Canadians Continue to Consume Too Much Sodium and Not Enough Potassium

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ABSTRACT

Objectives: Excessive sodium (Na) intakes and insufficient potassium (K) intakes are known contributors to hypertension. In July 2010, the Health Canada-led multi-stakeholder Sodium Working Group issued recommendations to lower Na intakes of Canadians. Baseline data and ongoing monitoring are needed.

Methods: Na and K content based on recently analyzed food composite samples from the Canadian marketplace were matched with over 35,000 dietary recalls from the Canadian Community Health Survey (CCHS 2.2). The distributions of usual intakes for Na and K were constructed using SIDE software and estimates by age and sex for the 5th, 10th, 25th, mean, median, 75th, 90th and 95th percentiles were determined.

Results: Based on recent analyses of Canadian foods, the majority of Canadians exceeded the Tolerable Upper Intake Level (UL) for Na for their age and sex group, including infants, children, adolescents and adults. In sharp contrast, few had Adequate Intakes (AI) of K.

Conclusion: Canadians of all ages need to decrease Na intakes below the UL. At the same time, increased consumption of dairy products, fruits and vegetables must be promoted to increase K intakes to current recommendations. Both dietary interventions are required to help lower hypertension in the Canadian population. We provide the first report based on direct analyses of Canadian foods, confirming the high Na and low K intakes of the Canadian population. With its annual sampling program of foods commonly consumed in Canada, the Total Diet Study provides an important sentinel system for monitoring these dietary risk factors for hypertension.

Key words: Sodium; potassium; diet; food analysis; nutritional requirements; population groups

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

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Sodium (Na) intakes are a major focus of public health concern in many countries at the present time. In July 2010, the Health Canada-led Sodium Working Group (SWG) released its strategy report, which emphasized the link of excessive Na intake to hypertension, while acknowledging its role in several other important chronic diseases.[1] Hypertension affects 20% of adults in Canada and another 20% have pre-hypertension.[2] Chronic, progressive hypertension is strongly associated with adverse cardiovascular changes leading to multi-organ damage, morbidity and death.[3]

Many people in Western societies consume too much Na and not enough potassium (K), both of which factors contribute to the high prevalence of hypertension in these populations.[4,5] For most adult North Americans, the Adequate Intake (AI) for Na is 1500 mg/d, while the Tolerable Upper Intake Level (UL) for Na is 2300 mg/d; the AI for K is 4700 mg/d for adults. There is no UL for K due to low intakes in North America and its ready excretion given normal kidney function.[6] It has been estimated that if the Na intake of Canadians were decreased by 1840 mg/d, bringing the intakes of adult men into alignment with the AI, the prevalence of hypertension would decrease by 30% and 23,500 cardiovascular disease events per year would be prevented.[7,8] This kind of projection is, to our knowledge, not available for K. However, the effect that increasing K intakes has on reducing hypertension is additive to the effect of decreasing Na intakes,[4] making it relevant to consider the two nutrients together.

An important recommendation of the SWG was to lower Na intakes of Canadians through changes in the food supply. Total Diet Studies (TDS) have been promoted by the World Health Organization and Health Canada for monitoring of a wide variety of chemicals in the food supply.[9] In the United States, TDS have long been used to track changes in nutrients including Na and K.[10] The advantage of TDS is that foods that are analyzed are prepared as if for household consumption, rather than being analyzed raw or as purchased.[11] The Canadian Total Diet Study is designed to collect and analyze market samples representing the majority of foods commonly purchased in Canada[9] for sentinel monitoring of changes in the Canadian food supply.

The purpose of this study was to create, using direct analysis of Na and K content of Canadian market foods, baseline information on population distributions of Na and K intakes by gender and age categories in the Canadian population. The specific objectives were

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to match the Na and K content of these recently analyzed Canadian food composites with the national dietary intake data in the Canadian Community Health Survey (CCHS 2.2). Previous reports had combined the Canadian Nutrient File (CNF) food composition data with CCHS 2.2 dietary intake data to estimate Na and K intakes,[12-14] but much of the data in the CNF are derived from US Department of Agriculture food composition tables[15,16] and not Canadian data. It is acknowledged that some of these data are a decade or more old. By combining dietary intake recall data from CCHS 2.2 with our recent food composition data using foods purchased in Canada for the TDS, we provide the first-ever baseline Canadian data that will allow Health Canada to track future changes in the Canadian food supply resulting from implementation of the SWG recommendations.

