The Relationship Between the Supply of Fast-food Chains and Cardiovascular Outcomes

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Karen Eny1

ABSTRACT

Objective: To examine the extent to which inter-regional differences in fast-food concentrations account for variations in all-cause mortality and acute coronary syndromes throughout Ontario, Canada.

Methods: Nine distinct fast-food chains were selected based on top sales data in 2001. The per capita rate of fast-food outlets per region was calculated for each of 380 regions throughout Ontario. Outcome measures, obtained using 2001 vital statistics data and hospital discharge abstracts, included regional per capita mortality rates and acute coronary syndrome hospitalization rates; head trauma served as a comparator. All regional outcomes were adjusted for age, gender, and socio-economic status, and were analyzed as continuous and rank-ordered variables as compared with the provincial average.

Results: Mortality and admissions for acute coronary syndromes were higher in regions with greater numbers of fast-food services after adjustment for risk. Risk-adjusted outcomes among regions intensive in fast-food services were more likely to be high outliers for both mortality (Adjusted Odds Ratio (OR): 2.52, 95% confidence intervals (CI): 1.54-4.13, p<0.001) and acute coronary hospitalizations (Adjusted OR: 2.62, 95% CI 1.42-3.59, p<0.001) compared to regions with low fast-food service intensity. There was no relationship between the concentration of fast-food outlets and risk-adjusted head-trauma hospitalization rates.

Interpretation: Inter-regional cardiac outcome disparities throughout Ontario were partially explained by fast-food service intensity. Such findings emphasize the need to target health promotion and prevention initiatives to highest-risk communities.

MeSH terms: Coronary disease; human; risk; food supply; restaurants; mortality

La traduction du résumé se trouve à la fin de l’article.

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METHODS

Data sources
We identified nine leading fast-food chains based on market shares, total sales, and data availability.21 They included: McDonalds®, KFC®, Taco Bell®, Wendy’s®, Harvey’s®, Swiss Chalet®, Dairy Queen®, Pizza Hut®, and Burger King®. For each fast-food chain, we abstracted postal codes to identify the geo-
The Relationship Between the Supply of Fast Foods and Risk-adjusted Outcomes*

<table>
<thead>
<tr>
<th>Regional Outcome Category</th>
<th>Supply of Fast Food (Tertile)</th>
<th>Incremental Increase in the Prevalence of Risk-adjusted Outcomes per 100,000 as Compared to Reference Category</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>0-9.5 outlets</td>
<td>Reference category</td>
<td>35.2</td>
</tr>
<tr>
<td></td>
<td>9.6-19.2 outlets</td>
<td></td>
<td>62.4</td>
</tr>
<tr>
<td></td>
<td>≥19.3 outlets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute coronary syndromes</td>
<td>0-9.5 outlets</td>
<td>Reference category</td>
<td>28.4</td>
</tr>
<tr>
<td></td>
<td>9.6-19.2 outlets</td>
<td></td>
<td>47.2</td>
</tr>
<tr>
<td></td>
<td>≥19.3 outlets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head trauma</td>
<td>0-9.5 outlets</td>
<td>Reference category</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>9.6-19.2 outlets</td>
<td></td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>≥19.3 outlets</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Incorporates 2001 data. The supply of fast food is reflected by the per-capita rate tertile of fast-food outlets within each neighbourhood region (Forward Sortation Area). Regional outcomes reflect the per-capita rate for all-cause mortality, acute coronary syndrome and head-trauma hospitalizations adjusted for age, gender, and socio-economic status.

Geographical regions

Each geographical region in Ontario was identified using the Forward Sortation Area (FSA). There were 504 FSAs in Ontario; the median population size for each FSA was 28,371 people (interquartile range: 17,317 – 42,741). We excluded any FSA consisting of fewer than 1,000 people, due to small population sizes. Given that rural regions may have a different composition of fast-food chains (and may favour smaller business restaurants rather than corporate chains), we only included those FSAs that had at least one of the nine unique fast-food chains examined. In total, 380 Forward Sortation Areas comprised the number of geographical regions in this study.

