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ARTICLE

Examination of food industry progress in reducing the sodium content of packaged foods in Canada: 2010 to 2013

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Abstract: In 2010, as part of a national sodium reduction strategy, Canada published sodium reduction benchmark targets for packaged foods; however, no evaluation of this policy has occurred. The objective was to evaluate changes in the sodium content of packaged foods, identify categories reduced in sodium, and determine the proportion meeting Health Canada's sodium reduction benchmarks. This was a cross-sectional analysis of Canadian packaged foods in 2010 and 2013 (n = 10 487 and n = 15 394, respectively). Sodium content was obtained from the Nutrition Facts table. Overall, 16.2% of food categories had significantly reduced sodium levels. The greatest shifts in the distribution of sodium within food categories occurred in imitation seafood (mean ± SD, mg/100 g; 602 ± 50 to 444 ± 81, 26.2%, p = 0.002), condiments (1309 ± 790 to 1048 ± 620, 19.9%, p = 0.005), breakfast cereals (375 ± 26 to 301 ± 242, 19.7%, p = 0.001), canned vegetables/legumes (269 ± 156 to 217 ± 180, 19.3%, p < 0.001), plain chips (462 ± 196 to 376 ± 198, 18.6% p = 0.004), hot cereals (453 ± 141 to 385 ± 155, 15.0%, p = 0.011), meat analogues (612 ± 226 to 524 ± 177, 14.4%, p = 0.003), canned condensed soup (291 ± 62 to 250 ± 57, 14.1%, p = 0.003), and sausages and wieners (912 ± 219 to 814 ± 195, 10.7%, p = 0.012). The proportion of foods meeting at least 1 of the 3 phases of the sodium reduction benchmark targets slightly increased (51.4% to 58.2%) and the proportion exceeding maximum benchmark levels decreased (25.2% to 20.8%). These data provide a critical evaluation of changes in sodium levels in the Canadian food supply. Although progress in reducing sodium in packaged foods is evident, the food industry needs to continue efforts in reducing the sodium in the foods they produce.

Key words: sodium, sodium reduction, food supply, food industry, diet, policy.

Résumé : En 2010, dans le cadre de la stratégie nationale de réduction de sodium, le Canada a publié des repères pour la réduction des teneurs en sodium dans les aliments transformés; toutefois, cette politique n'a pas fait l'objet d'une évaluation. Cette étude a pour objectif d'évaluer les modifications de la teneur en sodium dans les aliments transformés, d'identifier les catégories d'aliments concernés et de déterminer la proportion se conformant aux repères de réduction en sodium selon Santé Canada. L'étude consiste en une analyse transversale des aliments transformés au Canada en 2010 et en 2013 (n = 10 487 et n = 15 394, respectivement). Le contenu en sodium provient des tableaux de la valeur nutritive des produits. Globalement, 16,2 % des catégories d'aliments présentent des teneurs significativement réduites en sodium. Les plus grandes modifications de la répartition du sodium sont dans les simili-fruits de mer (moyenne ± écart-type, mg/100g; 602 ± 50 à 444 ± 81, 26,2 %, p = 0,002), les condiments (1309 ± 790 à 1048 ± 620, 19,9 %, p = 0,005), les céréales pour petits déjeuners (375 ± 26 à 301 ± 242, 19,7 %, p = 0,001), les légumes/légumineuses en conserve (269 ± 156 à 217 ± 180, 19,3 %, p < 0,001), les croustilles ordinaires (462 ± 196 à 376 ± 198, 18,6 % p = 0,004), les céréales chaudes (453 ± 141 à 385 ± 155, 15,0 %, p = 0,011), les succédanés de viande (612 ± 226 à 524 ± 177, 14,4 %, p = 0,003), les soupes condensées en conserve (291 ± 62 à 250 ± 57, 14,1 %, p = 0,003), les saucissons et les saucisses de Francfort (912 ± 219 à 814 ± 195, 10,7 %, p = 0,012). La proportion des aliments se conformant à au moins une des trois étapes de l'atteinte des teneurs repères réduites en sodium augmente légèrement (51,4 % à 58,2 %) et la proportion des aliments qui dépassent les teneurs maximales repères en sodium diminue (25,2 % à 20,8 %). Ces données constituent une évaluation critique des modifications des teneurs en sodium dans l'approvisionnement alimentaire au Canada. Même si la réduction de la teneur en sodium des aliments emballés fait des progrès évidents, l'industrie alimentaire doit continuer ses efforts pour la réduction de la teneur en sodium des aliments produits. [Traduit par la Rédaction]

Mots-clés : sodium, réduction du sodium, approvisionnement alimentaire, industrie alimentaire, régime alimentaire, politique.

