Canadian Journal of Public Health (2020) 111:247–256
https://doi.org/10.17269/s41997-019-00260-x

QUANTITATIVE RESEARCH

Store patterns of availability and price of food and beverage products across a rural region of Newfoundland and Labrador

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Received: 21 February 2019 / Accepted: 28 August 2019 / Published online: 30 October 2019

Abstract

Objectives Rural populations bear a disproportionate burden of diet-related risk, and one important explanation is retail food access disparities. Much existing literature has focused on subjective measures of the rural retail food environment, as well as urban-rural differences. The purpose of this paper is to examine how objectively measured food availability and prices vary within a rural region, and to explore how store features predict rural food availability and prices.

Methods We conducted an observational audit of a census of rural food stores ($n = 78$) using a modified Nutrition Environment Measures Survey instrument. The study was conducted on the Avalon Peninsula in Newfoundland and Labrador. Observed prices in-store were matched to nutrient composition data and converted to three units of measure for all analyses: unit price ($/kg), serving price ($/serving), and energy price ($/kcal). We examined average availability and prices across the region, and how store features were associated with prices.

Results Healthy food options were generally less available across the stores than regular items. However, with few exceptions, there were no clear or consistent patterns of difference in availability or pricing between stores of different types. No single product category stood out in terms of a clear price pattern. Store characteristics (including store type, size, ownership, or rurality) did not predict food prices.

Conclusions Food availability and prices varied in this rural region, but with limited differences between stores of different types. More research is needed on measuring rural environmental determinants of diet in Canada.

Résumé

Objectifs Les populations rurales supportent un fardeau disproportionné de risques liés au régime alimentaire, ce qui s'explique entre autres par les disparités d'accès aux magasins d'alimentation au détail. Une grande partie des articles scientifiques porte cependant sur les indicateurs subjectifs de l'environnement alimentaire au détail en zone rurale et sur les différences entre zones urbaines et rurales. Nous avons cherché à examiner objectivement les variations dans la disponibilité et les prix des aliments dans une région rurale et à déterminer si les caractéristiques des magasins prédisent la disponibilité et les prix des aliments en zone rurale.

Méthode Nous avons mené un audit d'observation des magasins d'alimentation recensés dans une zone rurale ($n = 78$) à l'aide de l'instrument Nutrition Environment Measures Survey modifié. L'étude a été menée sur la presqu'île Avalon à Terre-Neuve-et-Labrador. Les prix observés en magasin ont été assortis à la teneur en éléments nutritifs et convertis en trois unités de mesure pour toutes nos analyses : le prix de vente unitaire ($/kg), le prix par portion ($/portion) et le prix énergétique ($/kcal). Nous avons examiné la disponibilité et les prix moyens dans la région et les associations entre les caractéristiques des magasins et les prix.

Electronic supplementary material The online version of this article (https://doi.org/10.17269/s41997-019-00260-x) contains supplementary material, which is available to authorized users.

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Résultats Les aliments sains étaient généralement moins disponibles en magasin que les denrées alimentaires ordinaires. Par contre, à quelques exceptions près, nous n'avons pas observé de schémas de différence clairs ou systématiques entre différents types de magasins, que ce soit dans la disponibilité ou dans les prix des aliments. Aucune catégorie de produits ne s'est démarquée en affichant une tendance claire pour les prix. Les caractéristiques des magasins (type, taille, propriété ou ruralité) n'ont pas permis de prédire les prix des aliments.

Conclusions La disponibilité et les prix des aliments variaient dans cette région rurale, mais les différences selon le type de magasins étaient limitées. Il faudrait pousser la recherche pour mesurer les déterminants du régime liés à l'environnement rural au Canada.

Keywords Rural food access · Rural food environment · Grocery stores · Food prices · Food audit

Mots-clés Accès aux aliments en zone rurale · Environnement alimentaire en zone rurale · Épiceries · Prix des aliments · Audit alimentaire

Introduction

Poor diet is a leading preventable risk factor for the global burden of disease (Gakidou et al. 2017) and supporting healthier diets at a population level is a policy priority. Rural populations experience a disproportionate burden of diet-related chronic diseases risk and obesity (DesMeules et al. 2006; Galloway 2006). Disparities in food access and affordability at retail food stores are important contributors to dietary risk for rural populations (Lebel et al. 2016; Lucan et al. 2012).

Past evidence on the rural food environment has centred on food availability, and subjective experiences of grocery shopping and food access. Rural dwellers are deeply concerned about food access and affordability, and encounter higher grocery prices, which constrains their capacity to make healthy food purchasing decisions (Andress and Fitch 2016; Carnahan et al. 2016; Dean and Sharkey 2011; Jilcott et al. 2009; Valdez et al. 2016). A closer look at studies employing objective food environment measures, however, suggests that what we know about rural food access, particularly food prices, is a decidedly mixed picture.

