Prevalence of vitamin-mineral supplement use and associated factors among Canadians: results from the 2015 Canadian Community Health Survey

Pardis Keshavarz, Mojtaba Shafiee, Naorin Islam, Susan J. Whiting, and Hassan Vatanparast

Abstract: Vitamin/mineral supplements are used for improving micronutrient intake and preventing deficiencies, particularly for shortfall nutrients. We assessed the prevalence of vitamin/mineral supplement use and associated factors among a representative sample of Canadians aged ≥ 1 years. We used nationally representative data from the 2015 Canadian Community Health Survey (CCHS)-Nutrition. The prevalence of vitamin/mineral supplement use containing shortfall nutrients (vitamins: A, C, D, B6, B12 and folate; minerals: calcium, magnesium, and zinc) was examined in this study. Logistic regression models were performed to determine factors associated with vitamin/mineral supplement use among Canadian children (1–18 years) and adults (>19 years). The overall prevalence of vitamin/mineral supplement use was 38% among men and 53% among women. Males aged 14–18 years had the lowest prevalence (26.5%; 95% confidence interval (CI) = 21.9–31.0) and females aged ≥ 71 years had the highest prevalence (67.8%; 95% CI = 64.1–71.5) of vitamin/mineral supplement use. Female gender, older age, higher education level, higher income, living in urban areas, having chronic conditions, having a normal body mass index (BMI), and being non-smoker were independent positive predictors of vitamin/mineral supplement use among adults. Independent positive predictors of vitamin/mineral supplement use among Canadian children included younger age, having a normal BMI, and being food secure.

Novelty:

- The overall prevalence of vitamin/mineral supplement use among Canadian men and women was 38% and 53%, respectively.
- Sociodemographic and lifestyle variables were associated with vitamin/mineral supplement use, especially among Canadian adults.

Key words: vitamin/mineral supplements, shortfall vitamins, shortfall minerals, lifestyle factors, sociodemographic factors, Canadian population.

Résumé : Les suppléments de vitamines/minéraux sont utilisés pour enrichir l'apport en micronutriments et prévenir les carences, en particulier celles en nutriments. Nous évaluons la prévalence de l'utilisation de suppléments vitaminiques/minéraux et les facteurs associés parmi un échantillon représentatif de Canadiens âgés de ≥ 1 an. Nous utilisons des données représentatives à l'échelle nationale de l'Enquête sur la santé dans les collectivités canadiennes (ESCC)-Nutrition de 2015. Dans cette étude, nous examinons la prévalence de l'utilisation de suppléments de vitamines/minéraux contenant des nutriments insuffisants (vitamines : A, C, D, B6, B12 et folate; minéraux : calcium, magnésium et zinc). Des modèles de régression logistique sont réalisés pour déterminer les facteurs associés à l'utilisation de suppléments de vitamines et de minéraux chez les jeunes (1 à 18 ans) et adultes canadiens (>19 ans). La prévalence globale de l'utilisation de suppléments vitaminiques/minéraux est de 38 % chez les hommes et de 53 % chez les femmes. Les hommes âgés de 14 à 18 ans présentent la prévalence la plus faible (26,5 %; intervalle de confiance (IC) à 95 % = 21,9–31,0) et les femmes âgées de ≥ 71 ans présentent la prévalence la plus élevée (67,8 %; IC à 95 % = 64,1 à 71,5) de l'utilisation de suppléments de vitamines/minéraux. Le sexe féminin, un âge plus avancé, un niveau de scolarité plus haut, un revenu plus élevé, vivre en zone urbaine, souffrir de maladies chroniques, avoir un indice de masse corporelle (IMC) normal et être un non-fumeur sont des prédicteurs positifs indépendants de l'utilisation de suppléments de vitamines/minéraux chez les adultes. Les prédicteurs positifs indépendants de l'utilisation de suppléments de vitamines et de minéraux chez les enfants canadiens comprennent un jeune âge, un IMC normal et une sécurité alimentaire. [Traduit par la Rédaction]

Les nouveautés :

- La prévalence globale de l'utilisation de suppléments de vitamines et de minéraux chez les hommes et les femmes au Canada est de 38 % et 53 %, respectivement.

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- Les variables sociodémographiques et de mode de vie sont associées à l'utilisation de suppléments de vitamines et de minéraux, en particulier chez les adultes canadiens.

Mots-clés : suppléments vitaminiques/minéraux, carence en vitamines, carence en minéraux, facteurs liés au mode de vie, facteurs sociodémographiques, population canadienne.

1. Introduction

Dietary supplements are defined as any product containing vitamins, minerals, herbs, amino acids, and other substances with a physiological or nutritional effect, which are presented in forms such as tablets, capsules, powders, gel caps, soft gels, and liquids to supplement the normal diet (FDA 2018). Vitamin/mineral supplements are more commonly used than non-vitamin and non-mineral supplements for medical and nutritional purposes (Dwyer et al. 2017). Vitamin/mineral supplements can play a vital role in improving overall micronutrient intake and preventing deficiencies, particularly with regard to shortfall nutrients (Dwyer et al. 2017). For instance, we have previously shown that the prevalence of vitamin D inadequacy among vitamin D supplement non-users was 96.5% in 2015, while this amount was considerably lower among vitamin D supplement users (14.1%) due to the high contribution of vitamin D supplements (Vatanparast et al. 2020b). Similarly, the prevalence of calcium inadequacy among calcium supplement users was 31.9%, while this amount was more than double among calcium supplement non-users (68.0%) (Vatanparast et al. 2020a). However, it should be noted that vitamin/mineral supplement users may be at risk of high micronutrient intakes (Shakur et al. 2012). Using dietary data from 2004 Canadian Community Health Survey (CCHS, Cycle 2.2), Health Canada has identified 6 vitamins (i.e., vitamin B6, vitamin B12, folate, vitamin C, vitamin A, and vitamin D) and 4 minerals (i.e., calcium, magnesium, zinc, and phosphorus) as shortfall nutrients in the Canadian diet, defined by a cut-off of more than 10% of intakes below the estimated average requirement (EAR) (Health Canada 2014).