Introduction

Population-wide dietary sodium reduction is a public health priority worldwide (Beaglehole et al. 2011), due to the adverse cardiovascular and cerebrovascular outcomes associated with excess sodium consumption (Aburto et al. 2013; Institute of Medicine 2013). To address the health and economic burden of excess sodium, the United Nations has set a target for countries to reduce dietary salt intake by 30% by 2025 (World Health Organization (WHO) 2012). The average daily sodium intake in Canada is 3400 mg/day, which is more than 2 times higher than the recommended Adequate Intake level of 1500 mg and well above the Tolerable Upper Level of 2300 mg (Garrigeut 2007). Since most dietary sodium is

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derived from packaged and prepared foods, interventions to lower sodium in these foods is considered one of the most effective and equitable strategy to reduce sodium intakes (Fischer et al. 2009).

In 2010, a multi-stakeholder Sodium Working Group published Canada's Sodium Reduction Strategy. The Strategy included recommendations directed at the food supply, education and awareness, and research initiatives. The interim goal was to reduce average sodium consumption to 2300 mg/day by 2016 in the majority of the Canadian population (Sodium Working Group 2010). There were 10 food supply recommendations, including Recommendation 1–1: "The Working Group recommends that Health Canada continue to work with the food industry to establish voluntary sodium reduction targets by food category", to guide voluntary, incremental sodium reduction in packaged foods. Following a public consultation period, Health Canada published a set of benchmark targets to guide this process (Health Canada 2012).

Although the sodium reduction benchmark targets exist in Canada, the Sodium Working Group was disbanded prior to implementation of an evaluation framework, which was part of the Sodium Working Group's Terms of Reference. Therefore, there is currently no federal or provincial sodium-monitoring program to track the food industry's progress. Although sodium reduction efforts are occurring globally, most published studies report on changes in sodium in a few, pre-selected food categories (Dunford et al. 2011; Christoforou et al. 2013; Trevena et al. 2014) or selected foods (Jacobson et al. 2013). There are few comprehensive evaluations of changes to sodium levels across a broad range of food categories that contribute significant amounts of dietary sodium, and none in Canada. Such an analysis would give an indication of areas of success and challenge across a variety of sectors of the food supply. Therefore, the purpose of this study was to comprehensively assess changes in sodium levels in packaged foods sold in Canada from 2010 to 2013, particularly to determine changes in the distribution of sodium from 2010 to 2013 within foods categories, to assess the proportion of food categories that have had changes in sodium, and to examine food industry progress in meeting Health Canada's sodium reduction benchmark targets.

Materials and methods

This analysis utilized 2 cross-sectional datasets that are part of the University of Toronto Food Label Information Program (FLIP) database (Schermel et al. 2013). The database contains the nutrition information on a national sample of packaged foods and beverages that was systematically collected from February 2010 to April 2011 (n = 10 487) and from May 2013 to September 2013 (n = 15 394). Data included national and private-label brand foods from the 4 largest Canadian grocery chains, accounting for approximately 75% of food retail sales (Mintel International 2013). Products with multiple package sizes were captured only once. Data entered into the database included the Nutrition Facts table information, company, brand, price, container size, date and location of collection, and nutrition marketing information. The Canadian Nutrient File was used to create recipes so that food products could be reported "as consumed". Recipes were used so that like-products sold in different forms could be compared in an "as consumed" form in the same food category (i.e., so that baked cakes could be compared with dry mix cakes), which allows for accurate comparisons of sodium content when in a standardized format by food weight (mg sodium/100 g). Quality assurance procedures were implemented to ensure data quality and a protocol was developed to ensure consistency in classifications, weight conversions, and recipes between the 2010–2011 and 2013 datasets.

Assessment of sodium levels

The sodium content in foods was obtained from the Nutrition Facts table (mg/serving) and was converted to standardized units (mg/100 g). Health Canada's document *Guidance for the Food Industry on Reducing Sodium in Processed Foods* guided the classification of foods into food group categories, major subcategories, and minor subcategories (Arcand et al. 2014*a*; Health Canada 2012). Health Canada did not develop sodium reduction benchmarks for foods without a high sodium content or that did not contribute significantly to Canadian sodium intakes (i.e., fruit juices, dried pasta or rice without sauces or seasonings) (Health Canada 2012); therefore, the current analysis excluded these foods.