MATERIALS AND METHODS

Food sample acquisition and analysis

Sample collection and details of the analytical results have been reported previously.[17] Briefly, the 2007 Canadian TDS collection included 154 composites from a total of 930 foods, with different brands purchased at retail outlets in Vancouver, Canada. Each composite was made from foods representing the most popular brands based on supermarket shelf space. Food samples were processed as if for home consumption at the Kemptville Food Laboratory of the University of Guelph. No salt was added to the foods during or after cooking. Each composite was analyzed for Na and K content by atomic spectroscopy techniques on a PerkinElmer AAnalyst 400 (PerkinElmer, Norwalk, CT).[17] A few samples contained less than the detection limit of Na or K; an assigned value equal to the detection limit (2 mg/kg for either Na or K) was used for intake modelling.

Dietary intake data and matching to food composites

Dietary intake data from the Canadian Community Health Survey, Cycle 2.2 (CCHS 2.2), conducted between January 2004 and January 2005,[15] were used. These CCHS 2.2 data consisted of over 35,000 24-hour dietary recalls of specific foods by Canadians, with a second 24-hour recall from a random subset of individuals to permit statistical adjustment for within-person variation to estimate usual intakes. Our Canadian TDS composites, analyzed for Na and K content, were matched to foods in the CCHS food intake recall data. The degree of matching of foods from CCHS 2.2 to the TDS composites was evaluated as a proportion of the amount of food consumed (86.0% match) and the total energy consumed (75.2% match), establishing that most of the

Table 1. Percentile Estimates of Usual Sodium Intakes by Age and Sex Groups, Based on Analyses in the Canadian Total Diet Study 2007 (Vancouver), Including Percent Over the Adequate Intake (AI) and Tolerable Upper Intake Level (UL)

Sex	Years	N	Mean	(SE)	5th	(SE)	10th	(SE)	25th	(SE)	50th	(SE)	75th	(SE)	90th	(SE)	95th	(SE)	AI	%>AI	(SE)	UL	%>UL	(SE)
Both	1-3	2114	1731	*36*	983	*51*	1126	*48*	1388	*45*	1725	*46*	2121	*55*	2528	*75*	2796	*92*	1000	94.5	*1.5*	1500	66.9	*3.4*
	4-8	3235	2437	*38*	1725	*84*	1864	*73*	2117	*55*	2428	*47*	2779	*71*	3134	*114*	3367	*147*	1200	100	*0.1*	1900	88.3	*3.3*
Female	9-13	1980	2677	*58*	1664	*70*	1847	*66*	2180	*60*	2601	*63*	3098	*82*	3631	*120*	3997	*154*	1500	97.7	*0.9*	2200	73.9	*3.3*
	14-18	2256	2711	*47*	1773	*77*	1961	*73*	2307	*64*	2741	*62*	3228	*78*	3713	*109*	4028	*136*	1500	98.7	*0.6*	2300	75.4	*3.4*
	19-30	1854	2513	*64*	1689	*126*	1836	*111*	2100	*87*	2421	*76*	2774	*101*	3121	*150*	3344	*187*	1500	98.4	*1.2*	2300	59.7	*6.7*
	31-50	2686	2522	*49*	1460	*67*	1652	*64*	2010	*60*	2473	*61*	3022	*78*	3603	*111*	3996	*141*	1500	94.1	*1.5*	2300	59.4	*3.3*
	51-70	3200	2364	*42*	1467	*68*	1628	*64*	1929	*56*	2321	*51*	2785	*64*	3272	*97*	3602	*129*	1300	98	*0.8*	2300	51.3	*3.3*
	71+	2610	2074	*41*	1230	*48*	1377	*47*	1652	*46*	2004	*50*	2417	*64*	2857	*89*	3159	*113*	1200	95.8	*1.1*	2300	31	*3.3*
Male	9-13	2080	3247	*64*	2135	*95*	2333	*88*	2704	*78*	3187	*74*	3755	*91*	4355	*134*	4765	*175*	1500	99.9	*0.1*	2200	93.6	*2*
	14-18	2288	3816	*80*	2401	*122*	2690	*114*	3224	*102*	3888	*98*	4633	*122*	5394	*176*	5908	*224*	1500	99.9	*0.1*	2300	96.2	*1.3*
	19-30	1804	3758	*110*	2450	*180*	2696	*164*	3150	*139*	3728	*135*	4396	*182*	5082	*273*	5536	*347*	1500	100	*0.1*	2300	97	*1.7*
	31-50	2596	3336	*73*	1882	*123*	2150	*113*	2645	*98*	3281	*89*	4022	*109*	4797	*161*	5315	*204*	1500	98.7	*0.6*	2300	86.2	*2.9*
	51-70	2550	3045	*59*	1728	*83*	1958	*77*	2386	*69*	2948	*68*	3596	*88*	4302	*143*	4799	*194*	1300	99.1	*0.4*	2300	78.5	*2.7*
	71+	1520	2586	*59*	1533	*78*	1722	*76*	2073	*74*	2532	*78*	3071	*96*	3632	*131*	4012	*161*	1200	99.1	*0.4*	2300	62.8	*4.1*