Rates of dietary supplement usage, including vitamin/mineral supplements, have increased over the past decades in many nations, especially the United States (Gahche et al. 2011) and some European (Bates et al. 2011; Henderson et al. 2003; Savikko et al. 2014) and Asian (Kang et al. 2014; Lee and Kim 2009) countries. According to the US National Health and Nutrition Examination Survey (NHANES), 53.0% of adults aged 20 years or older reported use of at least a dietary supplement in 2003–2006, which represented a dramatic increase when compared with the percentage of dietary supplement users in 1988–1994 (42% in total) and 1971–1975 (28% of men and 38% of women) (Gahche et al. 2011). This upward trend was also observed in the United Kingdom, where the percentage of adults (19 to 64 years) taking supplements increased from only 9.0% of men and 17.0% of women in 1986/1987 (Henderson et al. 2003) to 33.0% (combined men and women) in 2008/2009–2010/2011 (Bates et al. 2011). Using nationally representative data from the 2004 Canadian Community Health Survey (Cycle 2.2), we have previously reported that the prevalence of vitamin/mineral supplement use among Canadian men and women aged 1 or older was 33.5% and 46.9%, respectively (Vatanparast et al. 2010). It is essential to update the prevalence data among the Canadian population to better understand the trend of vitamin/mineral supplement use.

Several previous national surveys in different countries revealed that besides demographic variables (e.g., female gender and older age) (Imai et al. 2006; Li et al. 2010; Marques-Vidal et al. 2017; Radimer et al. 2004), some socioeconomic and lifestyle variables such as education level, household income, place of residence, and smoking habit are associated with dietary supplement use among the general population. It has been reported that dietary supplement use is more common among more educated subjects (Bailey et al. 2011; Block et al. 2007; Foote et al. 2003; Kofoed et al. 2015;

Radimer et al. 2004) and those with higher household income (Block et al. 2007; Fennell 2004), as we also reported for Canadians using 2004 survey data (Vatanparast et al. 2010). A growing body of evidence suggests that individuals with healthier lifestyle (e.g., a lower prevalence of smoking and a normal weight) are more likely to use a dietary supplement (Kang et al. 2014; Kofoed et al. 2015; O'Brien et al. 2017).

Using cross-sectional data from the 2015 CCHS–Nutrition, the primary objective of the present study was to update the prevalence estimates of vitamin/mineral supplement use among different age and gender groups of Canadians. We also aimed to 1) examine the prevalence of use of supplements containing the shortfall vitamins and minerals; and 2) identify factors associated with vitamin/mineral supplement use among Canadian children (1–18 years) and adults (≥ 19 years).

2. Materials and methods

2.1. Data source

We used nationally representative data from the 2015 CCHS–Nutrition, which is a cross-sectional survey administered by Statistics Canada (Health Canada 2017). Data were collected at 2 time points, day 1 (all participants) and day 2 (37% of participants), with a 24-h dietary recall assessment method. The sample sizes for CCHS 2015 day 1 and day 2 were 20 487 and 7623, respectively. In this study, we used only Day 1 data. The overall CCHS 2015 response rate was 61.6% and the information on survey design and the detailed description of interview procedure is available elsewhere (Health Canada 2017). Indigenous peoples living on reserves, residents of institutions, the territories, crown lands and some remote areas; members of the regular Canadian Forces; and military and civilian residents of Canadian Forces bases were excluded from the survey. Respondents who were missing a response to the question concerning vitamin and mineral intake during the last month, pregnant and lactating women, individuals who did not report any food intake in the 24-h recall, and respondents who reported daily caloric intake outside the range of 200–8000 kcal/d were excluded from this analysis. The final sample size included 20 161 participants representing 34 005 286 Canadians (weighted frequency). The data was accessed at the Research Data Centre (RDC) of Statistics Canada. Since we performed a secondary data analysis based on data from a national survey conducted by Statistics Canada, this study was exempt from institutional review board approval.

2.2. Dietary and supplement intake

In the 2015 CCHS–Nutrition survey, multivitamins were defined as dietary supplements that contain at least 3 vitamins and may or may not contain minerals. The use of herbal and/or homeopathic supplements was not determined (Health Canada 2017; Martin et al. 2014). Individuals who had used 1 or more nutritional supplements during the past month were asked to locate the supplement container(s), from which the Natural Product Number (NPN) was recorded if available on the Licensed Natural Health Products Database (Health Canada 2017) and type of nutritional supplement. If the NPN was not available, the brand name and concentration of the main ingredients were recorded (e.g., calcium, 200 mg; vitamin D, 400 IU). In this study, anyone who reported taking a vitamin or mineral supplement at least once in the last month was defined as a vitamin/mineral supplement user.