Statistical analysis

Continuous variables were presented as mean and standard deviations. Percentiles were calculated for each food category and subcategory. Changes in the distribution of sodium between 2010 and 2013 were examined using the Kolmogorov–Smirnov test. To calculate the overall proportion of categories that had statistically significant changes in sodium, we counted major subcategories and minor subcategories, taking steps to ensure categories/foods were not double counted, i.e., all minor subcategories and major subcategories without minor subcategories were included (n = 105 categories overall). Categorical variables were presented as frequencies and percentages. Health Canada's sodium reduction benchmarks include 2 interim benchmark target levels (phase 1 and 2), a 2016 goal level (phase 3), and a maximum level for each food category (Health Canada 2012). Standardized units (mg/100 g) were used to determine the proportion of products meeting the phased benchmarks and the maximum levels. All analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary, N.C., USA).

Results

Changes in the distribution of sodium between 2010 and 2013

The analysis overall included 16 105 packaged foods from 2010 (n = 6918) and 2013 (n = 9199) in 12 major food categories, which were further divided into major subcategories and minor subcategories for detailed analyses. On examination of the distribution of sodium levels between 2010 and 2013, 16.2% of food categories had statistically significant decreases in sodium, 1.9% had statistically significant increases in sodium, and 81.9% of food categories had no change in sodium (Supplementary Table S1[1]). Statistically significant changes from 2010 to 2013 occurred in imitation and simulated seafood (mean ± SD, mg/100 g; 602 ± 50 to 444 ± 81; 26.2% reduction, p = 0.002), condiments (1309 ± 790 to 1048 ± 620; 19.9% reduction, p = 0.005), ready-to-eat breakfast cereals (375 ± 246 to 301 ± 242; 19.7% reduction, p = 0.001), canned vegetables and legumes (269 ± 156 to 217 ± 180; 19.3% reduction, p < 0.001), plain chips (462 ± 196 to 376 ± 198; 18.6% reduction, p = 0.004), instant hot cereals (453 ± 141 to 385 ± 155; 15.0% reduction, p = 0.011), meat analogues (612 ± 226 to 524 ± 177; 14.4% reduction, p = 0.003), canned condensed soup (291 ± 62 to 250 ± 57; 14.1% reduction, p = 0.003), sausages and wieners (912 ± 219 to 814 ± 195; 10.7% reduction, p = 0.012), granola and cereal bars (279 ± 108 to 254 ± 99; 9.0% reduction, p = 0.020), fresh and frozen meat and poultry (535 ± 228 to 496 ± 323; 7.3% reduction, p = 0.001), shelf-stable mixed dishes (330 ± 114 to 308 ± 111; 6.7% reduction, p = 0.002), packaged bread products (448 ± 125 to 418 ± 129; 6.6% reduction, p = 0.012) and pizza (529 ± 121 to 494 ± 118; 6.7% reduction, p = 0.018) (Table 1, Supplementary Table S1[1]). Median sodium levels showed similar trends.

[1]Supplementary data are available with the article through the journal Web site at http://nrcresearchpress.com/doi/suppl/10.1139/apnm-2015-0617.

Table 1. Changes in the sodium content of Canadian packaged foods from 2010 to 2013.