Service providers in rural communities tend to be small businesses oriented to local demand, whereas those in urban communities can offer scale or specialized functions (Halseth and Ryser 2006). Geographically remote communities tend to charge higher food prices across a range of food categories, in comparison with dense urban areas (Ferguson et al. 2015), with well-known infrastructure challenges in remote food supply (Skinner et al. 2016). Yet some rural-urban studies detect higher rural prices only for specific foods (Jithitikulchai et al. 2012; Rimkus et al. 2015; Tisone et al. 2014). Rural areas also have relatively more economically disadvantaged households, a barrier to service provision based on demand. Ecological studies combining urban and rural (Cummins et al. 2010) or within entirely rural regions have found that area socio-economic features do not predict food prices (Lasley and Litchfield 2008; Shanks et al. 2015). Specific foods, such as fresh fruits and vegetables, may represent exceptions (Dunn et al. 2011).

Food prices tend to rise with a decrease in store size (Cummins et al. 2010). Convenience stores, grocery stores, and supermarkets fall along an increasing gradient of affordability, presumably related to store size (Liese et al. 2007; Rimkus et al. 2015). Yet precisely how store type is associated with rural food prices remains unclear (Jithitikulchai et al. 2012; Ko et al. 2018; Liese et al. 2007; Rimkus et al. 2015).

These mixed findings suggest that there is variation among rural stores, beyond rural-urban differences. How stores vary within rural areas is a feature of food access disparities that merits investigation. The aim of this paper is to examine how food availability and prices vary within a rural region of Newfoundland and Labrador (NL), and to explore how store features predict availability and prices. Research on how retail stores factor into food access is limited for NL; annual government-led monitoring was recently made publicly available and showed that the average weekly food cost for a family of four was often higher in rural versus urban communities (Government of NL 2017).

Methods

Population and setting This study was conducted in Eastern NL. As of the 2016 Census, over two thirds of the NL population resided in rural areas (population < 1000 and density < 400 persons per km^2 (1026 per square mile)) or small population centres (population 1000–29,999) (Statistics Canada 2017a, b). NL has among the greatest burdens of diet-related non-communicable diseases and obesity in Canada. Both the island (Newfoundland) and the remote northern mainland (Labrador) face constraints to a reliable and consistent food supply. The province has a geographically dispersed population, limited agricultural capacity, seasonally limited alternatives to retail food sources (e.g., markets, roadside, wild foods), low population density, transportation infrastructure challenges, and adverse weather. The provincial food supply is heavily reliant on food distribution by sea or air transportation.

Design and measures Briefly, we completed a cross-sectional store audit encompassing all rural retail food stores defined by

North American Industry Classification System (NAICS) codes ($n = 78$) on the Avalon Peninsula. Detailed methods for the audit have been described elsewhere (Mah et al. 2019).

Food availability and price were measured using a Nutrition Environment Measures Survey in Stores (NEMS-S) (Glanz et al. 2007) adapted for the NL diet (NEMS-S-NL), with a detailed field protocol, specific items, and preferred brands. The NEMS-S is the single most widely used and adapted checklist audit instrument in the consumer food environments literature (Lytle and Sokol 2017). Data were collected in the following product categories: fresh fruit, fresh vegetables, frozen fruits/vegetables, canned fruits/vegetables, eggs, baked goods, beverages, bread, ready-to-eat breakfast cereal, cheese, chips (potato), frozen dinners, fresh/frozen meats and processed meats, meat alternatives (i.e., peanut butter, legumes), milk, rice, and pasta. Table 2 shows the number of items audited per category.

Briefly, the assignment of 'healthy' and 'regular' alternatives followed NEMS-S methodology and convention, applying Canada-specific dietary guidance. The NEMS-S audits an indicator checklist of foods and beverages, divided into measures that represent food categories. It assesses availability (including variety), price, and quality of healthy alternatives to 'regular' (typically purchased) grocery item counterparts (Glanz et al. 2007). All fruits and vegetables (fresh, frozen, canned), and eggs, were assigned as healthy. For other product categories, healthy alternatives were based on the NL provincial School Food Guidelines (Government of NL 2006) and Canada's Food Guide. The Supplementary Table offers added detail of healthy and regular coding.

Knowledge users formally partnered with our research team assessed face validity of the tool, including reference brands (Mah et al. 2019). The group included a regional health authority decision maker, a rural community member, staff of a non-governmental community food security organization (Food First NL), and regional nutritionists with healthy food basket measure experience. The NEMS-S has been previously assessed for face and construct validity (Lytle and Sokol 2017; Minaker et al. 2014).