Table 1. Prevalence of vitamin/mineral supplement use across age and gender-specific groups in Canada in 2015.

	n	Mean $\pm$ SE	Percentage of supplement users, %	
			Confidence interval	
			Lower	Upper
Children, 1–3 years	1 131 506	44.9 $\pm$ 2.4	40.3	49.5
Children, 4–8 years	1 901 543	45.5 $\pm$ 2.2	41.3	49.7
Males, 9–13 years	930 541	36.6 $\pm$ 2.2	32.2	41.0
Females, 9–13 years	884 165	37.0 $\pm$ 2.5	32.2	41.9
Males, 14–18 years	1 002 434	26.5 $\pm$ 2.3	21.9	31.0
Females, 14–18 years	940 484	32.7 $\pm$ 2.5	27.7	37.8
Males, 19–30 years	2 416 820	31.0 $\pm$ 3.1	25.0	37.1
Females, 19–30 years	2 001 624	41.4 $\pm$ 3.3	35.0	47.8
Males, 31–50 years	5 212 606	35.2 $\pm$ 2.0	31.2	39.2
Females, 31–50 years	5 151 715	46.4 $\pm$ 1.9*	42.7	50.1
Males, 51–70 years	4 499 873	42.6 $\pm$ 1.9	38.9	46.3
Females, 51–70 years	4 599 682	65.1 $\pm$ 1.8 [#]	61.6	68.7
Males, $\geq$ 71 years	1 466 481	51.0 $\pm$ 2.2	46.6	55.4
Females, $\geq$ 71 years	1 852 755	67.8 $\pm$ 1.9 [¥]	64.1	71.5

*Significant difference ($P < 0.05$) between males aged 31–50 years and females aged 31–50 years.[#]Significant difference ($P < 0.05$) between males aged 51–70 years and females aged 51–70 years.[¥]Significant difference ($P < 0.05$) between males aged $\geq$ 71 years and females aged $\geq$ 71 years.

2.3. Socio-demographic characteristics

The following variables were considered as covariates based on the literature: age, gender, self-reported chronic conditions, smoking status (only for adults), household income, household food security, education level (household level), obesity [body mass index (BMI, kg/m²) and BMI percentile], marital status (only for adults), province of residence, immigration status, ethnicity, and area of residence (urban/rural). The results are presented separately for adults and children.

Participants were classified into 15 groups based on Dietary Reference Intake (DRI) age and gender groups: 1–3 years, 4–8 years, 9–13 years, 14–18 years, 19–30 years, 31–50 years, 51–70 years and $\geq$ 70 years. The dietary reference guideline (DRI) for age and gender groups does not separate boys and girls from age 1 to 8. Total annual household income was categorized into 5 categories, as very low income (no income or $<$ \$20 000), low income (\$20 000 to \$39 999), middle income (\$40 000 to \$59 999), high income (\$60 000 to \$79 999), wealthy (\$80 000 or more). Participants were classified into 2 groups based on household educational levels (without vs. with university degree). The 18-item Household Food Security Survey Module (HFSSM) was used to measure the household food insecurity over the past 12 months (Health Canada 2017). Based on the number of affirmative responses, households were classified as food secure or food insecure. Participants who were 19 years or older reported if they had been diagnosed by a medical professional with (a) chronic health condition(s) that had lasted or were expected to last 6 months or more (long-term mental conditions were also included). Participants aged $\geq$ 19 years were classified into 2 categories based on their smoking habits (smoker vs non-smoker). Immigration status and ethnicity were captured by 2 categorical variables (immigrant vs non-immigrant and Caucasian vs. non-white). Province of residence was presented as a nominal variable in 5 categories: Quebec, Ontario, British Columbia (reference group), Atlantic (comprising New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland and Labrador) and Prairies (Alberta, Saskatchewan and Manitoba).

2.4. Statistical analysis

The proportion of vitamin/mineral supplement users and their distribution across DRI age and gender groups at the national level were estimated by descriptive analysis. Logistic regression was used to determine factors associated with vitamin/mineral supplement user among Canadian children (1–18 years) and

adults ($\geq$ 19 years). All estimates were obtained using sampling weights to account for non-response bias. Standard errors, coefficients of variation and confidence intervals were estimated using a bootstrapping procedure. Significant differences ($P < 0.05$) were tested with a confidence interval overlapping technique. A P -value < 0.05 was considered significant in all analyses. Stata version 16 was used to perform the regression analysis and SAS version 9.4 was used to conduct the descriptive analysis.

3. Results

The overall prevalence of vitamin/mineral supplement use was 38% among Canadian men and 53% among Canadian women. Table 1 demonstrates the prevalence of vitamin/mineral supplement use among the different age and gender groups of Canadians in 2015. Among all age and gender groups, females aged $\geq$ 71 years had the highest prevalence (67.8 $\pm$ 1.9%; 95% confidence interval (CI) = 64.1–71.5), and males aged 14–18 years had the lowest prevalence (26.5 $\pm$ 2.3%; 95% CI = 21.9–31.0) of vitamin/mineral supplement use. The prevalence of vitamin/mineral supplement use among children aged 1–3 years and 4–8 years was 44.9 $\pm$ 2.4% (95% CI = 40.3–49.5) and 45.5 $\pm$ 2.2% (95% CI = 41.3–49.7), respectively. As presented in Table 1, older adults were more likely to be vitamin/mineral supplement users than younger adults, and females were more likely to be vitamin/mineral supplement users than males.