	Year	*n*	Mean sodium (mg/100 g)	Sodium Percentiles (mg/100 g)						Mean %Δ	*p*[a]
				Min	10th	25th	50th	75th	Max		
Bakery products											
Packaged bread products	2010	379	448±125	11	298	368	446	521	976	−6.7	0.012
	2013	445	418±129	0	267	351	413	507	782		
Cookies	2010	309	298±141	18	121	189	294	393	900	−7.0	0.344
	2013	398	277±128	0.4	100	185	286	360	667		
Granola and cereal bars	2010	172	279±108	13	150	200	269	333	553	−9.0	0.020
	2013	200	254±99	16	150	187	243	304	553		
Crackers	2010	268	749±376	0	357	500	676	951	2105	−1.3	0.537
	2013	301	739±316	0	375	525	700	900	1857		
Pancakes, waffles, French toast	2010	71	531±110	248	404	462	515	614	775	−5.5	0.154
	2013	92	502±119	242	357	425	506	599	769		
Breadcrumbs and croutons	2010	53	878±305	133	450	714	929	1143	1357	1.9	0.732
	2013	64	895±392	133	357	586	904	1175	1800		
Baked desserts	2010	379	301±145	25	143	193	280	388	1408	−1.0	0.512
	2013	482	298±128	18	150	204	298	371	956		
Breakfast cereal											
Ready to eat breakfast cereals	2010	230	375±246	0	33	173	383	552	933	−19.7	0.001
	2013	250	301±242	0	7	82	255	481	929		
Instant hot cereal	2010	50	453±141	200	267	319	464	576	711	−15.0	0.011
	2013	60	385±155	0	201	300	442	475	778		
Cheese											
Natural cheese	2010	348	659±311	125	333	500	667	733	2533	5.3	0.908
	2013	437	694±405	12	333	500	667	733	3000		
Processed cheese products	2010	47	1467±378	310	935	1381	1600	1714	2000	4.0	0.948
	2013	56	1525±313	788	1000	1390	1619	1758	1905		
Fats and oils											
Margarine, salted	2010	49	672±110	300	550	600	700	700	1000	−2.8	0.856
	2013	49	653±93	300	600	600	650	700	850		
Butter, salted	2010	20	670±127	550	550	600	600	800	950	−0.9	0.998
	2013	19	664±188	71	550	600	600	800	950		
Mayonnaise	2010	96	882±243	375	567	742	900	1000	1500	−5.4	0.236
	2013	124	834±225	267	533	656	833	1000	1467		
Salad dressing	2010	163	948±328	233	531	781	938	1125	1813	−8.9	0.101
	2013	167	864±381	12	406	688	867	1000	2600		
Fish and seafood											
Canned tuna	2010	28	312±107	83	117	250	309	393	500	−9.0	0.508
	2013	46	284±108	27	117	250	294	327	596		
Other canned fish and seafood	2010	109	390±134	80	235	298	400	473	774	42.8	0.126
	2013	121	557±804	45	244	327	400	536	6000		
Frozen fish and seafood	2010	174	474±259	45	200	300	424	580	1436	11.0	0.443
	2013	219	526±831	24	200	289	400	595	8796		
Mixed dishes											
Shelf-stable mixed dishes	2010	358	330±114	0	226	262	310	377	822	−6.7	0.002
	2013	374	308±111	6	199	247	283	350	822		
Refrigerated and frozen appetizers, sides, and entrees	2010	528	337±157	49	191	231	301	400	1214	3.3	0.457
	2013	779	348±168	18	189	231	317	421	1214		
Pizza	2010	91	529±121	200	386	447	542	604	832	−6.6	0.018
	2013	156	494±118	215	361	416	494	568	1000		
Pizza snacks and frozen sandwiches	2010	63	504±145	329	341	398	461	563	906	−3.2	0.500
	2013	54	488±89	338	376	430	481	542	716		
Frozen fries, hash browns, and potato patties	2010	45	228±170	18	20	47	200	365	595	1.8	0.970
	2013	67	232±154	15	24	76	200	365	595		
Dry mashed or scalloped potatoes	2010	30	352±170	217	232	274	313	378	1178	−11.6	0.458
	2013	38	311±68	134	223	275	310	351	449		
Meat and meat substitutes											
Bacon	2010	7	694±152	420	420	589	776	813	840	−6.5	0.499
	2013	35	649±173	298	389	575	640	760	1038		
Sausages and wieners	2010	100	912±219	245	671	794	872	1036	1857	−10.7	0.012
	2013	141	814±195	254	571	730	827	921	1436		
Packaged deli meats	2010	171	1096±346	424	727	889	1000	1321	2429	−0.9	0.100
	2013	238	1086±388	394	683	810	972	1309	2429		
Meat sticks and jerky	2010	15	1759±635	750	1040	1154	1733	2300	2771	−9.3	0.280
	2013	40	1595±468	750	963	1312	1527	1949	2533		

Table 1 (*concluded*).

