Neighbourhood Effects on Hospitalization in Early Childhood

Lan T.H. Vu, MD, PhD,¹ Nazeem Muhajarine, PhD²

ABSTRACT

Objective: To determine whether characteristics of neighbourhoods in which children live, such as socio-economic disadvantage, physical infrastructure, programs and services, social disconnection, smoking prevalence, and overcrowding, are related to hospitalization rates from birth to age six, independent of individual-level factors.

Methods: We studied a population of 8,504 children born in Saskatoon, Canada, over a three-year period (1992-1994). The birth cohort was retrospectively followed until children reached age six. Birth registry records were linked to health care utilization files to create continuous histories of health care utilization for each child. Information on the neighbourhood in which the child’s family resided at his or her birth was extracted from Statistics Canada’s 1991 Census and numerous local sources. A longitudinal and multilevel design was employed to examine the effect of neighbourhood characteristics and individual-level factors on childhood hospitalization rate.

Results: Male children, children born to mothers under 20 years of age, Aboriginal children, children in low-income families, and those with adverse birth outcomes had significantly higher rates of hospitalization. In addition to these individual factors, children living in economically disadvantaged neighbourhoods, neighbourhoods in poor physical condition, and neighbourhoods with higher average household size had significantly higher rates of hospitalization.

Conclusions: The kind of neighbourhood families live in has an impact on their children’s risk of hospitalization, above and beyond the family’s own characteristics. These findings provide additional support for a ‘healthy community’ approach that uses community development and healthy public policy to create safe, health-promoting neighbourhoods for all families.

Key words: Children’s hospitalization; neighbourhood effects; adverse birth outcomes; family income status

This study employed a longitudinal and multilevel design to examine the impact of neighbourhood characteristics on hospitalization rates in early childhood, including not only socio-economic disadvantage, but also physical infrastructure, programs and services, social disconnection, smoking prevalence, and household size.

METHODS

Source population and data extraction

The study employed a population sample of 8,504 singleton children born between April 1, 1992 and March 31, 1994 in the city of Saskatoon (population approximately 230,000), Saskatchewan, Canada. Births were identified through the registry of the provincial government’s vital statistics branch. Birth registry records for the cohort were then linked to health care utilization files maintained by the health ministry to create continuous histories of health care utilization from birth to six years of age.

For each child, the neighbourhood of residence at birth was identified. Neighbourhoods in this study are specific geo-spatial units with identifiable boundaries, defined by the municipal government and recognized by city residents. Information on neighbourhood characteristics was obtained from Statistics Canada’s 1991 census and local data sources, such as the municipal planning department and custom-developed neighbourhood surveys.

Study outcome

The outcome studied was hospitalization rate, a count measure calculated by dividing the number of hospitalizations from birth to...
age six by total number of children observed. Hospitalization was
defined as any contact with the health care system involving an
overnight hospital stay of one or more days. If a child was hospi-
talized more than once, each episode was counted as a separate hos-
pitalization.

**Predictor variables**

We examined the influence on hospitalization rate of factors at two
levels: individual and neighbourhood. Individual-level variables
relate to parents and children. Parental factors were: marital status
(married/common-law, single parent, and unknown), mother’s age
(<20 years, 20–40 years, and >40 years), and father’s age (same
categories as mother’s age). In addition, family socio-economic status
was measured using an annual assessment of whether the child’s
family had received government income support. Variables related
to children were: Aboriginal status, gender, age, and birth outcome
status (normal birth, one adverse birth outcome such as preterm or
low birth weight, and two or more adverse birth outcomes).

At the neighbourhood level, six factors were examined. Four of
the six domains were derived from principal component analysis of
multiple items relating to neighbourhood context (socio-economic
disadvantage, physical condition, social disconnection, and avail-
ability and accessibility of programs and services for young children),
and two domains consisted of single items (average
household size, smoking prevalence). The constructs reflected in
each domain are some of the key neighbourhood factors that have
been theorized to influence children’s growth and develop-
ment. The Appendix presents the variable items comprising each domain.

**Statistical approach**

We employed a three-stage strategy to build multilevel models
for hospitalization rate. The first model was fitted with no explana-
tory variables and the second model included individual-level vari-
ables. Individual-level variables were entered one at a time as
random effects; if a significant variance component was reported,
the variable was kept as a random effect; otherwise the variable was
constrained to be fixed across neighbourhoods. Finally, in the third
stage, variables at both neighbourhood and individual levels were
included, to test for the effects of neighbourhood variables inde-
pendent of the individual-level variables. The goodness of fit of the
model was evaluated by examining the change in variance among
the three models. In the second model, the variance at the indi-
nual level was significant (p=0.03); in the final model, with the
addition of neighbourhood factors, this variance became non-
significant (p=0.9), indicating the improvement of the model fit
when neighbourhood factors were added.