Table 2 reports the prevalence of vitamin/mineral supplement use by education, obesity status and food security status among different age groups of Canadians. The prevalence of vitamin/mineral supplement use was significantly higher among Canadians aged $\geq$ 51 years living in a household with a university degree compared with their same-age counterparts who came from households without a university degree (54.6 $\pm$ 2.7% vs 40.3 $\pm$ 1.8% for males and 72.6 $\pm$ 2.5% vs 63.0 $\pm$ 1.6% for females). Obese females aged 9–18 years were significantly less likely to use vitamin/mineral supplements than their non-obese counterparts (25.6 $\pm$ 2.8% vs 38.0 $\pm$ 2.6%). Further, food secure males aged $\geq$ 51 years were significantly more likely to use vitamin/mineral supplements than their food insecure counterparts (45.9 $\pm$ 1.6% vs 24.6 $\pm$ 5.0%).

The prevalence of the shortfall vitamins (vitamin B6, vitamin B12, folate, vitamin C, vitamin A, and vitamin D) supplement use across age and gender groups of Canadians is reported in Table 3. Among all age and gender groups, children aged 4–8 years had

Table 2. Prevalence of vitamin/mineral supplement use by education, obesity status and food security status among different age and gender groups of Canadians.

	Prevalence of vitamin/mineral supplement use, %						
	Children, 1–8 years	Males, 9–18 years	Males, 19–50 years	Males, ≥51 years	Females, 9–18 years	Females, 19–50 years	Females, ≥51 years
Education – household level							
No university degree							
Mean ± SE	46.1±2.5	29.9±2.2	31.8±2.3	40.3±1.8	33.6±2.3	42.5±2.1	63.0±1.6
CI	(41.3–51.0)	(25.5–34.3)	(27.2–36.4)	(36.8–43.9)	(29.2–38.0)	(38.3–46.7)	(59.8–66.1)
A university degree							
Mean ± SE	46.9±2.5	33.2±2.3	36.6±2.8	54.6±2.7*	36.4±3.1	48.7±2.8	72.6±2.5*
CI	(42.0–51.9)	(28.6–37.8)	(31.2–42.1)	(49.4–59.9)	(30.4–42.5)	(43.3–54.1)	(67.8–77.5)
Obesity status^a							
Non-obese							
Mean ± SE	51.3±2.4	32.7±2.5	31.1±3.5	47.1±3.6	38.0±2.6	49.4±3.1	72.9±2.7
CI	(46.7–56.0)	(27.9–37.6)	(24.3–37.9)	(40.0–54.1)	(32.9–43.1)	(43.3–55.6)	(67.6–78.3)
Obese							
Mean ± SE	45.6±4.0	27.8±3.2	37.3±2.6	46.1±2.3	25.6±2.8 [#]	40.5±2.7	64.2±2.1
CI	(37.7–53.6)	(21.6–34.0)	(32.1–42.5)	(41.7–50.6)	(20.1–31.2)	(35.2–45.8)	(60.1–68.2)
Food security status							
Insecure							
Mean ± SE	42.0±4.6	23.9±4.6	23.9±4.4	24.6±5.0	28.0±4.7	45.7±4.8	51.7±5.6
CI	(33.0–50.9)	(14.8–32.9)	(15.2–32.7)	(14.7–34.4)	(18.8–37.2)	(36.2–55.2)	(40.7–62.6)
Secure							
Mean ± SE	47.1±1.9	32.5±1.7	35.1±1.9	45.9±1.6 [‡]	35.7±1.9	44.9±1.7	67.0±1.4
CI	(43.3–50.8)	(29.2–35.8)	(31.4–38.9)	(42.7–49.1)	(31.9–39.5)	(41.5–48.4)	(64.3–69.8)

Note: CI: confidence interval.

^aBody mass index (BMI) percentiles for children and BMI (kg/m²) for adults.

*Significant difference ($P < 0.05$) between individuals with a university degree and those without a university degree.

[#]Significant difference ($P < 0.05$) between obese and non-obese individuals.

[‡]Significant difference ($P < 0.05$) between food secure and food insecure individuals.

the highest prevalence of vitamin B6 ($33.9 \pm 2.0\%$; 95% CI = 30.1–37.7), vitamin B12 ($33.7 \pm 2.0\%$; 95% CI = 29.9–37.6), folate ($33.5 \pm 2.0\%$; 95% CI = 29.7–37.4), vitamin C ($36.9 \pm 2.1\%$; 95% CI = 32.8–40.9), and vitamin A ($34.4 \pm 2.0\%$; 95% CI = 30.5–38.2) supplement use. Females aged ≥ 71 years and 51–70 years had the highest prevalence of vitamin D supplement use [$53.1 \pm 1.9\%$ (95% CI = 49.3–56.9) and $52.4 \pm 2.0\%$ (95% CI = 48.4–56.3), respectively]. Adolescent males and females aged 14–18 years had the lowest prevalence of shortfall vitamin supplement use.

Table 4 shows the prevalence of the shortfall minerals (calcium, zinc, and magnesium) supplement use across age and gender groups of Canadians. Among all age and gender groups, females aged 51–70 years had the highest prevalence of calcium ($41.5 \pm 1.9\%$; 95% CI = 37.7–45.3) and magnesium ($31.3 \pm 1.7\%$; 95% CI = 27.9–34.6) supplement use, and females aged ≥ 71 years had the highest prevalence of zinc ($28.4 \pm 1.8\%$; 95% CI = 24.9–31.9) supplement use. Adolescent males aged 14–18 years had the lowest prevalence of calcium supplement use ($8.1 \pm 1.4\%$; 95% CI = 5.4–10.8), and females aged 9–13 years had the lowest prevalence of zinc ($8.4 \pm 1.3\%$; 95% CI = 5.8–11.0) and magnesium ($4.5 \pm 0.9\%$; 95% CI = 2.8–6.2) supplement use.