	Year	*n*	Mean sodium (mg/100 g)	Sodium Percentiles (mg/100 g)						Mean %Δ	*p*[a]
				Min	10th	25th	50th	75th	Max		
Fresh and frozen meat and poultry	2010	257	535±228	49	289	380	483	680	1330	−7.3	0.001
	2013	348	496±323	49	265	353	450	562	5000		
Meat analogues	2010	28	612±226	135	319	447	600	774	1154	−14.4	0.003
	2013	70	524±177	290	332	409	473	565	1020		
Soup											
Broth	2010	48	248±85	33	204	237	276	360	469	6.5	0.202
	2013	110	264±114	16	61	213	264	350	494		
Canned condensed soup	2010	71	291±62	128	221	248	291	333	477	−14.1	0.003
	2013	77	250±57	128	186	194	248	298	399		
Ready to serve soup	2010	142	247±67	55	183	189	252	281	474	−7.7	0.076
	2013	147	228±83	8	137	188	234	256	536		
Dry soup mixes	2010	56	305±93	135	208	250	280	349	628	−12.1	0.059
	2013	54	268±81	5	168	243	260	310	463		
Fresh and instant oriental noodles	2010	17	222±110	37	99	154	183	336	451	16.2	0.025
	2013	76	258±79	110	164	204	236	314	451		
Snacks											
Plain chips	2010	81	462±196	0	240	360	460	540	1000	−18.6	0.004
	2013	106	376±198	0	160	270	368	480	960		
Flavoured chips	2010	151	734±218	200	520	600	700	840	1460	−7.2	0.090
	2013	185	681±181	279	460	540	658	800	1351		
Popcorn	2010	58	647±295	0	304	467	653	800	1350	−3.9	0.580
	2013	75	622±220	213	375	460	594	760	1170		
Pretzel and snack mixes	2010	30	1146±466	213	758	850	990	1480	2080	−15.9	0.104
	2013	56	964±385	175	480	637	957	1280	1720		
Sauces, dips, gravies, and condiments											
Pasta sauce	2010	169	444±239	136	272	331	399	496	2667	−3.2	0.246
	2013	228	430±292	70	248	292	372	468	3600		
Tomato sauce	2010	13	256±168	15	15	38	308	385	485	16.0	1.00
	2013	17	297±177	15	23	231	308	385	736		
Other sauces, dips, gravies, and condiments	2010	500	986±806	0	333	468	733	1200	5800	6.1	0.002
	2013	825	1046±1243	0	300	417	621	1105	9600		
Canned vegetables and legumes											
Canned vegetables and legumes	2010	328	269±156	0	20	192	263	335	1238	−19.3	<0.001
	2013	371	217±180	0	8	128	211	293	2143		
Vegetable juice and cocktail	2010	35	210±93	51	53	136	233	249	370	−12.4	0.234
	2013	41	184±81	53	54	160	187	241	327		
Pickled vegetables	2010	112	820±423	188	383	533	767	974	2467	6.0	0.390
	2013	153	869±499	17	357	567	800	1069	3500		
Olives	2010	47	1489±492	633	750	1000	1563	1867	2533	−1.9	0.996
	2013	90	1461±477	556	758	1067	1567	1813	2667		

Note: Data are presented as means ± standard deviation. A complete, detailed analysis of all subcategories is provided in Supplementary Table S1.[1] This table presents a summary of data. For data on all major categories, major subcategories, and minor subcategories, please see the online supplementary material.

[a]Statistically significant changes in the distribution of sodium were determined by the Kolmogorov–Smirnov test. A p value <0.05 was considered statistically significant.