Fast-food outlets

All fast-food chains were aggregated together, regardless of food type, and tallied within each Forward Sortation Area. Given that the number of fast-food restaurants was hypothesized to correlate with population density, we divided the number of fast-food outlets by the population size within each geographical region.

Outcomes

Our outcome measures included region-specific per capita mortality rate, and region-specific per capita acute coronary syndrome hospitalization rate (i.e., unstable angina and acute myocardial infarctions) during the 2001 calendar year. Unstable angina was defined using the most responsible diagnostic fields (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] Code 411, 413), as was acute myocardial infarction (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] Code 410). Previous studies in Ontario have validated these codes against clinical chart abstraction.22,23 We also compared each region’s outcome (and their 95% confidence interval) to the provincial average using risk adjustments (indirect standardization) for age and gender. Each region was then categorized into one of three subgroups: “low-outlier”, “average”, or “high-outlier”, based upon their rank when compared to the provincial average.

As a comparator, we explored the relationship between fast-food supply and head trauma (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9CM] Code 800-804).

We chose head trauma as a neutral variable given the lack of evidence supporting any clear biological ties to regional nutritional behaviours.

Analyses

The per capita distribution of fast-food outlets per Forward Sortation Area was categorized into equal tertiles, defined as follows: fewer than 9.6 outlets per 100,000 population; 9.6 to 19.3 outlets per 100,000 population; greater than 19.3 outlets per 100,000 population. Using ordinary least squares regression, we then examined how the concentration of fast-food outlets was correlated to the average age, socio-economic status, and size of the population. The relationship between fast-food outlet intensity (i.e., tertile) and risk-adjusted outcomes were examined with and without adjustments for median neighbourhood household income using least squares regression techniques. Given that one of our objectives was to explain whether the relationships between fast-food intensity and outcomes are different across socio-economic status, we tested the significance of an interaction among medium household income, fast-food intensity and risk-adjusted regional outcomes.

Multiple ordinal logistic regression techniques were used to examine whether fast-food service intensity predicted the likelihood that a region was classified as a “high-outlier”, “average” or “low-outlier” outcome performer, after adjusting for median neighbourhood household income.

As a sensitivity analysis, we examined the relationship between the per-capita rate of fast-food outlets per region and outcomes by modeling the fast-food chains as a con-
Mortality and admissions for acute coronary syndromes were higher among regions with greater number of fast-food services after adjustments for risk (Table I). Each increase of one fast-food outlet per 100,000 people in a region corresponded to an additional one death per 100,000 persons, after adjusting for baseline sociodemographic differences (p<0.001). While lower neighbourhood income regions were associated with a higher prevalence of acute coronary syndromes and mortality, there were no significant interactions among socio-economic status, per-capita rates of fast foods, and outcomes in Ontario (p=0.42 for all-cause mortality; p=0.52 for acute coronary syndromes).

Risk-adjusted outcomes among communities with more intensive supplies of fast-food services were more likely to be high outliers for both mortality (Adjusted OR: 2.52, 95% CI: 1.54-4.13, p<0.001) and acute coronary hospitalizations (Adjusted OR: 2.62, 95% CI: 1.42-3.59, p<0.001) than were regions with low fast-food service supply intensity (Table II).

In contrast to outcomes of mortality and acute coronary syndrome hospitalizations, there was no relationship between the concentration of fast-food outlets and risk-adjusted rates of head trauma (R²=0.007; p=0.27) throughout the province.

**DISCUSSION**

Health services researchers continue to examine reasons for regional variations in health status and outcomes.7,8,24-26 Cardiovascular mortality rates have been shown to vary two-fold across communities throughout Canada.3,27 Canadian researchers have recently demonstrated that over 40% of such regional outcome variations are explained by differences in the prevalence of traditional cardiac risk factors, such as smoking and obesity.8,27 While self-reported nutritional behaviours have also been associated with cardiovascular outcomes in selected regions,17,28 ours is the first study to illustrate the positive relationship between the supply of fast-food restaurants and the prevalence of cardiovascular disease and death across communities.