Factors associated with vitamin/mineral supplement use among the Canadian population are presented in Table 5. Among Canadian children (1–18 years), age, food security status, obesity, and the province of residence were significant independent predictors of vitamin/mineral supplement use. Both adolescent males (odds ratio (OR): 0.26; 95% CI = 0.17–0.39) and females (OR: 0.32; 95% CI = 0.21–0.50) were less likely to use a vitamin/mineral supplement than children aged 1–3 years. Food secure children were more

likely to use a vitamin/mineral supplement than food insecure children (OR: 1.45; 95% CI = 1.03–2.04), and obese children were less likely to use a vitamin/mineral supplement than non-obese children (OR: 0.75; 95% CI = 0.60–0.95). Among Canadian adults (≥ 19 years), older age, female gender, having a university degree, living in urban areas, and having a chronic condition were significant positive predictors of vitamin/mineral supplement use (Table 5). Significant negative predictors of vitamin/mineral supplement use were low income, obesity (OR: 0.79; 95% CI = 0.65–0.95) and being a current smoker (OR: 0.55; 95% CI = 0.44–0.68). Females aged 19–30 years and males aged ≥ 71 years were 1.65 times and 1.94 times, respectively, more likely to use a vitamin/mineral supplement than males aged 19–30 years. Further, adults living in Quebec (OR: 0.64; 95% CI = 0.50–0.82) were less likely and those living in Ontario (OR: 1.52; 95% CI = 1.15–2.00), the prairies (OR: 1.61; 95% CI = 1.27–2.02), and British Columbia (OR: 1.67; 95% CI = 1.26–2.22) were more likely to use a vitamin/mineral supplement than adults living in the Atlantic provinces. Factors associated with use of each shortfall nutrient-containing supplement are reported in supplementary Table S1.¹

4. Discussion

Using data from the 2015 CCHS–Nutrition, we aimed to update the prevalence estimates of vitamin/mineral supplement use among the Canadian population. Our results showed that the prevalence of vitamin/mineral supplement use was 38% and 53%, respectively, among Canadian men and women in 2015. Among Canadian adults, female gender, older age, healthier lifestyle, and higher socioeconomic status were associated with higher

¹Supplementary data are available with the article at <https://doi.org/10.1139/apnm-2021-0090>.

Table 3. Prevalence of shortfall vitamins supplement use across age and gender groups of Canadians in 2015.

	Percentage of shortfall vitamins supplement use (%)											
	Vitamin B6			Vitamin B12			Folate			Vitamin C		
	Mean ± SE	CI		Mean ± SE	CI		Mean ± SE	CI		Mean ± SE	CI	
Children, 1–3 years	25.5 ± 2.0	(21.6–29.4)		25.5 ± 2.0	(21.6–29.4)		25.9 ± 2.1	(21.8–30.0)		30.1 ± 2.0	(26.2–34.1)	
Children, 4–8 years	33.9 ± 2.0	(30.1–37.7)		33.7 ± 2.0	(29.9–37.6)		33.5 ± 2.0	(29.7–37.4)		36.9 ± 2.1	(32.8–40.9)	
Males, 9–13 years	23.9 ± 2.1	(19.7–28.0)		24.0 ± 2.1	(19.8–28.1)		24.6 ± 2.2	(20.4–28.8)		29.4 ± 2.3	(25.0–33.9)	
Females, 9–13 years	23.1 ± 2.0	(19.2–27.1)		23.4 ± 2.0	(19.5–27.3)		22.9 ± 2.0	(19.0–26.8)		28.7 ± 2.2	(24.3–33.1)	
Males, 14–18 years	14.3 ± 1.7	(11.0–17.5)		15.8 ± 1.8	(12.3–19.3)		14.1 ± 1.6	(10.9–17.3)		18.3 ± 1.9	(14.6–22.0)	
Females, 14–18 years	15.0 ± 1.7	(11.7–22.6)		15.0 ± 1.6	(11.9–18.2)		15.4 ± 1.7	(12.1–18.7)		20.2 ± 1.8	(16.6–23.9)	
Males, 19–30 years	17.2 ± 2.8	(11.7–22.6)		17.4 ± 2.8	(11.9–22.8)		16.9 ± 2.8	(11.4–22.4)		21.0 ± 2.9	(15.3–26.7)	
Females, 19–30 years	19.6 ± 2.8	(14.1–25.1)		22.5 ± 2.8	(17.0–27.9)		19.1 ± 2.7	(13.8–24.4)		24.4 ± 2.9	(18.7–30.2)	
Males, 31–50 years	17.6 ± 1.5	(14.6–20.5)		20.4 ± 1.7	(17.1–23.8)		17.5 ± 1.5	(14.5–20.5)		22.2 ± 1.9	(18.4–26.0)	
Females, 31–50 years	24.9 ± 1.7*	(21.6–28.2)		26.6 ± 1.7	(23.2–30.0)		24.7 ± 1.7*	(21.4–28.0)		26.7 ± 1.7	(23.4–30.1)	
Males, 51–70 years	20.9 ± 1.6	(17.8–24.0)		23.5 ± 1.6	(20.0–26.6)		21.1 ± 1.6	(18.0–24.2)		25.4 ± 1.6	(22.2–28.7)	
Females, 51–70 years	25.6 ± 1.5	(22.5–28.6)		31.4 ± 1.7*	(28.2–34.7)		26.2 ± 1.6	(23.2–29.3)		31.8 ± 1.7	(28.5–35.2)	
Males, ≥71 years	18.9 ± 1.7	(15.5–22.3)		27.0 ± 1.9	(23.2–30.7)		19.0 ± 1.7	(15.6–22.4)		27.2 ± 1.8	(23.6–30.8)	
Females, ≥71 years	25.5 ± 1.8	(21.9–29.0)		32.6 ± 1.9	(28.9–36.3)		25.5 ± 1.8	(21.9–29.1)		33.6 ± 1.7	(30.2–37.1)	