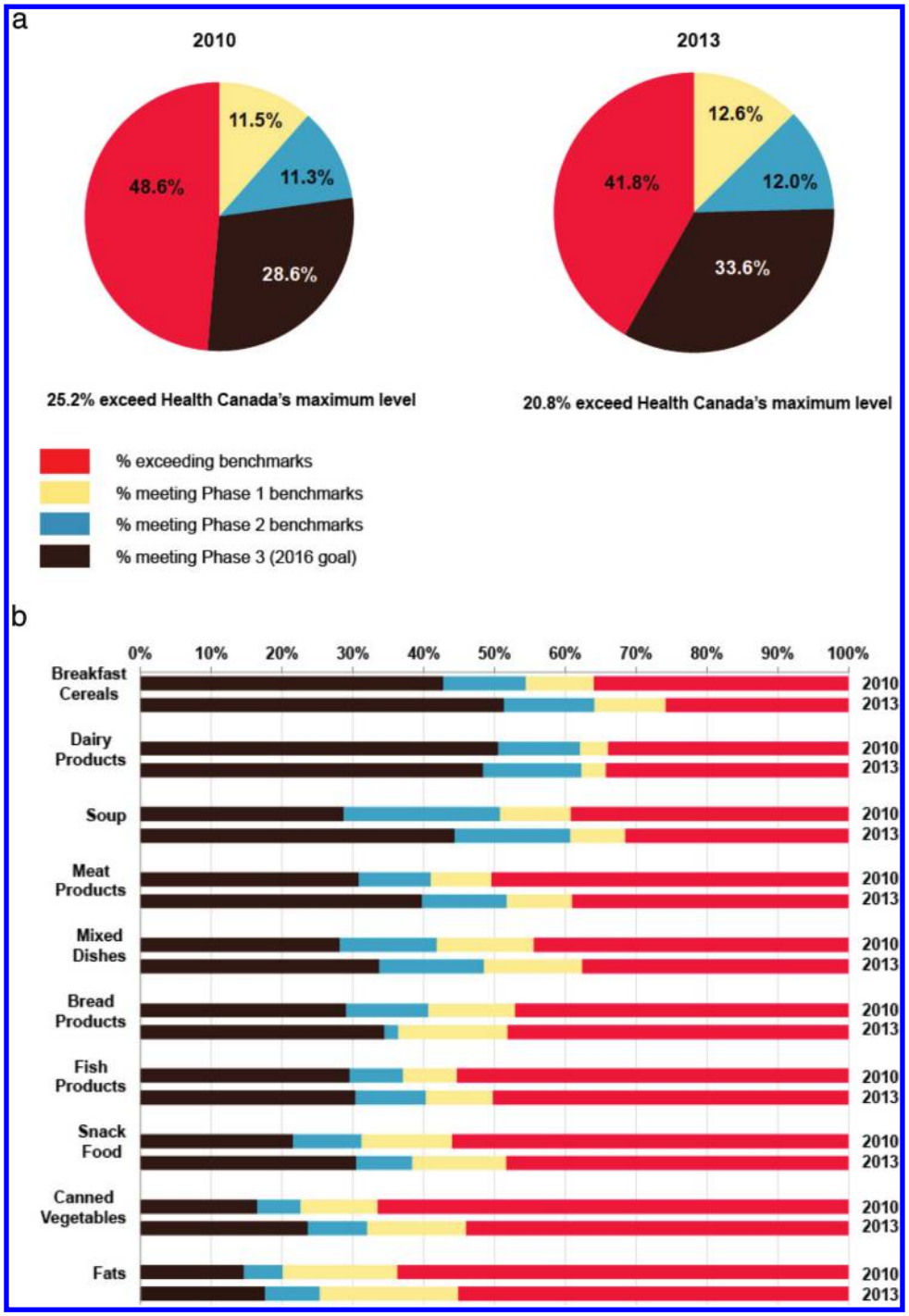
For the above-mentioned categories, the statistically significant changes in the distribution of sodium for major subcategories were often driven by certain minor food categories. For example, English muffins (462 ± 190 to 299 ± 77, 35.3% reduction, $p = 0.008$) and pantry rolls and buns (488 ± 88 to 444 ± 78; 9.0% reduction, $p = 0.003$) influenced the significant reduction in sodium in packaged breads from 2010 to 2013, whereas the other 9 minor packaged bread categories, which included pantry breads, had no significant change (Supplementary Table S1[1]). Likewise, changes to the shelf-stable mixed dishes major subcategory was influenced by pasta noodles with sauce (324 ± 76 to 291 ± 78; 10.2%; reduction, $p < 0.001$), with no significant change in the 5 other minor categories. Breaded meat and poultry (605 ± 157 to 523 ± 198; 13.6% reduction, $p = 0.001$) and chicken wings (779 ± 244 to 705 ± 266; 9.5% reduction, $p = 0.012$) were the minor categories responsible for the sodium reduction observed in the fresh and frozen meat and poultry major subcategory.

In contrast, 3 categories showed a statistically significant increase in mean sodium levels from 2010 to 2013. These included the sauces, dips, gravies, and condiments major subcategory (986 ± 806 to 1046 ± 1243; 6.1% increase, $p = 0.002$), which was influenced by the minor category soya and other oriental sauces (1355 ± 1345 to 3783 ± 2443; 179.2% increase, $p < 0.001$) (Table 1, Supplementary Table S2[1]). Sodium levels were also higher in oriental noodles in 2013 compared with 2010 (222 ± 110 to 258 ± 79; 16.2% increase, $p = 0.025$). Several other categories had nutritionally relevant but not statistically significant increases in sodium, such as uncooked moisture enhanced meat, seasoned and stuffed fish and seafood, and sweet oriental sauces. However, these changes in the distribution of sodium likely resulted from large outliers or by sampling variation between 2010 and 2013.

Changes in the proportion of products meeting Health Canada's sodium benchmarks

Overall, there was a slight increase in the proportion of foods that met at least one of the benchmark targets, from 51.4% of products in 2010 to 58.2% in 2013 (Fig. 1*a*, Supplementary Table S2[1]). This pattern was evident in most major food categories with the great-

Fig. 1. (*a*) Proportion of packaged foods meeting and exceeding Health Canada's sodium benchmark targets in 2010 and 2013. The proportion of all packaged food products that do not meet any of the benchmark targets (red) and that meet the interim benchmark targets of phase 1 (yellow), phase 2 (blue), and the 2016 goal (phase 3) benchmark targets (brown) as established by Health Canada (Health Canada 2012). Full set of data are presented in Supplementary Table S2.[1] (*b*) Proportion of packaged foods by food group categories meeting and exceeding sodium benchmark targets in 2010 and 2013. The proportion of products in food group categories that do not meet any of the benchmark targets (red) and that meet the interim benchmark targets of phase 1 (yellow), phase 2 (blue), and the 2016 goal (phase 3) benchmark targets (dark brown) as established by Health Canada (Health Canada 2012). Full set of data are presented in Supplementary Table S2.[1] [Colour online.]



est improvements from 2010 to 2013 observed among canned vegetables and legumes (33.5% to 46.1%), meat and meat substitutes (49.6% to 61.0%), and ready-to-eat breakfast cereals (64.1% to 74.2%). In contrast, nut butters had a lower proportion of products that met any benchmark in 2013 (83.3% to 71.4%) (Fig. 1*b*, Supplementary Table S2[1]).

