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Original quantitative research

Micro-level factors associated with alcohol use and binge drinking among youth in the COMPASS study (2012/13 to 2017/18)

Simone D. Holligan, PhD (1, 2); Wei Qian, PhD (2); Margaret de Groh, PhD (1); Ying Jiang, MD (1); Scott T. Leatherdale, PhD (2)

This article has been peer reviewed.

Abstract

Introduction: This study examined the associations of micro-level factors with current alcohol use and binge drinking among a large sample of Canadian youth.

Methods: This descriptive-analytical study was conducted among high school students enrolled in the COMPASS study between 2012/13 and 2017/18. We used generalized estimating equations modelling to determine associations between micro-level factors and likelihood of current versus non-current alcohol use and binge drinking among respondents.

Results: Students reporting current cannabis use were more likely to report current alcohol use over never use (odds ratio [OR] = 4.46, 95% confidence interval [CI]: 4.33–4.60) compared to students reporting non-current cannabis use. Students reporting current smoking of tobacco products were more likely to report current binge drinking over never binge drinking (OR = 2.52, 95% CI: 2.45–2.58), compared to non-smoking students. Students reporting weekly disposable incomes of more than $100 were more likely to report current over never binge drinking (OR = 2.14, 95% CI: 2.09–2.19), compared to students reporting no weekly disposable income.

Conclusion: Higher disposable incomes, smoking of tobacco products and use of cannabis were associated with current alcohol use and binge drinking among youth. Findings may inform design of polysubstance use prevention efforts in high schools.

Keywords: *youth, alcohol, binge drinking, cannabis, marijuana, smoking*

Highlights

- Prevalence of current alcohol use ranged between 52% and 58%, and rates of current binge drinking ranged between 34% and 41% for students in the COMPASS study between 2012/13 and 2017/18.
- Current cannabis use was associated with a 4.5-fold increased likelihood of current versus never alcohol use, and a 4-fold increased likelihood of current versus never binge drinking compared to non-using students, between 2012/13 and 2017/18.
- Current smoking was associated with a 2-fold increased likelihood of current versus never alcohol use, and a 2.5-fold increased likelihood of current versus never binge drinking compared to non-smoking students between 2012/13 and 2017/18.
- Weekly disposable incomes of more than $100 were associated with an 87% increased likelihood of current versus never alcohol use, and a 2-fold increased likelihood of current versus never binge drinking compared to students with no disposable income between 2012/13 and 2017/18.

Introduction

Heavy alcohol use in adolescents can negatively affect their mental and physical development.[1] Heavy drinking, defined as males consuming five or more and women consuming four or more alcoholic drinks on one occasion,[2] has been associated with lower academic performance and other risk behaviours including smoking and use of illicit drugs among youth.[3] Data from the 2014-15 Canadian Student Tobacco, Alcohol and Drugs Survey (CSTADS) indicated that while rates of alcohol use were similar among girls and boys, the rates rose with increasing grade levels.[3] Additional studies have shown that binge drinking tended to emerge between 13 and 15 years of age and peaked during late adolescence and early adulthood,[4,5] and that binge drinking during adolescence was predictive of binge drinking into early adulthood. Youth were also more likely to engage in binge drinking if they were smokers or used cannabis, were in a higher grade, or had more spending money.[4] Data from the USA's National Longitudinal Survey of Youth 1979 indicated that binge drinking between the ages of 17 and 20 years increased the relative risk of binge drinking between ages 30 and 31 years by over 2-fold for males and over 3-fold for females.[6]

Heavy alcohol use in youth has also been associated with behaviours that are health-compromising and have future social costs.

Author references:

1. Public Health Agency of Canada, Ottawa, Ontario, Canada
2. School of Public Health and Health Systems, University of Waterloo, Waterloo, Ontario, Canada

Correspondence: Simone D. Holligan, 200 University Avenue West, Waterloo, ON N2L 3G1; Tel: 519-888-4567; Email: sholligan@uwaterloo.ca

Harmful alcohol use that begins in adolescence and carries on into adulthood has been associated with lifestyle-related cancers, liver disease and cardiovascular disease, with harmful alcohol use defined as > 4 standard drinks per day for men, and > 2 standard drinks per day for women in the past month.[6] Other work has shown associations between binge drinking and low levels of school engagement in terms of skipping classes and not completing assigned homework.[7] Alternatively, positive well-being in youth has been associated with decreased likelihood of binge drinking.[8] Indeed, tendency for alcohol use and binge drinking may indicate how well an individual is navigating the adolescent life-stage in terms of physical health, mental health and psychosocial development.[9]

COMPASS (Cohort study on Obesity, Marijuana use, Physical activity, Alcohol use, Smoking and Sedentary behaviour) is a prospective cohort study enabling the evaluation of health behaviours and psychosocial functioning of a large sample of Canadian youth.[10] COMPASS collects hierarchical and longitudinal data from a convenience sample of secondary schools and the students between Grades 9 and 12 who attend these schools. The objective of our repeated, cross-sectional study was to determine whether the alcohol use and binge drinking statuses of Canadian youth were associated with their sex, ethnicity, grade level, smoking status, cannabis use and level of disposable income, over a six-year period. Findings may inform primary prevention efforts for reducing alcohol use among youth.