Food price assessment Data were collected over six days in August 2015. Consistent with NEMS protocol, we assessed regular prices (without sale prices such as volume discounts). Observed prices for each item were matched to nutrient composition data using the Canadian Nutrient File 2015 and Canada's Food Guide to calculate three standardized prices: unit price ($/kg), serving price ($/serving), and energy price ($/1000 kcal). We calculated average item prices, then calculated average product category prices. We also calculated average category prices separating healthy and regular items, so that each product category had an average healthy category price and an average regular category price. Finally, we calculated a price index, estimated as the ratio of average regular to healthy category prices. For analyses involving the price index, we imputed missing prices using the average price for that item across all stores. For all other analyses, we did not impute the missing price for unavailable products.

Store features Store attributes were based on our dataset derived from NL administrative data, verified through publicly available commercial directories, followed by groundtruthing, the gold-standard method for rural store enumeration (Caspi and Friebur 2016). Store type was coded by NAICS code, as supermarket (445110) or convenience (merged: 445120, convenience stores, and 447110, gas stations with convenience). Store size was assessed during fieldwork, using number of cash registers as a proxy for store size. Store ownership was coded as independent, national chain, or provincial chain. Store rurality was based on the NL Accessibility-Remoteness (A-R) Index (continuous variable, 0 to 1), a multivariate index developed by the provincial Statistics Agency to classify communities according to weighted daytime population and network travel distances to essential services (Newfoundland and Labrador Statistics Agency 2014). The A-R Index can also be rendered as six strata of relative rurality, from highly accessible to very remote. Highway access was dichotomized to stores located within 1 km of a main highway and those located > 1 km distant.

Analysis Descriptive statistics were used to summarize the characteristics of the stores.

Availability We calculated the proportion of stores with availability in each product category. We compared whether proportions of items available differed by store type and ownership (chi-square test, $\alpha < 0.05$). A comparison of availability at independent stores, provincial chains, and national chains, using pairwise Pearson chi-square tests adjusted for multiple tests using the Holm method, was also conducted.

Prices We examined average prices for each product category, for healthier and regular items. We then compared average category prices for healthier versus regular products using unequal variances t tests, $\alpha < 0.05$ with Bonferroni correction. Next, we inspected descriptively how average prices for each product category compared between different kinds of stores. Average item prices were normally distributed, permitting straightforward comparisons between stores. Since product categories combined diverse food items into retail-relevant categories, category prices were rarely normally distributed. We used two-way analysis of variance (ANOVA) with log-transformed prices per serving ($/serv) to compare healthy and regular prices for each audited item in convenience stores compared with supermarkets, stores with one checkout in comparison with two or more checkouts, and independently owned stores and provincial chains in comparison with national chains (not shown).

Finally, we explored a series of linear regression models to evaluate whether rurality was associated with price. We tested

each product category separately, using rurality (NL A-R Index) as the independent variable, and average product category price or the derived price index as the dependent variable. Proportion of category available, store size, and store type were tested as covariates but did not improve the model.

Price analyses were tested in each of the three units of measure ($/kg, $/serving, and $/1000 kcal). All analyses were conducted using R (https://www.r-project.org/).

Results

Table 1 describes stores audited and the province as a whole. As of the 2011 Census by the NL A-R Index, the vast majority of the population of NL resides in communities from highly accessible to moderately remote. Only 2.7% of the NL population resides in remote and very remote communities, the two rurality categories beyond moderately remote. Store rurality in this study ranged from 0 (highly accessible) to 0.45 (moderately remote).

Availability Items from most product categories were available in the majority of stores (Table 2). There was more limited availability of the healthier options in a few product categories: frozen fruits, frozen vegetables, baked goods, frozen dinners, pasta, and rice.

Supermarkets had a greater proportion of items available overall than convenience stores (+ 17.8%, $p \sim 0.0$), but this difference between store types did not persist when healthy (− 3.3%, $p = 0.21$) and regular (+ 3.1%, $p = 0.32$) availability were examined separately. Table 3 shows item availability by store ownership. For any given ownership type, there was a greater proportion of regular compared with healthy items available: e.g., in national chains (+ 11.3%, $p \sim 0.0$) and independent stores (+ 11.1%, $p = 0.004$). National chains performed better than independents in healthy item availability (+ 7.0%, $p = 0.007$), but not regular item availability (− 4.1%, $p = 0.52$). Provincial chains fared best, with a small non-significant difference in regular and healthy item availability (+ 6.3%, $p \sim 1.0$), and a significantly greater healthy item availability than at independent stores (+ 13.5%, $p = 0.036$).

Prices—Average product category prices Table 2 summarizes average category prices, for healthy and regular products, in three units of measure ($/kg, $/serving, and $/1000 kcal).

We detected significant differences between average category prices ($/kg, 95%CI) for the healthy in comparison with the regular products in five product categories. Healthy options were cheaper for baked goods −$5.42 (3.55–7.30), $p = 3.3$ E−6; meat alternatives −$1.74 (0.92–2.56), $p = 4.3$ E−5; and milk −$3.18 (3.00–3.37), $p = 1.2$ E−47. Healthy options were more expensive for: cheese +$8.74 (4.75–12.74), $p = 6.3$ E−5; and pasta +$3.16 (2.40–3.93), $p = 6.0$ E−8.