In 2013, the greatest proportion of products meeting the phase 3 goal benchmark targets were among breakfast cereals (51.3%), dairy products (48.5%), soups (44.4%), and meat and meat substitutes (39.8%) (Fig. 1*b*, Supplementary Table S2[1]). From 2010 to 2013, most categories made a positive change towards meeting the phase 3 benchmark targets, increasing from 28.6% to 33.6%, over-

all. The greatest positive changes were seen in soups (28.4% to 44.4%), meat and meat substitutes (30.8% to 39.8%), snack foods (21.6% to 30.4%), and ready-to-eat breakfast cereals (42.7% to 51.3%). In contrast, nut butters and dairy products had a decrease in the proportion of products meeting the phase 3 goal benchmark level, 43.3% to 28.6% and 50.6% to 48.5%, respectively.

The proportion of foods that exceeded Health Canada's maximum benchmark level reduced from 25.2% in 2010 to 20.8% in 2013 (Fig. 1*a*, Supplementary Table S2[1]). The greatest reductions were observed among meat and meat substitutes (60.9% to 46.2%), canned vegetables and legumes (28.7% to 21.5%), breakfast cereals (14.6% to 9.0%), and bakery products (24.3% to 19.6%). These data are supported by the findings of a shift in the distribution of sodium from 2010 to 2013, whereby many categories had reduced sodium levels at the maximum end of the range, such as packaged bread products (range: 11–976 to 0–782 mg/100 g) and canned condensed soup (range: 128–477 to 128–399 mg/100 g). Additionally, a slight reduction in sodium content was also observed at the 75th percentile for many of these categories. These data point to efforts that are being made to improve the products with the highest levels of sodium.

Discussion

This data provides a detailed first evaluation of the effects of Canada's voluntary approach to sodium reduction in foods that contribute the most sodium to the Canadian diet, work that is crucial in the absence of any federal or provincial sodium-monitoring program. Globally, this study is one of the largest known comprehensive assessments of changes to sodium levels in the food supply, and offers insight into food categories that are rapidly improving. In this study, only 16% of categories showed a statistically significant reduction in sodium from 2010 to 2013. Thus, despite some foods that had modest changes, the majority of food categories achieved no significant change (i.e., did not attain statistical significance). There was an overall increase in the proportion of foods meeting one of Health Canada's sodium benchmark targets, from 51.4% in 2010 to 58.2% in 2013, and a reduction in the proportion of foods exceeding Health Canada's maximum benchmark level (25.2% to 20.8%). This data has identified areas for action for the government and the food industry as other sodium reduction initiatives are implemented in an effort to meet the sodium intake goals set for 2016.

The 2010 "baseline" data on sodium levels in packaged foods represented the food supply at the release of Canada's Sodium Reduction Strategy in 2010, with comparable data 2 years into implementation of that Strategy. The benchmark targets were set to achieve a 25%–30% overall sodium reduction by 2016, with interim targets developed to encourage incremental reductions of approximately one-third (8%–10% reduction) for phase 1, and two-thirds (16%–20% reduction) for phase 2. Examining the data in this manner allows for the observation of gradual incremental reductions that are occurring in the food supply, given that this is a midterm analysis. Indeed, our data show that some manufacturers have opted to make dramatic reformulations in a short period of time. For example, ready-to-eat breakfast cereals, instant hot cereals, canned vegetables and legumes, plain chips, condiments, and imitation and simulated seafood each achieved a reduction in sodium of almost 15% or more. More modest, yet significant reductions in sodium of 7% to 14% occurred in packaged bread products, canned condensed soup, sausages and wieners, granola and cereal bars, fresh and frozen meat and poultry, shelf-stable mixed dishes, pizza, and meat analogues. These early, progressive changes may reflect the nature of sodium reduction in these types of foods, i.e., they may be more easily reformulated considering product quality and food safety or reformulated products may be well-accepted by consumers. In categories that did not achieve statistical significance, there was evidence of product reformulations occurring at the higher range of sodium, as demonstrated by lower sodium levels at the 75th percentile, lower maximum values, and reductions in the proportion of foods exceeding Health Canada's maximum benchmark level. Despite these successes, statistically significant reductions in sodium were only observed in a small number of food categories. Since variations in food intake patterns vary across population subgroups, sodium reduction will eventually need to occur across all sectors of the foods supply to ensure equitable benefits for all Canadians.