Fast foods represent the largest component of food establishment sales.29 Reports from the US Department of Labor, Bureau of Labor Statistics, have demonstrated a 339% increase in food expenditures spent away from home in the United States between 1974 and 1994 – a 1.7-fold magnitude increase over food dollars spent at home over the same time period.13 Given the exponential growth in fast-food supply during the past several decades, one may reasonably hypothesize that a large component of such increasing expenditures originates from accelerated community fast-food demands and consumption.11,12,30,31 Numerous studies have concluded that the poor nutritional value, the excessive salt content, and the degree of saturated fats and trans-fatty acid associated with fast-food products likely perpetuate the prevalence of hypercholesterolemia, hypertension, type-II diabetes mellitus, obesity, and cardiovascular disease in westernized societies.32,35

**Table II**

<table>
<thead>
<tr>
<th>Regional Outcome Category</th>
<th>Supply of Fast Food (Tertile)</th>
<th>Adjusted Odds Ratio (for poorer risk-adjusted outcome ranking)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Number of outlets per 100,000 people)</td>
<td>(+/- 95% CI)</td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>0-9.5 outlets</td>
<td>Reference category</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>9.6-19.2 outlets</td>
<td>1.48 (0.90-2.42)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥19.3 outlets</td>
<td>2.52 (1.54-4.13)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Acute coronary syndromes</td>
<td>0-9.5 outlets</td>
<td>Reference category</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>9.6-19.2 outlets</td>
<td>1.65 (1.04-2.63)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥19.3 outlets</td>
<td>2.26 (1.42-3.59)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Head trauma</td>
<td>0-9.5 outlets</td>
<td>Reference category</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>9.6-19.2 outlets</td>
<td>1.06 (0.47-2.42)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥19.3 outlets</td>
<td>1.14 (0.51-2.53)</td>
<td>0.75</td>
</tr>
</tbody>
</table>

* Incorporates 2001 data. The supply of fast food is reflected by the per-capita rate tertile of fast-food outlets within each neighbourhood region (Forward Sortation Area). Regional outcomes reflect the per-capita rate for all-cause mortality, acute coronary syndrome and head-trauma hospitalizations adjusted for age, gender, and socio-economic status. Outliers are identified using the 95% CI and comparing to the provincial averages. Outliers whose lower 95% CI lies above the provincial average is identified as a high-outlier; conversely, outliers whose upper 95% CI lies below the provincial average is identified as a low-outlier. The relationship between fast-food intensity and outlier status incorporated ordinal logistic regression and reflects the likelihood that fast-food supply is situated among sequentially poorer outcome regions.

**RESULTS**

**Fast-food outlet distribution**

Among the 9 unique fast-food chains examined, there were 1,630 fast-food outlets (median: 3 outlets per geographical region). The number of region-specific fast-food outlets was correlated with the population size per region (spearman r=0.33; p<0.001). After adjusting for population size, there was a median of 15.2 outlets per 100,000 individuals per Forward Sortation Area (Inter-quartile range (IQR): 7.5-22.3 per 100,000 individuals). While the absolute per-capita rate of fast-food outlets weakly and inversely correlated with the average population age per region (r=-0.12; p=0.02), there was no significant relationship between fast-food outlet concentration and median household neighbourhood income.

**Fast-food outlets and outcomes**

The median age-gender standardized mortality and acute coronary syndrome hospitalization rates were 583 per 100,000 (IQR: 499.5-671.5 per 100,000] and 226 per 100,000 [IQR: 168.5-334.5 per 100,000] across Ontario respectively. Mortality and admissions for acute coronary syndromes were 583 per 100,000 and 226 across Ontario respectively. (IQR: 499.5-671.5 per 100,000] and 226 across Ontario respectively. Fast-food outlets and outcomes hold neighbourhood income. The number of region-specific fast-food outlets weakly and inversely correlated with the average population age per region. While the absolute per-capita rate of fast-food outlets was correlated with the average population age per region (r=0.33; p<0.001). After adjusting for population size, there was a median of 15.2 outlets per 100,000 individuals per Forward Sortation Area (Inter-quartile range (IQR): 7.5-22.3 per 100,000 individuals). While the absolute per-capita rate of fast-food outlets weakly and inversely correlated with the average population age per region (r=-0.12; p=0.02), there was no significant relationship between fast-food outlet concentration and median household neighbourhood income.
The relationships between fast-food restaurants and outcomes were similar in high- and low-income communities. The lack of an interaction among socio-economic status, fast-food supply, and outcomes may suggest that the community fast-food demands are driven by multiple factors, such as taste preferences, advertising, affordability, and convenience. Such influencing factors likely extend across all social and economic spectra in a similar and consistent fashion. In this regard, our results are consistent with at least one other study, which demonstrated that the impact of self-reported fast-food eating behaviours on BMI were similar among low- and high-income individuals.