Prices—Units of measure The top three most expensive average category prices, in the different units of measure, were for the following products (see Table 2):

- Unit prices ($/kg): cheese (healthy), chips (regular), chips (healthy)
- Serving prices ($/serving): frozen dinners (healthy), frozen dinners (regular), fresh/frozen meats
- Energy prices ($/1000 kcal): fresh vegetables, frozen fruits, fresh fruits

Table 1 Summary of store characteristics on the rural Avalon Peninsula and for all of Newfoundland and Labrador, 2015

		Avalon Peninsula, rural ($n = 78$)		NL Province ($n = 807$)	
		n	%	*n*	%
All stores[1]		78	100	807	100
Store type[1]					
	Supermarkets	17	22	165	20
	Convenience	61	78	642	80
Ownership					
	National chain	17	22	225	28
	Provincial chain	6	8	110	14
	Independent	55	70	472	58
Store size[2]					
	One checkout	49	65		
	Two or more checkouts	27	36		

[1] All retail food stores encompassing 'supermarkets and other grocery' (NAICS 445110), 'convenience' (NAICS 445120), and 'gas station with convenience' (NAICS 447110), defined by North American Industry Classification System (NAICS). For the purposes of the analyses in this paper, 'convenience stores' and 'gas stations with convenience' were collapsed into a single 'convenience' category

[2] Store size is unavailable at the province level as we coded this variable in the store audit based on groundtruthing

Table 2 Number and proportion of stores with food availability, and average prices for each product category, rural Avalon, NL 2015

				Healthy items					Regular items				
		Number of items audited per store		Stores available		Average price (in each unit of measure)			Stores available		Average price (in each unit of measure)		
Group	Product category	Healthy ($n = 48$)	Regular ($n = 22$)	*n*	%	$/kg (95%CI)	$/serv (95%CI)	$/1000 kcal (95%CI)	*n*	%	$/kg (95%CI)	$/serv (95%CI)	$/1000 kcal (95%CI)
Produce[1]													
	Fruits, fresh	6	–	47	60	$ 6.02 (4.76–7.28)	$ 0.51 (0.39–0.63)	$ 11.59 (8.84–14.34)					
	Fruits, frozen	1	–	15	19	$ 9.46 (8.93–9.99)	$ 0.77 (0.73–0.82)	$ 18.55 (17.52–19.58)					
	Fruits, canned	2	–	68	87	$ 5.09 (4.86–5.33)	$ 0.67 (0.64–0.70)	$ 9.90 (9.24–10.57)					
	Vegetables, fresh	10	–	66	85	$ 4.49 (4.11–4.87)	$ 0.31 (0.29–0.33)	$ 19.53 (17.19–21.86)					
	Vegetables, frozen	1	–	16	21	$ 4.54 (3.93–5.15)	$ 0.35 (0.30–0.39)	$ 5.89 (5.10–6.69)					
	Vegetables, canned	2	–	72	92	$ 3.92 (3.74–4.10)	$ 0.41 (0.39–0.43)	$ 13.22 (11.89–14.56)					
	Eggs	1	–	65	83	$ 6.94 (6.76–7.11)	$ 0.69 (0.68–0.71)	$ 4.92 (4.80–5.04)					
Packaged													
	Baked goods[2]*	2	3	5	6	$ 9.83 (8.60–11.05)	$ 0.55 (0.49–0.61)	$ 4.25 (4.02–4.49)	57	73	$ 15.25 (13.96–16.54)	$ 1.17 (1.04–1.30)	$ 4.53 (4.13–4.92)
	Beverages[3]	1	3	16	21	$ 2.30 (1.64–2.96)	$ 0.30 (0.21–0.39)	$ 4.99 (3.56–6.42)	75	96	$ 2.50 (2.34–2.66)	$ 0.47 (0.44–0.49)	$ 7.70 (6.99–8.42)
	Bread	3	3	52	67	$ 6.24 (6.04–6.44)	$ 0.22 (0.21–0.23)	$ 2.43 (2.35–2.51)	58	74	$ 6.17 (5.98–6.37)	$ 0.22 (0.21–0.22)	$ 2.37 (2.29–2.44)
	Cereal	1	1	59	76	$ 15.92 (14.18–17.66)	$ 0.48 (0.43–0.53)	$ 4.09 (3.65–4.54)	53	68	$ 13.88 (12.31–15.44)	$ 0.42 (0.37–0.46)	$ 3.50 (3.11–3.90)
	Cheese**	2	1	44	56	$ 20.83 (16.98–24.68)	$ 1.04 (0.85–1.23)	$ 5.13 (4.18–6.08)	58	74	$ 12.09 (11.50–12.67)	$ 0.25 (0.24–0.27)	$ 4.63 (4.41–4.85)
	Chips	2	1	69	88	$ 16.68 (15.67–17.69)	$ 0.56 (0.52–0.60)	$ 3.20 (3.00–3.40)	76	97	$ 17.95 (17.17–18.73)	$ 0.77 (0.74–0.81)	$ 3.37 (3.23–3.52)
	Frozen dinner	1	1	27	35	$ 12.81 (11.30–14.33)	$ 2.91 (2.56–3.25)	$ 5.57 (4.91–6.23)	40	51	$ 11.21 (10.22–12.20)	$ 2.54 (2.32–2.77)	$ 3.50 (3.19–3.81)
	Meats	4	5	59	76	$ 9.46 (8.83–10.08)	$ 1.12 (0.97–1.26)	$ 5.91 (5.12–6.71)	65	83	$ 10.36 (9.50–11.22)	$ 0.90 (0.83–0.97)	$ 4.09 (3.78–4.39)
	Meat alternatives*	3	1	73	94	$ 6.80 (6.17–7.43)	$ 0.55 (0.50–0.59)	$ 4.91 (4.29–5.54)	60	77	$ 8.54 (8.02–9.05)	$ 0.28 (0.26–0.30)	$ 1.45 (1.36–1.54)
	Milk*	4	1	72	92	$ 2.45 (2.40–2.49)	$ 0.63 (0.62–0.64)	$ 4.87 (4.74–5.01)	68	87	$ 5.63 (5.45–5.81)	$ 0.75 (0.73–0.77)	$ 6.12 (5.93–6.32)
	Pasta**	1	1	15	19	$ 8.17 (7.50–8.83)	$ 0.45 (0.42–0.49)	$ 2.35 (2.15–2.54)	70	90	$ 5.00 (4.73–5.27)	$ 0.37 (0.35–0.39)	$ 3.17 (3.00–3.33)
	Rice	1	1	15	19	$ 7.14 (6.03–8.24)	$ 0.70 (0.59–0.81)	$ 1.93 (1.63–2.23)	65	83	$ 8.24 (7.87–8.61)	$ 0.81 (0.77–0.84)	$ 2.26 (2.16–2.36)