Note: CI: confidence interval.

*Significant difference ($P < 0.05$) between males aged 31–50 years and females aged 31–50 years.

#Significant difference ($P < 0.05$) between males aged 51–70 years and females aged 51–70 years.

‡Significant difference ($P < 0.05$) between males aged ≥71 years and females aged ≥71 years.

prevalence of vitamin/mineral supplement use. Further, younger age, lower BMI, and greater food security were significant independent predictors of vitamin/mineral supplement use among Canadian children.

Using nationally representative data from the 2004 CCHS, we previously showed that the prevalence of vitamin/mineral supplement use was 33% and 47% among Canadian men and women, respectively (Vatanparast et al. 2010). These rates have increased by approximately 5% in 2015 for both genders, being 38% and 53%, respectively. The same upward trend in the prevalence of vitamin/mineral supplement use has been observed in other developed countries such as the United States, the United Kingdom, Korea, and Finland (Bates et al. 2011; Gabche et al. 2011; Henderson et al. 2003; Korea Centers for Disease Control and Prevention 2010; Lee and Kim 2009; Savikko et al. 2014; Stierman et al. 2020). According to the data provided by the Korea National Health and Nutrition Examination Survey (KNHANES), the proportion of Korean men and women aged 20 years or older taking dietary supplements were 21.8% and 32.0%, respectively, in 2005 (Lee and Kim 2009), but this increased to 27.4% and 40.5%, respectively, in men and women aged 19 years or older in 2009 (Korea Centers for Disease Control and Prevention 2010). In a study conducted in Finnish community-dwelling older people (≥75 years), Savikko et al. reported that the proportion of respondents using at least 1 vitamin, mineral, and fish-oil product increased from 49.8% in 1999 to 66.8% in 2009 (Savikko et al. 2014). These findings suggest that high-income countries, including Canada, have all experienced an upward trend in the use of vitamin/mineral supplements. However, it should be noted that comparing the results across different countries and study populations is difficult, given the differences in the type of supplements included in the studies.

Our results revealed that independent positive predictors of vitamin/mineral supplement use among Canadian adults included female gender, older age, higher education level, higher income, living in urban areas, having chronic conditions, having a normal BMI, and being non-smoker. We previously reported that age, being female, high household income and education, and being food-secure were positively associated with supplement use (Vatanparast et al. 2010). The current study shows that these characteristics remain for Canadians in 2015. Lower supplement use in low-income Canadians (<\$40 000 per year) compared with high-income Canadians (≥\$80 000 per year) is concerning as we also showed previously that supplement use is not a priority in low-income Canadians, yet this may be the group that needs to fill nutrient gaps that are more common in food insecure households (Whiting et al. 2010). Burnett et al. used cross-sectional data from the 2011–2012 National Nutrition and Physical Activity Survey (NNPAS) to examine the characteristics of Australian adults who take supplements. The authors found that supplement use was higher among females, older age groups, highly educated adults, never-smokers, and those from the least socioeconomic disadvantaged neighbourhood (Burnett et al. 2017). However, no significant association was observed between weight status and supplement use (Burnett et al. 2017). Using more recent data from the 2014–2015 National Health Survey, O'Brien and colleagues reported that independent predictors of supplement use among Australian adults included being female, older age, having a higher education level, being born outside Australia, having a healthy BMI compared with those who were obese, being physically active, and being a non-smoker (O'Brien et al. 2017). Using data from the 2007–2009 KNHANES, Kang et al. reported that dietary supplement use among Korean adults (≥20 years) was higher in women, in middle-aged groups and in individuals with higher education and low drinking and smoking preferences (Kang et al. 2014). In a study conducted in 54 948 Danes aged 50–64 years, it was found that older age groups, female gender, and higher educated participants were more likely to use a dietary supplement of any type (Kofoed et al. 2015). Further, an additional point in the health index, including physical activity,

Table 4. Prevalence of shortfall minerals supplement use across age and gender groups of Canadians in 2015.