Our results serve to reinforce the importance of community profiling when exploring inter-regional variations in health status and outcomes. The ability to distinguish high- from low-mortality regions by the fast-food supply of restaurants in a neighbourhood underscores the need for targeted health promotion and prevention strategies to communities with poorest health profiles and lifestyle behaviours. Other policy implications may include tax-based or financial reform initiatives and restrictions in the availability of fast-food restaurants, which together may curtail fast-food demands and promote the consumption of healthier nutritional products in high-mortality regions.

Our study has several important limitations. First, the ecological cross-sectional design examined communities, not individuals. Our study was not designed to examine the relationship between fast-food consumption and individual outcomes – an analysis which would necessitate a longitudinal study of sufficient duration to account for the cumulative effects of fast-food exposure over time. Accordingly, we cannot presume causality between fast-food consumption and health-related outcomes per se. Notwithstanding, our analysis did adjust for differences in the age, gender, and socio-economic composition of communities – three of the most important determinants of population outcomes. Furthermore, available evidence has demonstrated that temporal trends in the relative variation of fast-food consumption have remained consistent across demographic subgroups, suggesting some level of stability in regional market shares over time. Second, we examined only a selected number of fast-food restaurants. While the selection of such restaurants was based on top available sales, it is possible that smaller rural communities may have consisted of a preponderance of small-business independent fast-food restaurants as opposed to multi-chain conglomerates, which tend to be concentrated in larger urban communities. Nonetheless, we did restrict the analysis to communities containing at least one of the selected fast-food chains to minimize such biases. Moreover, fast-food sales in Ontario account for nearly half of the total fast-food sales in Canada. Therefore, our results are likely to be generalizable to other regions worldwide, and unlikely to change were a wider array of fast-food restaurants to be selected.

In conclusion, inter-regional differences in the supply of fast-food restaurants predicted variations in all-cause mortality and acute coronary syndrome hospitalizations across communities in Ontario. Such findings reinforce the importance of health promotion and prevention strategies, especially when targeted to communities characterized by poorer health and higher mortality.

REFERENCES

RÉSUMÉ

Objectif : Examiner la mesure dans laquelle les différences interrégionales dans la concentration des restaurants rapides expliquent les écarts dans la mortalité toutes causes confondues et dans les syndromes coronariens aigus à l’échelle de l’Ontario.


Résultats : Après ajustement selon le risque, la mortalité et les hospitalisations liées aux syndromes coronariens aigus étaient supérieures dans les régions où l’on trouvait le plus grand nombre de restaurants rapides. Les résultats ajustés selon le risque dans les régions à forte concentration de restaurants rapides étaient plus susceptibles de présenter des valeurs aberrantes élevées, tant pour la mortalité (rapport de cotes ajusté (RC) = 2,52, intervalle de confiance (IC) de 95 % = 1,54-4,13, p<0,001) que pour les hospitalisations liés aux syndromes coronariens aigus (RC ajusté = 2,62, IC de 95 % = 1,42-3,59, p<0,001), que dans les régions à faible concentration de restaurants rapides. Nous n’avons constaté aucun lien entre la concentration des restaurants rapides et les taux d’hospitalisation pour traumatismes crâniens ajustés selon le risque.

Interprétation : Les disparités interrégionales dans les résultats cardiaques en Ontario s’expliquent en partie par le niveau de concentration des restaurants rapides, d’où la nécessité d’orienter les initiatives de promotion de la santé et de prévention en fonction des collectivités les plus vulnérables.