Table 2. Percentile Estimates of Usual Potassium Intakes by Age and Sex Groups, Based on Analyses in the Canadian Total Diet Study 2007 (Vancouver), Including Percent Over the Adequate Intake (AI)

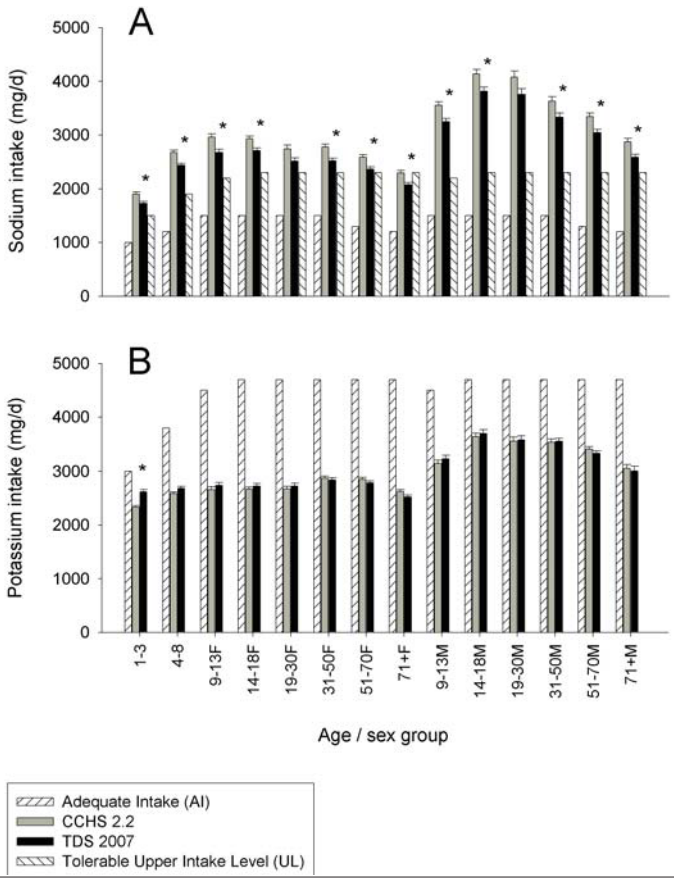
Sex	Years	N	Mean	(SE)	5th	(SE)	10th	(SE)	25th	(SE)	50th	(SE)	75th	(SE)	90th	(SE)	95th	(SE)	AI	%>AI	(SE)	UL	%>UL	(SE)
Both	1-3	2114	2619	*42*	1367	*52*	1598	*52*	2040	*50*	2576	*51*	3191	*62*	3878	*87*	4355	*111*	3000	31.5	*2.1*	–*	–	–
	4-8	3235	2684	*37*	1599	*51*	1801	*45*	2165	*41*	2633	*43*	3176	*58*	3745	*84*	4129	*106*	3800	9.1	*1.4*	–	–	–
Female	9-13	1980	2739	*54*	1529	*53*	1739	*50*	2135	*48*	2644	*55*	3234	*74*	3839	*101*	4236	*123*	4500	3.1	*0.8*	–	–	–
	14-18	2256	2730	*44*	1496	*52*	1715	*50*	2131	*50*	2665	*53*	3308	*67*	4004	*93*	4465	*117*	4700	3.4	*0.7*	–	–	–
	19-30	1854	2728	*54*	1596	*68*	1800	*65*	2176	*61*	2657	*63*	3218	*78*	3798	*107*	4184	*133*	4700	1.9	*0.6*	–	–	–
	31-50	2686	2842	*39*	1568	*48*	1798	*47*	2238	*44*	2772	*49*	3381	*61*	4025	*89*	4473	*123*	4700	3.5	*0.8*	–	–	–
	51-70	3200	2786	*38*	1604	*54*	1829	*50*	2230	*45*	2730	*44*	3306	*54*	3903	*72*	4299	*89*	4700	2.3	*0.5*	–	–	–
	71+	2610	2525	*35*	1436	*48*	1635	*47*	2002	*46*	2465	*46*	3005	*51*	3578	*65*	3968	*79*	4700	1.2	*0.3*	–	–	–
Male	9-13	2080	3239	*62*	1881	*76*	2118	*74*	2571	*69*	3150	*71*	3830	*88*	4568	*122*	5076	*152*	4500	10.9	*1.7*	–	–	–
	14-18	2288	3696	*74*	2058	*87*	2375	*83*	2956	*77*	3692	*85*	4567	*111*	5528	*159*	6205	*205*	4700	22.2	*2.3*	–	–	–
	19-30	1804	3580	*77*	2022	*97*	2294	*94*	2809	*89*	3481	*91*	4270	*118*	5096	*165*	5655	*208*	4700	15.8	*2.5*	–	–	–
	31-50	2596	3550	*58*	2040	*76*	2320	*73*	2835	*66*	3490	*68*	4242	*86*	5038	*120*	5578	*149*	4700	15	*1.8*	–	–	–
	51-70	2550	3322	*49*	1934	*61*	2191	*57*	2656	*53*	3225	*59*	3886	*74*	4595	*102*	5088	*128*	4700	8.7	*1.3*	–	–	–
	71+	1520	3008	*89*	1591	*83*	1834	*82*	2289	*79*	2890	*87*	3604	*112*	4368	*163*	4919	*205*	4700	6.6	*1.6*	–	–	–