	Percentage of shortfall minerals supplement use, %					
	Calcium		Zinc		Magnesium	
	Mean $\pm$ SE	CI	Mean $\pm$ SE	CI	Mean $\pm$ SE	CI
Children, 1–3 years	11.5 $\pm$ 1.8	(8.0–14.9)	11.9 $\pm$ 1.5	(8.9–14.8)	5.5 $\pm$ 1.2	(3.2–7.9)
Children, 4–8 years	13.0 $\pm$ 1.3	(10.3–15.6)	12.8 $\pm$ 1.5	(9.9–15.7)	6.3 $\pm$ 1.1	(4.2–8.4)
Males, 9–13 years	10.0 $\pm$ 1.5	(7.1–12.9)	8.9 $\pm$ 1.3	(6.3–11.5)	5.9 $\pm$ 1.1	(3.8–8.1)
Females, 9–13 years	11.4 $\pm$ 1.5	(8.4–14.4)	8.4 $\pm$ 1.3	(5.8–11.0)	4.5 $\pm$ 0.9	(2.8–6.2)
Males, 14–18 years	8.1 $\pm$ 1.4	(5.4–10.8)	9.1 $\pm$ 1.4	(6.3–11.8)	6.7 $\pm$ 1.1	(4.5–8.8)
Females, 14–18 years	9.2 $\pm$ 1.2	(6.8–11.7)	9.0 $\pm$ 1.2	(6.6–11.4)	7.2 $\pm$ 1.1	(5.1–9.3)
Males, 19–30 years	13.5 $\pm$ 2.5	(8.6–18.4)	13.4 $\pm$ 2.4	(8.6–18.2)	13.2 $\pm$ 2.4	(8.4–17.9)
Females, 19–30 years	17.9 $\pm$ 2.5	(12.9–22.8)	16.1 $\pm$ 2.6	(10.9–21.2)	16.0 $\pm$ 2.6	(10.9–21.1)
Males, 31–50 years	16.8 $\pm$ 1.4	(14.0–19.7)	15.8 $\pm$ 1.4	(13.1–18.6)	15.6 $\pm$ 1.4	(12.8–18.4)
Females, 31–50 years	23.1 $\pm$ 1.7*	(19.8–26.3)	20.8 $\pm$ 1.6	(17.6–24.0)	20.8 $\pm$ 1.6	(17.7–23.9)
Males, 51–70 years	22.2 $\pm$ 1.7	(19.0–25.5)	19.1 $\pm$ 1.5	(16.1–22.0)	21.3 $\pm$ 1.6	(18.1–24.6)
Females, 51–70 years	41.5 $\pm$ 1.9 [#]	(37.7–45.3)	26.0 $\pm$ 1.6 [#]	(22.9–29.0)	31.3 $\pm$ 1.7 [#]	(27.9–34.6)
Males, $\geq$ 71 years	21.7 $\pm$ 1.9	(18.1–25.4)	20.1 $\pm$ 1.7	(16.8–23.4)	19.6 $\pm$ 1.6	(16.3–22.8)
Females, $\geq$ 71 years	40.2 $\pm$ 1.9 [‡]	(36.4–44.0)	28.4 $\pm$ 1.8 [‡]	(24.9–31.9)	30.3 $\pm$ 1.8 [‡]	(26.8–33.7)

Note: CI: confidence interval.

*Significant difference ($P < 0.05$) between males aged 31–50 years and females aged 31–50 years.

[#]Significant difference ($P < 0.05$) between males aged 51–70 years and females aged 51–70 years.

[‡]Significant difference ($P < 0.05$) between males aged $\geq$ 71 years and females aged $\geq$ 71 years.

smoking, alcohol, and diet was associated with 19% higher likelihood of any supplement use. Conversely, an additional point in the metabolic risk index, including urinary glucose, waist circumference, and measured hypertension was associated with 17% lower likelihood of being user of any supplement (Kofoed et al. 2015). These results clearly suggest that those with healthy lifestyle characteristics and better socioeconomic status are more likely to use vitamin/mineral supplements.

Our results showed that independent positive predictors of vitamin/mineral supplement use among Canadian children and adolescents included younger age, having a normal BMI, and being food secure. However, parental educational level and household income were not related to vitamin/mineral supplement use among Canadian children and adolescents. Using nationally representative data from the 1999–2004 NHANES, Shaikh et al. reported that younger age, being born in the United States, higher income, greater physical activity, lower BMI, better self-reported health, and greater food security were associated with greater use of vitamin and mineral supplements among United States children and adolescents aged 2 to 17 years (Shaikh et al. 2009). In another study conducted in United States children and adolescents (≤ 18 years), it was revealed that dietary supplement and multivitamin-minerals use were associated with higher household food security level and higher family income (Jun et al. 2018). In the most recently released data from the 2017–2018 NHANES, the overall prevalence of dietary supplement use among United States children and adolescents was 34.0%. Supplement use among females was higher than that among males (37.3% vs 30.8%), and prevalence of supplement use was highest among children aged 2–5 years (43.3%) followed by those aged 6–11 years (37.5%). Further, in contrast to our findings, increasing income and education of the household reference person was associated with a higher prevalence of dietary supplement use among children and adolescents (Stierman et al. 2020). In a study conducted in Korean teenagers aged 13–18 years, Kim et al. found that the prevalence of vitamin/mineral supplement use was highest in females, high-school students, individuals living in rural communities, and those from families in high socioeconomic strata (Kim et al. 2001). Another study conducted in adolescents living in Germany showed that adolescents with overweight were less likely to use dietary supplements compared with adolescents with normal weight (Perlitz et al. 2019). The results of our study indicate that younger age, lower BMI, and

higher food security are major factors associated with vitamin/mineral supplement use among Canadian children and adolescents.

The strengths of our study include using a large nationally representative study sample, updating the prevalence of vitamin/mineral supplement use using the most recent CCHS data, and determining the prevalence of shortfall nutrients supplement use, which are known to be of public health concern. We acknowledge the limitations of our study, including (a) all information on vitamin/mineral supplement use was self-reported, which leave the potential for misclassification of vitamin/mineral supplement use.