A three-level non-linear Poisson model was built for the hospi-
talization rate. Level 1 accounted for repeated measurements nest-
ed within an individual subject, such as yearly recipient status of
income assistance from birth to six years. Level 2 accounted for
individual-level non-repeated variables, and Level 3 incorporated
neighbourhood characteristics. To work with the rates rather than
the counts, an additional parameter known as an offset was used.
The offset parameter was calculated as follows: 1) Offset was set to
be equal to the log (base e) of 12 months if the child was observed
for a whole year within the six-year period; 2) If a child was
observed for only part of a follow-up year (e.g., became lost to
follow-up by moving out of the study region), the offset parameter
was set to be equal to the log of the number of actual months
(a value between 1 and 11) that the child was in the study.

**RESULTS**

**Characteristics of the study population and
neighbourhoods**

Tables 1 and 2 present the characteristics of the study population
and the neighbourhoods. On average, 20% of children in this study
population were considered to live in low-income families (i.e.,
their families received income assistance from the government in
a given year). As Table 2 shows, neighbourhoods in Saskatoon vary
considerably on the characteristics we assessed; for example, the
prevalence of smoking ranged 20-fold from the neighbourhood
with the lowest rate to the highest.

**Multilevel predictors of hospitalization**

Table 3 presents the final multilevel model. At the individual level,
being younger, male, Aboriginal, from a low-income family, having
one or more adverse birth outcomes, and being born to a mother
under 20 years of age increased children’s risk of hospitalization.
A significant interaction effect between low income and adverse birth
outcomes was found. The impact of one or more adverse birth out-
comes on hospitalizations was stronger for children in low-income
families, compared to families that did not receive income assis-
tance.

Three neighbourhood factors were significantly associated with
hospitalization, over and above the effects of individual-level fac-
tors. First, children who lived in low-income neighbourhoods were
more likely to be hospitalized. The attributable risk of neighbour-
hood socio-economic disadvantage (corresponding to a difference
in the value of the neighbourhood variable from the 10th to the 90th
percentile) was 10%. Second, better neighbourhood physical con-
dition was associated with a lower hospitalization rate (attributable
risk 18.3%). Figure 1 depicts the impact of neighbourhood physi-

**Table 1. Study Sample Characteristics**

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother’s marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married/Common Law</td>
<td>5831</td>
<td>68.6</td>
</tr>
<tr>
<td>Single</td>
<td>2480</td>
<td>29.2</td>
</tr>
<tr>
<td>Unknown</td>
<td>193</td>
<td>2.2</td>
</tr>
<tr>
<td>Mother’s age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–40</td>
<td>7597</td>
<td>89.3</td>
</tr>
<tr>
<td>&lt;20</td>
<td>835</td>
<td>9.8</td>
</tr>
<tr>
<td>&gt;40</td>
<td>72</td>
<td>0.9</td>
</tr>
<tr>
<td>Father’s age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–40</td>
<td>6951</td>
<td>81.7</td>
</tr>
<tr>
<td>&lt;20</td>
<td>251</td>
<td>3.0</td>
</tr>
<tr>
<td>&gt;40</td>
<td>413</td>
<td>4.9</td>
</tr>
<tr>
<td>Unknown</td>
<td>889</td>
<td>10.4</td>
</tr>
<tr>
<td>Birth outcome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>7396</td>
<td>87.0</td>
</tr>
<tr>
<td>One adverse birth outcome</td>
<td>718</td>
<td>8.4</td>
</tr>
<tr>
<td>More than one adverse birth outcome</td>
<td>390</td>
<td>4.6</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4412</td>
<td>51.9</td>
</tr>
<tr>
<td>Female</td>
<td>4092</td>
<td>48.1</td>
</tr>
<tr>
<td>Child’s Aboriginal status</td>
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<td></td>
</tr>
<tr>
<td>Non-Aboriginal</td>
<td>7543</td>
<td>88.7</td>
</tr>
<tr>
<td>Aboriginal</td>
<td>961</td>
<td>11.3</td>
</tr>
<tr>
<td>Family income assistance status by follow-up year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Received assistance in Year 1</td>
<td>1191</td>
<td>14.1</td>
</tr>
<tr>
<td>Received assistance in Year 2</td>
<td>1700</td>
<td>20.2</td>
</tr>
<tr>
<td>Received assistance in Year 3</td>
<td>1616</td>
<td>19.3</td>
</tr>
<tr>
<td>Received assistance in Year 4</td>
<td>1700</td>
<td>20.1</td>
</tr>
<tr>
<td>Received assistance in Year 5</td>
<td>2040</td>
<td>24.1</td>
</tr>
<tr>
<td>Received assistance in Year 6</td>
<td>2211</td>
<td>26.2</td>
</tr>
</tbody>
</table>
Socio-economic disadvantage may affect health outcomes indirectly by shaping the physical condition on hospitalization. The lighter areas represent neighbourhoods in better physical condition. These neighbourhoods also have smaller dots, which indicate a lower hospitalization rate. Third, greater average household size was associated with a higher risk of hospitalization (attributable risk 12.4%). Taken together, the effects of these three neighbourhood factors were sizeable, with a combined attributable risk of 40%.