* no UL has been established for potassium[1]

Table 3. Estimated Percent Contribution of Food Groups to Usual Sodium and Potassium Intakes, Based on Analyses in the Canadian Total Diet Study 2007 (Vancouver)

	Children		Males				Females				Total
	1-3	4-8	9-13	14-18	19-70	71+	9-13	14-18	19-70	71+	Population
Sodium											
Milk and dairy products	29.4	23.1	20.5	19.9	14.8	12.9	20.5	19.1	16.6	15.2	16.8
Meat, poultry and fish	12.4	11.4	13.3	14.0	14.7	15.9	12.7	9.8	13.3	12.7	13.7
Soups and fast foods	15.8	17.5	17.5	18.2	20.5	19.6	18.8	18.9	17.8	21.8	19.1
Bread and cereals	22.7	27.8	27.1	25.2	25.7	30.2	27.3	27.4	24.9	28.2	25.9
Vegetables	6.6	8.0	7.0	7.4	8.6	7.5	6.9	8.4	9.8	7.6	8.6
Fruit	1.0	0.8	0.5	0.4	0.4	0.4	0.7	0.5	0.5	0.4	0.5
Snacks and sweets	2.1	3.0	3.2	2.2	1.9	1.6	3.0	2.4	2.5	1.9	2.3
Ingredients and sauces	8.5	7.6	9.9	11.2	10.5	9.0	8.9	11.8	11.3	9.1	10.4
Baby foods	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Beverages	0.6	0.7	0.9	1.5	2.8	2.9	1.0	1.6	3.3	3.1	2.6
Potassium											
Milk and dairy products	55.4	43.6	40.5	35.8	22.0	25.9	38.5	35.1	25.1	25.6	27.5
Meat, poultry and fish	5.5	7.7	10.6	12.5	14.1	11.7	9.4	10.0	12.0	10.9	12.2
Soups and fast foods	2.1	3.5	4.1	5.0	4.4	2.3	3.9	4.7	3.2	2.4	3.8
Bread and cereals	4.6	7.0	7.4	7.2	6.8	7.2	7.3	7.4	6.2	6.8	6.6
Vegetables	6.8	11.8	13.6	15.2	16.9	15.6	14.3	15.9	17.3	16.2	16.1
Fruit	22.3	22.8	19.3	18.3	16.7	18.6	22.5	20.7	18.6	21.9	18.5
Snacks and sweets	1.2	2.3	2.6	2.0	2.4	2.3	2.4	2.2	2.5	2.0	2.4
Ingredients and sauces	0.4	0.8	0.9	1.1	0.7	0.4	0.8	1.0	0.6	0.4	0.7
Baby foods	1.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Beverages	0.2	0.5	0.8	2.9	16.0	15.9	0.7	3.0	14.4	13.9	12.2

Figure 1. Mean sodium (A) and potassium (B) intakes of Canadians by age and sex group, compared to Adequate Intake (AI) and Tolerable Upper Intake Level (UL) values[1]



TDS 2007 = present study based on food analyses from the Canadian Total Diet Study 2007, combined with food recall data from the Canadian Community Health Survey (CCHS 2.2). CCHS 2.2 = based on references 14 and 15, with food composition from the Canadian Nutrient File combined with the food recall data from CCHS 2.2.
* = within a group of bars, TDS 2007 value significantly different from CCHS 2.2 value ($p<0.05$).

