning rate among the three neighbourhood income trend groups. There were significant differences in the 2 to 4 year old poisoning rate among the three groups of neighbourhoods \( [F(2, 507) = 4.27, p < .05] \). To further assess the differences among the means, the Games-Howell procedure for unequal variances was employed. There was a significant difference in the pairwise comparisons between the mixed trends neighbourhood category and the declining neighbourhood trends category only, with the declining trends category having the lowest mean rate. There were no significant differences in outcome between the improving and mixed trends neighbourhood groups or the improving neighbourhood trends group and declining trends group. For the one-way ANOVA, η2 = .02, representing a small effect size.

Ninth, a one-way ANOVA was performed to test for differences in the mean level of poisoning among 5 to 6 year olds among the three neighbourhood income trends conditions.
Thus, post hoc tests were not conducted. The ANOVA did not reach significance, $F(2, 504) = 1.242, p = .29$, and post hoc tests were not undertaken. Not surprisingly, the magnitude of the effect as assessed by $\eta^2$ was small, with the neighbourhood income trends factor accounting for 1% of the variance in the 5 to 6 year old poisoning rate.

Tenth, a one-way ANOVA was undertaken to test for differences among the three levels of neighbourhood income trend on the fire and burn rate for 0 to 1 year olds. There were no statistically significant differences between group means [$F(2,504) = 1.66, p = .19$]. Therefore, follow-up tests were not conducted to assess the pairwise differences between means. For the one-way ANOVA, $\eta^2 = .01$, representing a small effect size.

Eleventh, a one-way ANOVA was conducted to compare the effect of neighbourhood income trends on the burn rate for 2 to 4 year olds. There were no statistically significant differences among group means as determined by the one-way ANOVA [$F(2, 501) = .498, p = .608$]. Therefore, post hoc tests to compare the pairwise differences between means were unnecessary. The strength of the relationship between neighbourhood income trends and burn rate for 2 to 4 year olds was weak. As shown by $\eta^2$, neighbourhood income trends accounted for less than 1% of the variance of the outcome variable.

Finally, a one-way ANOVA was conducted to determine the relationship among neighbourhood income trends on rates of burns for 5 to 6 year olds. There was no significant relationship between neighbourhood income trends in the three categories and the 5 to 6 year old burn rate [$F(2, 495) = 2.47, p = .09$]. Post hoc tests were not undertaken. The effect size, as estimated by CityGroup and fire/hot object or substance injuries among 5-6 year olds was weak, with only 1% of the variance in burns among 5 to 6 year olds accounted for by neighbourhood income trends.
Summary of Results for set of Research Questions # 4

When the results are broken down by age category, the overall pattern suggests that the mixed income category of neighbourhood had the highest mean rates of injury across age categories. The exceptions were the fall rates for 2 to 4 year olds and 5 to 6 year olds. These rates were highest for the improving income neighbourhood category. Significant results tended to occur for overall injuries and fall injuries but not poisoning and burn injuries. The very low rate of poisoning among 5 to 6 year olds is corroborated by Agran et al.’s (2003) breakdown of injury causes by age. The more mature 5 to 6 year olds appear less vulnerable to consuming poisonous substances than younger children.

Between 2 and 10 outliers inclusive were removed from the analysis for the second set of research questions in objective 2. For the poisoning rate for 0 to 1 year olds, the significance of the F test changed to reflect a significant result when 6 outliers were included. The post hoc comparison between the declining neighbourhood category and the mixed trends category became significant. However, the overall pattern of results did not change for this age and injury category, with the mixed trends condition displaying the highest mean rate and the declining trends condition displaying the lowest mean rate. With respect to the burn rate for 5 to 6 year olds, the significance of the F test changed when 12 outliers were included in the analysis. The pairwise comparison between the improving and declining neighbourhood condition changed from bordering on significance (p = .05) to significant (p = .01).