[1] The produce group includes canned and frozen vegetables along with fresh, as these are all considered healthier options in our region and the promotion of frozen and canned fruit and vegetable alternatives is important to rural nutrition promotion. The original NEMS-S did not contain frozen or canned vegetables but these have been added by our team and others in subsequent Canadian and US adaptations of checklist audit instruments

[2] Asterisks indicate product categories where we detected a significant difference between average category prices ($/kg) for healthier as compared with regular options. A single asterisk * shows the healthier options were cheaper than the regular; a double asterisk ** indicates that healthier options were more expensive than the regular

[3] Due to fieldwork error, healthy option beverage items were only audited in 16 stores (21%)

Table 3 Correlation matrix comparing availability of regular and healthy items, in stores of different business ownership, rural Avalon, NL, 2015

	Difference in availability, of *Y*–*X*, with *p* values				
	X axis				
Y axis	Healthy items available in **independent stores**	Regular items available in **independent stores**	Healthy items available in **national chain stores**	Regular items available in **national chain stores**	Healthy items available in **provincial chain stores**
Proportion of regular items available in **independent stores**	11.1% 2.9 E−09*				
Proportion of healthy items available in **national chain stores**	7.0% 0.007*	−4.1% 0.52			
Proportion of regular items available in **national chain stores**	18.3% 7.3 E−10*	7.2% 0.14	11.3% 0.004*		
Proportion of healthy items available in **provincial chain stores**	7.2% 0.19	−3.9% ~1.0	0.2% ~1.0	−11.1% 0.050	
Proportion of regular items available in **provincial chain stores**	13.5% 0.036*	2.4% ~1.0	6.5% ~1.0	−4.1% ~1.0	6.3% ~1.0

*p value at < 0.05, no overlapping confidence intervals, associations in the expected direction

Average prices in stores of different business characteristics With few exceptions, we could not detect consistent relationships between store characteristics and average prices. Neither differences in store type, nor in store size, nor in store ownership were associated with average item prices. One exception was that supermarkets appeared to have significantly lower average prices for the peanut butter item than convenience stores, a finding consistent using unit, serving, and energy prices.

Table 4 shows a cross-tabulation of the average category prices ($/kg) in stores by business characteristics. The table is organized roughly along increasing size and formalization of businesses, from left to right, for each store feature. The average price ($/kg) for fresh fruits and vegetables was lowest in smaller stores (convenience, 1 checkout) in each subgrouping, and for fresh vegetables, in provincial chains; but each subgroup had overlapping 95%CIs.