Canadian diet was represented by TDS composites. Examination of the lists of unmatched foods revealed that these were typically consumed by few individuals, made only very small contributions (<0.5%) to Na or K intakes, and were widely distributed across the TDS food groups. Where no match was possible for a given food, the corresponding value from the original CCHS 2.2 reports was retained,[12,13] to ensure that all foods had Na and K values in modelling. This facilitated comparison between the CCHS 2.2 reports and the TDS-based Na and K intake estimates in the present work.

Statistical methodology

Distributions of Na and K usual intakes were constructed using SIDE software (Version 1.11, Iowa State University Center for Survey Statistics and Methodology, Ames, IA), which uses the method described by Nusser et al.[18] Usual intake distributions were represented by output of selected percentiles (5th, 10th, 25th, median, 75th, 90th, and 95th) and the mean. Because the CCHS 2.2 has a complex survey design, the standard error for each point estimate was computed by bootstrap replication methodology,[19] using bootstrap weights provided by Statistics Canada for the CCHS 2.2 dataset. The estimated percentage of population intakes above the AI for both Na and K were calculated, as was the estimated percentage above the UL for Na. Mean values of Na and K intakes derived from TDS were compared to the CCHS 2.2 reports[12,13] using t-test with Bonferroni correction.[20]

RESULTS

Na intakes based on TDS 2007 results showed that most Canadians exceeded the UL for Na (Table 1). Only women ≥71 years had <50% of intakes above the UL, although the proportion was still >30%. For males 9-30 years old, the proportion with Na intakes above the UL was >90%. Mean Na intakes based on TDS 2007 were, across most age and sex groups, significantly lower than those reported in CCHS 2.2 (Figure 1a), suggesting that Na intakes of Canadians might be declining, though they remain high with most exceeding the UL. For 19-30 year old men and women, the lower TDS-based intakes were not statistically significant.

K intakes based on the TDS showed that most Canadians were below the AI (Table 2), with the proportion ranging from 68.5% for

children aged 1-3 years to 98.8% for women aged 71+. Males were generally more successful in meeting the AI for K in all age groups where the sexes were considered separately. K intakes based upon TDS 2007 were mostly similar to those reported in CCHS 2.2, suggesting that K intakes of Canadians are relatively static (Figure 1b). Only for 1-3 year olds were K intakes based on TDS results significantly higher than had been reported in the original CCHS 2.2 report based on the CNF.

Milk and dairy products, breads and cereals, and soups and fast foods were main TDS food groups contributing to Na intakes in this study (Table 3), with each contributing 15-30%. Within each group (data not shown), either the more highly processed foods (higher in Na content), or foods with more moderate Na content but a high rate of consumption, contributed the most. Some changes in the ranking of TDS food groups contributing to Na intakes were found between different age and sex groups.

Milk and dairy products and fruit made substantial contributions (17-55%) to K intakes in Canada (Table 3). With increasing age, the degree of contribution by milk and dairy products declined, and contributions by vegetables and meat, poultry and fish increased. In adults, the beverage category made a larger contribution to K intakes (14-16%), mostly due to increased coffee and tea consumption (data not shown).

DISCUSSION

TDS in Canada began in 1969, although the pattern of compositing of the food samples has changed over time.[21] In an early round of the Canadian TDS, samples collected in 1974-1975 in Halifax, Montreal, Winnipeg and Vancouver were combined into just 10 food group composites. These 10 samples were assayed for Na and K, leading the authors to conclude that intakes of Na were 2- to 5-fold higher than recommended, but K intakes were sufficient to meet the intake recommendations that were current at that time.[22] Results of the present work, based on a broader and more representative set of Canadian food composite samples, show that mean Na intakes exceed the UL for most groups, while mean K intakes fail to meet the present-day AI for any age and sex group. Although Na intakes for most groups were somewhat lower here than in the CCHS 2.2 reports,[12,13] the general pattern was similar and continued to emphasize an important public health issue. Since Na intake estimates in both the CCHS 2.2 report and the present work did not include salt added in cooking or at the table, actual Na intakes could be up to 10-15% higher.[23] High sodium contributors included many processed foods, in agreement with the observation that over three quarters of the sodium in a Western diet is added in food processing.[23]