Overall, the majority of categories (84%) had no significant change in sodium content between 2010 and 2013. Additionally, some of the foods that contribute the most significant amounts of dietary sodium remained relatively unchanged. For example, changes to the sodium content of packaged bread products were driven by reductions in English muffins and rolls and buns. Whereas, pantry breads, a widely consumed food, had only a 6.7% reduction in sodium with no significant change in the distribution of sodium from 2010 to 2013, a less than the expected rate of reduction. Other countries have made far greater gains in the reformulation of breads. Over a similar time period, sodium in breads have been reduced by 18% in Argentina and Spain (Ballesteros 2014; NCD Health Promotion and Control Department 2014), 12% in France (De L'Agence Nationale de Sécurité Sanitaire de L'alimentation de L'environnement et du Travail 2012), and 9% in Australia (Dunford et al. 2011). After breads, processed meats are the second greatest contributor to the sodium intakes of Canadians. Only sausages and wieners and fresh and frozen meat and poultry products had significantly lower levels of sodium in 2013. Importantly, the widely consumed package deli meat category had an insignificant 0.9% reduction in mean sodium levels, with no differences from 2010 to 2013 in the sodium content of either fully cooked or dry cured meats (data not presented). While some movement has been made on the proportion of deli meats that exceed Health Canada's maximum benchmark level, as a whole, sodium levels have not changed enough to shift the distribution of the sodium content of foods in this category. On examination of all of the packaged foods included in this analysis, 41.8% of foods still do not meet any benchmark target and 20.8% still exceed Health Canada's maximum benchmark level; therefore, there is still much progress to be made.

This data are a snapshot of the food industry's progress 2 years into Health Canada's sodium reduction target date of 2016; however, it raises the question of the effectiveness and sustainability of a voluntary approach to reducing sodium levels in packaged foods in the absence of other complementary policies or programs. In comparison, the success of voluntary trans fat reduction in the Canadian food supply is largely attributable to Health Canada's Trans Fat Monitoring Program, which conducted planned, periodic analysis and public reporting of the trans fat content in foods (Ratnayake et al. 2009*a*, 2009*b*; Krenosky et al. 2012). A recent assessment found that 97% of Canadian packaged and restaurant foods fall within the recommended trans fat limits (Arcand et al. 2014*b*). In the current Canadian political climate, however, it is unlikely that more assertive steps to sodium reduction will occur in Canada. Therefore, responsibility is now placed upon the food industry to honor their commitments, on the government and other third parties to monitor food industry progress, and on consumers to choose lower sodium foods. Although Canadian consumers report a preference for lower sodium foods (Wong et al. 2013), some of the top-reported barriers to reducing sodium intake are the limited variety of lower sodium packaged foods and restaurant foods (Arcand et al. 2013). Therefore, industry must continue their efforts to meet the needs of engaged consumers. Reducing sodium across the food supply will also improve the health of Canadians who do not actively seek out lower sodium foods.

While this study offers a comprehensive look at nutritional changes in the packaged food supply, there are limitations. There

were sample size differences between 2010 and 2013 in some food categories; however, the grocery stores where data were sampled remained the same, ensuring that major national brands on the market were captured. This analysis also included private label brands, a growing segment of the grocery marketplace that may have differing levels of sodium (International Markets Bureau 2010; Trevena et al. 2015). Cost limitations restricted access to sales weighted data for this analysis, therefore data are presented and analyzed unweighted to market share. However, studies have shown little variation between weighted and unweighted means with only select food group categories being affected (Ni Mhurchu et al. 2011). We also relied on the Nutrition Facts table data to provide information about sodium content, an approach taken by many investigators worldwide. However, even among products selectively identified for analysis, the proportion of inaccurate sodium content on the Nutrition Facts table remains relatively low (Fitzpatrick et al. 2014). Finally, since the 2010 "baseline" data collection extended into early 2011, the data may not represent a true baseline in relation to the Sodium Reduction Strategy recommendations and thus underestimate the observed magnitude of sodium reduction.

In summary, this study is the first comprehensive examination of early successes and shortcomings of the efforts made by the food industry in a voluntary program of reducing the sodium content of Canadian packaged foods. Though some progress has been made in various sectors, this data supports the need for continued efforts by the food industry in lowering the sodium content of packaged food items and for continued monitoring of this progress as foods are reformulated to meet the 2016 benchmark targets.

Conflict of interest statement

The authors have no conflicts of interest to disclose.

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