**DISCUSSION**

These results support the hypothesis that neighbourhood characteristics influence childhood hospitalization independent of the effects of family socio-economic status and other individual factors. Other multilevel studies have reported associations between neighbourhood socio-economic status and adverse birth outcomes, chronic disease among adults, and health behaviours. This study differed from previous research in that it examined young children from birth to age six; used a longitudinal design; and controlled for a wide range of neighbourhood characteristics.

How might lower socio-economic neighbourhoods harm the health of children regardless of their own family income level? Some have suggested that the neighbourhood socio-economic context could affect health outcomes indirectly by shaping the physical condition, social environment and services, and amenities available in neighbourhoods. In this study, physical condition and availability and accessibility of programs and services for families were taken into account, so these factors were not confounders of the association between neighbourhood socio-economic context and hospitalization. However, we did not control for other amenities, such as grocery stores and public transportation. Lack of access to healthy food and other essentials may have contributed to the relationship we observed between low-income neighbourhoods and higher hospitalization rates. Socio-economic disadvantage may also affect neighbourhoods’ social environment, possibly by increasing social isolation and affecting social and cultural norms.

While our ‘social disconnection’ variable took into account some aspects of the social environment, such as transiency and voter participation (see Appendix), there are other dimensions we did not capture.

In addition to socio-economic disadvantage, we found the physical condition and average household size of neighbourhoods to have significant impacts on childhood hospitalization. The physical conditions in this study reflect housing conditions, traffic volume, road conditions, and level of noise within a neighbourhood – factors that have been found to be associated with health problems in children, such as lead poisoning and respiratory diseases.

The association between average household size and hospitalization may reflect the fact that neighbourhoods with more crowded
homes present a more conducive environment for the spread of communicable and respiratory diseases; for example, household crowding has been found to increase young children’s risk of acute lower respiratory infection.28

Three other neighbourhood factors – social disconnection, smoking prevalence, and availability and accessibility of programs and services for children and families – were not found to be significantly associated with hospitalization rate. This might be due to inter-correlations among neighbourhood variables, if, for example, the most socio-economically disadvantaged neighbourhoods also have high social disconnection and smoking rates. Neighbourhood socio-economic disadvantage and physical condition together may capture the underlying mechanisms of neighbourhood effects on childhood hospitalization better than these other domains singularly.

Study limitations may have reduced the accuracy with which we were able to estimate the effect of neighbourhood factors on childhood hospitalization. For instance, duration of residence in a neighbourhood (i.e., exposure time) was not measured, which, depending on the underlying risk profile of a neighbourhood, could have resulted in either under- or overestimation of the neighbourhood effect. The impact of the neighbourhood may have been underestimated because we did not examine whether neighbourhood factors influence childhood hospitalization indirectly through their effects on adverse birth outcomes. In other words, since neighbourhood socio-economic disadvantage has been shown to affect birth outcomes,29 controlling for the effect of adverse birth outcomes on hospitalization may have resulted in over-control. On the other hand, if there were individual-level socio-economic influences on hospitalization that our measure of family socio-economic disadvantage failed to take into account, this would lead to an overestimation of the neighbourhood’s effect. However, we did control for single parent status, mother’s age, and Aboriginal ethnicity, which, taken together, likely captured most of the unmeasured individual-level confounders related to socio-economic status, such as health behaviours, education level, and psychosocial factors. One other study limitation is that the neighbourhood data were collected at a single point in time, and therefore we could not examine the effects of neighbourhood stability or change on children. The interpretation of the study findings should be read with the consideration of these potential limitations in mind.

Our results suggest that efforts aimed at reducing childhood morbidity might be more effective if they targeted neighbourhood risk factors in addition to the usual individual factors. The environmental factors identified in this study could affect children’s health in many ways, and addressing them through community development and healthy public policies makes sense from the perspective of population health promotion. Strengthening neighbourhoods’ economic well-being, improving air quality, enhancing the pedestrian-friendliness of streets, and providing safe, affordable, adequate housing for all citizens are fundamental strategies for healthy communities.

**REFERENCES**


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