Finally, we examined relative rurality of stores and how it predicted prices. This set of regression analyses yielded null results. We did not detect any association between store rurality and average product category prices, or the price index.

Discussion

Main findings Healthy options were generally less available across the stores than regular items, but no store feature stood out in terms of a consistent pattern of availability. Average product category prices varied more than we anticipated, but no single product category stood out in terms of a clear price pattern. With few exceptions, store characteristics (including store type, size, ownership, or rurality) did not predict food prices.

Are healthy options more expensive? The healthy option was cheaper in some product categories (baked goods, meat alternatives, milk), and more expensive in others (cheese and pasta). This was likely an artefact of bimodal distributions of the price variable, where relatively distinct products were compared as the healthy and regular options in a category, such as hard cheddar cheese (healthy) versus processed cheese slices (regular). The findings for pasta likely reflect an actual price difference, since the alternatives were white and whole wheat/wholegrain spaghetti with the same reference brand.

Independent stores acting independently? Our findings could be explained by the high proportion of independent stores in NL (Canadian Convenience Stores Association 2015). The effect of store ownership (chain/independent) is a gap in the food access literature, but an important dimension of the food system given the extent of grocery industry consolidation and transnationalization of capital (Wrigley et al. 2005; International Panel of Experts on Sustainable Food Systems (IPES-Food) 2017). One possibility is independent store prices were heterogenous but distributed in a way that masked differences in average prices when compared as a group in relation to chains.

Several findings were counterintuitive. We expected that fresh produce items, prominent in rural food access studies (Ko et al. 2018), would be priced lowest at chain supermarkets, where they could be reliably procured through vertically integrated suppliers, as compared with the eclectic supplier base for independent convenience stores. But provincial (not national) chains appeared to fare best on availability overall, and there were no consistent differences in pricing between stores of different type, size, ownership, or rurality.

Table 4 Average prices for each product category ($/kg, with 95%CI), in stores of different type, ownership, and size, rural Avalon, 2015