The general pattern of food category sources for Na and K in the Canadian diet is similar to results published from other countries including Italy,[24] France,[11,25] New Zealand[26] and the United States.[27] In a report based on the CCHS 2.2 dataset (using the CNF values for Na and K content of foods), intake modelling indicated that breads, breakfast cereals, cookies, bars and cakes accounted for 19-21% of Na intakes.[28] The bread and cereals group from the present study includes a number of additional foods (e.g., pasta dishes, rice, pies, pancakes, muffins), which accounts for some of the difference between these two reports, in addition to analytical composition differences.

There is a continuing need for monitoring and assessment of the Na and K intakes of the Canadian population, particularly in the years preceding and following the issuance of the SWG strategy report. Marketplace changes can affect the accuracy of food composition databases, which may become dated.[29] This is a limitation of previous reports[12,13] which used the CNF as the source of food composition data, given that those data have been accumulated over years or even decades. The nature of the TDS, with collections repeated on a regular basis, is suited to such a program of ongoing monitoring as all of the food composition values within a TDS study collection are from the same place and time. The current report should be viewed as a baseline, from which changes will be monitored as the recommendations of the SWG are implemented. One of the strengths of the TDS approach is the opportunity to monitor changes in food composition in order to assess changes in nutrient intake patterns over time in the Canadian population.

The SWG recommendations are intended to lower Na intakes of Canadians, through reduction of Na content of foods, education and awareness activities to promote better dietary choices, and conduct of supporting research. While not specifically considered in the SWG report, improving K intakes in the population at present requires an individual commitment which can be supported by public health education programs. Decreased Na intakes and increased intake of low-fat dairy products, fruits and vegetables, all of which are good sources of K, are recommended by the Canadian Hypertension Education Program as part of effective management of hypertension.[30] Continued monitoring through the TDS of the Na and K intakes of Canadians will help to evaluate the success of implementing such recommendations.

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RÉSUMÉ

Objectifs : Des apports excessifs en sodium (Na) et insuffisants en potassium (K) sont deux facteurs contribuant à l'hypertension. En juillet 2010, le Groupe de travail multi-intervenants sur le sodium, dirigé par Santé Canada, a publié la Stratégie de réduction du sodium pour le Canada. Des données de base et un suivi permanent sont requis.

Méthode : Les contenus en Na et en K basés sur des analyses récentes d'échantillons composites d'aliments vendus sur le marché canadien ont été appariés avec plus de 35 000 « rappels alimentaires » [feuilles de rappels des aliments ingérés] de l'Enquête sur la santé dans les collectivités canadiennes, cycle 2.2, volet nutrition (ESCC 2.2). Les distributions des apports typiques en Na et en K ont été établies en utilisant le logiciel SIDE, et les estimations par âge et par sexe pour les 5e, 10e, 25e, 75e, 90e et 95e centiles, ainsi que pour la moyenne et la médiane, ont été déterminées.

Résultats : D'après des analyses récentes d'aliments canadiens, les apports en Na de la majorité des Canadiens (nourrissons, enfants, adolescents et adultes) excèdent l'apport maximal tolérable (AMT) pour leur groupe d'âge et leur sexe. Par contre, peu de Canadiens ont des apports suffisants (AS) en K.

Conclusion : Les Canadiens de tous les âges ont besoin de réduire leurs apports en Na en dessous de l'AMT. Parallèlement, la consommation accrue de produits laitiers, de fruits et de légumes doit être promue afin d'augmenter les apports en K jusqu'aux niveaux recommandés. Ces deux interventions sont requises afin de réduire l'hypertension au Canada. Notre rapport est le premier à être fondé directement sur des analyses d'aliments canadiens; il confirme les apports excessifs en Na et insuffisants en K des Canadiens. Grâce à son programme d'échantillonnage annuel des aliments habituellement consommés au Canada, l'étude de la diète totale fournit un système sentinelle important pour le suivi de ces facteurs de risque d'hypertension d'origine alimentaire.

Mots clés : sodium; potassium; régime alimentaire; analyse d'aliment; besoins nutritifs; groupes de population