There is an imbalance in supplement use across different generations. In early childhood and older adults, we see the highest consumption rate of vitamin/mineral supplement use. At the same time there is a need to have specific strategies for the age groups in between such as for women in reproductive years. In addition, as we mentioned in the discussion, low-income individuals would require more attention regarding supplement intake of shortfall nutrients, since they were less likely to be a vitamin/mineral supplement user compared with high-income individuals. Among Canadian adults, male gender, younger age, and lower socioeconomic status were associated with lower prevalence of vitamin/mineral supplement use. These individuals need different strategies to be able to consume shortfall nutrient supplements. Therefore, from a population health perspective, our findings will fill the gap in literature for the use of policy makers and health promotion programs to take into consideration such factors in addressing the shortfall nutrients. Lastly, it should be noted that supplement use among those who meet the requirements may increase the risk of exceeding the tolerable upper intake level (UL) for all nutrients. For example, using data from the 2004 CCHS, Shakur et al. reported that $\geq 10\%$ of supplement users in some age/gender groups had intakes of vitamin A, vitamin C, folic acid, niacin, zinc, calcium, iron, and magnesium greater than the UL (Shakur et al. 2012).

In conclusion, the prevalence of vitamin/mineral supplement use among Canadian men and women was 38% and 53%, respectively, in 2015, which represents a notable increase with respect to the previous 11 years (33% in males and 47% in females). The prevalence of vitamin/mineral supplement use was the lowest among males aged 14–18 years (26.5%) and the highest among females aged ≥ 71 years (67.8%). Among Canadian adults, female gender, older age, healthier lifestyle (i.e., lower BMI and being non-

Table 5. Factors associated with vitamin/mineral supplement use across age and gender groups of Canadians.

Variables	Adjusted OR (95% CI) ^a	
	Children, 1–18 years	Adults, ≥19 years
Age and gender groups		
Children, 1–3 years ^b	1	—
Children, 4–8 years	0.72 (0.50–1.07)	—
Male, 9–13 years	0.44 (0.30–0.64)	—
Female, 9–13 years	0.44 (0.29–0.65)	—
Male, 14–18 years	0.26 (0.17–0.39)	—
Female, 14–18 years	0.32 (0.21–0.50)	—
Male, 19–30 years ^c	—	1
Female, 19–30 years	—	1.65 (1.07–2.54)
Male, 31–50 years	—	1.28 (0.85–1.91)
Female, 31–50 years	—	1.93 (1.27–2.92)
Male, 51–70 years	—	1.68 (1.12–2.54)
Female, 51–70 years	—	4.36 (2.95–6.43)
Male, ≥71 years	—	1.94 (1.24–3.05)
Female, ≥71 years	—	4.39 (2.85–6.75)
Annual household income		
\$80 000 or more	1	1
\$60 000 to \$79 999	1.17 (0.83–1.66)	0.85 (0.64–1.12)
\$40 000 to \$59 999	0.88 (0.63–1.21)	0.76 (0.58–1.00)
\$20 000 to \$39 999	1.01 (0.71–1.43)	0.71 (0.54–0.94)
No income or <\$20 000	0.88 (0.59–1.31)	0.71 (0.50–0.99)
Education – household level		
No university degree	1	1
A university degree	0.93 (0.74–1.17)	1.24 (1.04–1.48)
Food security status		
Insecure	1	1
Secure	1.45 (1.03–2.04)	1.27 (0.90–1.80)
Obesity status^d		
Non-obese	1	1
Obese	0.75 (0.60–0.95)	0.79 (0.65–0.95)
Ethnicity		
Non-white	1	1
Caucasian, white	1.22 (0.92–1.62)	1.23 (0.96–1.56)
Immigrant status		
Landed immigrant	1	1
Non-immigrant, Canadian born	1.27 (0.85–1.91)	0.95 (0.74–1.20)
Area of residence		
Rural	1	1
Urban	1.29 (0.96–1.73)	1.34 (1.04–1.74)
Province of residence^e		
Atlantic provinces	1	1
Quebec	0.64 (0.47–0.89)	0.64 (0.50–0.82)
Ontario	1.87 (1.40–2.51)	1.52 (1.15–2.00)
Prairie provinces	2.09 (1.59–2.74)	1.61 (1.27–2.02)
British Columbia	2.10 (1.54–2.85)	1.67 (1.26–2.22)
Marital status		
Married	—	1
Single	—	1.00 (0.82–1.22)
Smoking status		
Non-smoker	—	1
Smoker	—	0.55 (0.44–0.68)

Table 5 (concluded).

Variables	Adjusted OR (95% CI) ^a	
	Children, 1–18 years	Adults, ≥19 years
Chronic condition		
No	—	1
Yes	—	1.48 (1.20–1.81)

^aThe odds ratio (OR) for each variable is adjusted for every other variable shown in the table.

^bReference group for children.

^cReference group for adults.

^dBody mass index (BMI) percentiles for children and BMI (kg/m²) for adults.

^eAtlantic provinces include New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland and Labrador. Prairies provinces include Alberta, Saskatchewan and Manitoba.

smoker) and higher socioeconomic status (i.e., higher education level and higher income) were associated with higher prevalence of vitamin/mineral supplement use. Further, younger age, lower BMI, and greater food security were major factors associated with vitamin/mineral supplement use among Canadian children.

Conflict of interest statement

The authors have no conflict of interest to declare.

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