		Store business characteristics						
		Type ($n = 78$ stores)		Ownership ($n = 78$ stores)			Size ($n = 76$ stores[2])	
Group	Product category	Convenience	Supermarkets	Independents	Provincial chains	National chains	1 checkout	2 or more checkouts
Produce								
	Fruits, fresh	$ 5.27 (3.67–6.88)	$ 7.11 (5.08–9.14)	$ 5.71 (3.97–7.45)	$ 7.38 (1.11–13.65)	$ 6.13 (4.89–7.38)	$ 5.55 (3.41–7.70)	$ 6.36 (4.77–7.96)
	Fruits, frozen	$ 9.40 (8.64–10.15)	$ 9.49 (8.77–10.21)	$ 10.06 (9.28–10.84)	$ 9.57 (8.75–10.38)	$ 8.73 (8.17–9.29)	$ 8.85 (8.26–9.44)	$ 9.61 (8.99–10.23)
	Fruits, canned	$ 5.05 (4.81–5.30)	$ 5.21 (4.63–5.79)	$ 4.95 (4.70–5.20)	$ 4.06 (3.46–4.66)	$ 5.81 (5.27–6.35)	$ 4.93 (4.65–5.21)	$ 5.34 (4.94–5.75)
	Vegetables, fresh	$ 4.13 (3.71–4.55)	$ 5.33 (4.55–6.11)	$ 4.40 (3.93–4.88)	$ 4.29 (3.10–5.48)	$ 4.86 (4.13–5.59)	$ 4.07 (3.57–4.57)	$ 4.98 (4.40–5.56)
	Vegetables, frozen	$ 4.76 (3.56–5.95)	$ 4.37 (3.76–4.98)	$ 4.66 (3.78–5.54)	$ 3.95 (not applicable)[3]	$ 4.46 (3.43–5.48)	$ 3.93 (2.67–5.19)	$ 4.82 (4.16–5.47)
	Vegetables, canned	$ 3.94 (3.74–4.15)	$ 3.84 (3.50–4.19)	$ 3.90 (3.70–4.10)	$ 4.08 (3.13–5.03)	$ 3.94 (3.57–4.30)	$ 3.96 (3.71–4.20)	$ 3.89 (3.66–4.13)
	Eggs	$ 6.97 (6.75–7.18)	$ 6.84 (6.58–7.11)	$ 6.91 (6.68–7.14)	$ 7.21 (6.77–7.65)	$ 6.91 (6.63–7.19)	$ 6.97 (6.72–7.21)	$ 6.88 (6.63–7.13)
Packaged								
	Baked goods	$ 16.33 (14.83–17.83)	$ 12.10 (10.27–13.94)	$ 15.78 (14.19–17.36)	$ 15.06 (11.04–19.07)	$ 13.15 (10.98–15.32)	$ 16.48 (14.77–18.18)	$ 13.02 (11.32–14.71)
	Beverages[1]	$ 2.55 (2.38–2.73)	$ 2.22 (1.89–2.54)	$ 2.49 (2.30–2.67)	$ 2.19 (1.75–2.63)	$ 2.57 (2.23–2.91)	$ 2.49 (2.29–2.69)	$ 2.44 (2.18–2.69)
	Bread	$ 6.24 (6.07–6.42)	$ 6.11 (5.89–6.33)	$ 6.16 (5.98–6.34)	$ 6.27 (5.89–6.65)	$ 6.29 (6.01–6.56)	$ 6.30 (6.10–6.50)	$ 6.10 (5.91–6.29)
	Cereal	$ 15.00 (13.52–16.47)	$ 14.82 (13.15–16.49)	$ 14.98 (13.59–16.38)	$ 17.07 (11.39–22.75)	$ 14.27 (11.78–16.76)	$ 15.44 (13.60–17.27)	$ 14.15 (13.01–15.29)
	Cheese	$ 16.34 (13.84–18.83)	$ 14.63 (13.25–16.02)	$ 16.06 (13.42–18.70)	$ 13.05 (10.21–15.90)	$ 16.28 (14.58–17.99)	$ 15.90 (13.57–18.23)	$ 16.04 (12.76–19.32)
	Chips	$ 17.24 (16.44–18.04)	$ 16.86 (15.45–18.26)	$ 16.78 (15.92–17.64)	$ 17.04 (14.68–19.41)	$ 18.27 (16.96–19.58)	$ 16.61 (15.69–17.53)	$ 17.83 (16.78–18.89)
	Frozen dinner	$ 12.08 (10.98–13.19)	$ 11.38 (10.02–12.75)	$ 12.12 (10.95–13.29)	$ 12.93 (10.79–15.06)	$ 10.84 (9.61–12.06)	$ 12.12 (10.74–13.50)	$ 11.68 (10.57–12.79)
	Meats	$ 9.56 (8.87–10.26)	$ 10.66 (9.79–11.52)	$ 9.46 (8.91–10.01)	$ 8.13 (7.00–9.26)	$ 12 (10.44–13.56)	$ 8.91 (8.23–9.60)	$ 10.96 (10.12–11.79)
	Meat alternatives	$ 7.13 (6.54–7.72)	$ 7.44 (6.48–8.41)	$ 7.04 (6.45–7.63)	$ 7.29 (5.61–8.96)	$7.73 (6.53–8.93)	$ 7.09 (6.43–7.76)	$ 7.41 (6.61–8.22)
	Milk	$ 3.32 (3.11–3.53)	$ 3.20 (2.83–3.57)	$ 3.36 (3.14–3.59)	$ 3.13 (2.55–3.71)	$ 3.17 (2.78–3.56)	$ 3.36 (3.12–3.61)	$ 3.21 (2.92–3.49)
	Pasta	$ 5.36 (4.99–5.72)	$ 6.08 (5.24–6.92)	$ 5.33 (4.95–5.71)	$ 6.19 (3.85–8.54)	$ 5.96 (5.29–6.63)	$ 5.26 (4.85–5.68)	$ 6.00 (5.39–6.61)
	Rice	$ 8.19 (7.76–8.62)	$ 7.67 (6.91–8.43)	$ 8.01 (7.55–8.48)	$ 6.97 (5.26–8.68)	$ 8.48 (7.94–9.03)	$ 8.30 (7.80–8.81)	$ 7.72 (7.15–8.29)

[1] Due to fieldwork error, healthy option beverage items were only audited in 16 stores (21%)

[2] Due to fieldwork error, checkout numbers were not audited in 2 stores

[3] An observation for frozen vegetables was available in only 1 provincial chain store

Tyranny of the supermarket model Some of our findings were broadly consistent with the existing rural food access literature. We confirmed that supermarkets appear to have better overall product availability than convenience stores, but comparable differences in healthy versus regular food availability. Past studies of rural food access have shown that small proximal stores may have poorer availability and higher prices than distant chain supermarkets, encouraging consumers to shop outside their local community. Yet our study did not detect any differences in pricing by store features where rural consumers could save money at the 'big' stores such as supermarkets or national chains. The main benefit of shopping at those stores seemed to be a higher proportion of items available overall.

It is worth reflecting on the social construction of choice in contemporary multi-line retail settings and how it informs the role of large chain supermarkets in shopping decisions. Grocery shopping at major supermarkets for choice and good value, preferentially to small convenience stores, is an economic behaviour but also a social norm, even though there is debate in the literature about whether supermarkets should be considered 'healthy' food sources at all, given the wide range of unhealthy (regular) items in-store.

Limitations and strengths

This study builds upon methodology for rural food environment assessment in a few ways. Key strengths included coverage of a full rural region, with a mix of rurality, which contributes to the literature beyond urban-rural differences. We completed a census of stores to capture all exposures, except for non-food retailers (e.g., pharmacies were excluded).

We elected to use observed prices matched to nutrient composition data to compare stores, in place of the NEMS-S scoring algorithm. The NEMS-S original validation study showed good construct validity and strong inter-rater and test-retest reliability for the instrument in the field (Glanz et al. 2007). The NEMS-S scoring algorithm did not fare well in predicting differences between stores. The validation study for the original NEMS-S showed that the Price subscore of the algorithm yielded statistically significant results in the opposite direction to the Availability subscore, Quality subscore, and Total score. Another problem with the NEMS-S scoring algorithm is that it assigns excess weight to nutritionally desirable outcomes: for example, for price, + 2 score is awarded if healthy items are priced the same or cheaper than their regular counterpart; − 1 is awarded if regular items are more expensive.

Our nutrient composition approach contributes to expanding the analytic options for store audit data. A strength is that we used three units of measure (unit, serving, and energy), which allowed us to explore how bias may occur in price estimates and interpretation (Lipsky 2009), particularly comparisons between healthy and regular foods. For example, unit price ($/kg) and serving price ($/serving) tended to 'show' that energy dense, processed, regular foods are 'expensive' options. Energy prices ($/1000 kcal) emphasized high fruit and vegetable costs.

This analysis had a number of limitations. It was based on a NEMS-S checklist audit, so items assessed may not be representative of whole-of-store nutrition exposures. We imputed prices for missing values in some analyses, consistent with existing literature (Dunn et al. 2011). Consistent with the NEMS-S protocol, we assessed regular prices, and did not assess the effect of promotions or discounts—further research could capture differences in how healthy and regular foods are promoted through price incentives.

Another limitation was average prices. Although we had observations for many stores ($n = 78$), combining theoretically similar foods into product categories that are relevant to retailers or to diets can result in skewed, multimodal, or otherwise superficially unrecognizable distributions for price. Our recommendation for future inventory-type audit tools is to inspect a greater variety of foods in each category, for an improved distribution of nutrients and price.

As a cross-sectional study, we could not account for temporal variation in food availability or prices, including unpredictability of prices (Gittelsohn and Sharma 2009). For a car-dependent rural consumer, predictability in the shopping experience is of great value, leading rural consumers to do 'stock-up' shopping at more well-trafficked urban stores. Another temporal challenge with cross-sectional retail observational studies is seasonal variation, even amid growing standardization in the food supply. Summertime data collection may have overestimated average availability and underestimated price.

A final limitation is the distinctiveness of NL. Some trends we observed may be singular to the province, for example, those due to the high proportion of independent stores or provincewide determinants of food supply. Nonetheless, our study offers generalizable lessons for other rural jurisdictions across Canada and elsewhere. Rural and remote regions globally are facing a common set of socio-demographic and macroeconomic transitions. Diverse data points will be needed to evaluate the full set of potential impacts on diets and rural food access.

Conclusions

The cost of a healthy diet is under growing scrutiny as a public health problem (Monsivais et al. 2013; Rydén and Hagfors 2011). Food prices are a top if not the leading factor in consumption decisions (Glanz et al. 1998), but our understanding of rural food access and particularly price disparities is incomplete. Food prices have risen steadily over time, and from 2007 to 2012, food prices rose faster than any other component of consumer spending in Canada (Rollin 2013). This type of relative increase has the potential to seriously amplify population dietary disparities,

especially for rural households that allocate a greater proportion of household spending to food (Rollin 2013). Food supply subsidy mechanisms that address excess costs of freight for remote areas have failed to trickle down to improving availability or retail prices experienced by consumers (Galloway 2014). There is considerable debate about which policy levers best address disparities in food access and affordability for rural and remote populations, who face overlapping geographic and economic constraints.

This census of rural stores confirmed some of the consumer food environment patterns in existing rural store literature. The key outcome, however, was unexplained variation in rural food availability and price patterning, not generally associated with store features. In conclusion, with apologies to Tolstoy, we submit:

All stores are alike; each unhealthy store is unhealthy in its own way.

Acknowledgements K Jameson and N Moody contributed to conceptualization and oversight for the Health Canada project. Thanks to the stores and research team members, particularly B Knox, S Pomeroy, B Harnett, M Caravan, and L Burgess who contributed to field data collection. R Harris, L Minaker, and Y Yi offered feedback on earlier analyses.

Funding information This work was supported in part by Health Canada's Office of Nutrition Policy and Promotion [MOA #4500327812 to CM]; the Canadian Institutes of Health Research [FRN PG1-144782 to CM]; the Canada Research Chairs program [to CM]; and the Nova Scotia Graduate Scholarship program [to NT].

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethics approval This research did not involve human subjects but was reviewed by an institutional research ethics board, as part of a multicomponent project. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Health Research Ethics Board of Newfoundland and Labrador.

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