Methods

Survey description

COMPASS facilitates assessment of the influence of the built environment, policies and programming on various student-level outcomes. COMPASS collects hierarchical and longitudinal data based on intrapersonal, interpersonal, school-level, and community-level factors across years. Student-level assessments are made on rates of alcohol use, cannabis and tobacco use, obesity, school connectedness, bullying, academic achievement and mental health. COMPASS data collection commenced in the 2012/13 school year and occurs annually, with collection from over 100 000 students from 162 schools in Alberta, British Columbia, Ontario, Quebec and Nunavut. Recruitment began with schools in Ontario in 2012/13, and schools from Alberta were included in 2013/14. Recruitment increased over 2014/15 and 2015/16. In 2016/17, schools from Quebec, British Columbia and Nunavut were added. More schools in Quebec and British Columbia were recruited in 2017/18. Further details on COMPASS, including the sample and data collection process, are available online (www.compass.uwaterloo.ca). Ethics approval for this study was obtained from the University of Waterloo's Office of Research Ethics (ORE # 17264) and relevant school boards.

Analytical sample

This repeated, cross-sectional study used data on alcohol use and binge drinking among a large sample of high school students from schools in Alberta, British Columbia, Ontario, Nunavut and Quebec between 2012/13 and 2017/18; no data were obtained for Grade 12 students in Quebec between 2016/17 and 2017/18. Student-level assessment of alcohol use and binge drinking was conducted via the COMPASS Student Questionnaire, described elsewhere.[10] The sample size generally increased across years, with a total of 24 173 student respondents in 2012/13; 45 298 student respondents in 2013/14; 42 355 student respondents in 2014/15; 40 436 student respondents in 2015/16; 46 957 student respondents in 2016/17; and 66 501 student respondents in 2017/18.

Measures

Demographic variables included: sex (girls, boys); ethnicity (White, Black, Asian, off-reserve Aboriginal, Latino/Hispanic and Other/Mixed/Missing); grade level (Grade 9, Grade 10, Grade 11 and Grade 12); and level of disposable income each week ($0, $1–$20, $21–$100 and more than $100). A response of "Mixed" for ethnicity was deduced from more than one selection from the ethnicity query.

Frequency of alcohol use was determined using the question, "In the last 12 months, how often did you have a drink of alcohol that was more than just a sip?" Responses were grouped as *Never user* ("I have never drunk alcohol"), *Non-current user* ("I did not drink alcohol in the last 12 months" or "I have only had a sip of alcohol"), and *Current user* ("Less than once a month" or "Once a month" or "2 or 3 times a month" or "Once a week" or "2 to 3 times a week" or "4 to 6 times a week" or "Every day"). Frequency of binge drinking was determined using the question, "In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?" Responses were grouped as *Never user* ("I have never done this"), *Non-current user* ("I did not have 5 or more drinks on one occasion in the last 12 months"), and *Current user* ("Less than once a month" or "Once a month" or "2 to 3 times a month" or "Once a week" or "2 to 5 times a week" or "Daily or almost daily").

Current smoking status was determined using the question, "On how many of the last 30 days did you smoke one or more cigarettes?" Responses were grouped as *Non-smoker* ("None"), and *Current smoker* ("1 day" or "2 to 3 days" or "4 to 5 days" or "6 to 10 days" or "11 to 20 days" or "21 to 29 days" or "30 days ([every day]").

Current cannabis use was determined using the question, "In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash)" with responses grouped as *Non-current* ("I have never used marijuana" or "I have used marijuana but not in the last 12 months"), and *Current use* ("Less than once a month" or "Once a month" or "2 or 3 times a month" or "Once a week" or "2 or 3 times a week" or "4 to 6 times a week" or "Every day").

Statistical analysis

We conducted descriptive statistics for all study variables. We fitted generalized estimating equations (GEE) models using the SAS PROC GEE procedure with a binomial distribution and a logit function. Given the repeated cross-sectional nature of this study resulting in correlated and clustered data, working correlation structures of compound symmetry, autoregressive, independent, unstructured and exchangeable were tested to ensure model fit. All models used an exchangeable working correlation structure based on the results of these analyses. Empirical standard error estimates were used to calculate confidence intervals and test statistics. Concordance statistics provided goodness-of-fit estimates for the logistic models. All analyses were conducted using the statistical software package SAS 9.4 (SAS Institute Inc., Cary, NC, USA). Statistical significance for the logistic models was set at $p < .05$.

Results

Demographics

Table 1 shows that the sample of high school students was balanced between boys and girls across years; approximately 50.0% for each. Distribution of student respondents by grade level varied between 21.6% and 27.3% between 2012/13 and 2015/16, while proportions of Grade 12 students decreased in 2016/17 (19.3%) and in 2017/18 (17.6%). Most students identified as White, with proportions ranging from 65.4% to 73.8% across years; mean proportions for other ethnicities across years were 4.3% for Black, 6.9% for Asian, 3.2% for off-reserve Aboriginal, and 2.3% for Latino/Hispanic; the proportion of students who identified as Asian in 2017/18 was approximately double that of previous school years. Prevalence of current smoking behaviour ranged between 10.1% and 11.7% across years, while prevalence of current cannabis use ranged between 23.0% and 26.0% across years. The proportion of students reporting a disposable income between $1 and $20 per week varied between 30.2% and 34.9% between 2012/13 and 2017/18. Prevalence of current alcohol use and current binge drinking ranged between 51.5% and 57.5%, and between 33.6% and 40.5% across years, respectively; prevalence was lowest in 2017/18.

Factors associated with alcohol use

Compared to students reporting non-current cannabis use, students reporting current cannabis use were more than four times more likely to report current versus never alcohol use (odds ratio [OR] = 4.46, 95% confidence interval [CI]: 4.33–4.60; Table 2). Students who identified as current smokers were more likely than non-smoking students to report current versus never alcohol use (OR = 2.11, 95% CI: 2.03–2.21). Compared to females, males were less likely to display current versus never alcohol use (OR = 0.87, 95% CI: 0.86–0.88), and non-White students were less likely than White students to display current versus never alcohol use (OR = 0.65, 95% CI: 0.64–0.66). Compared to Grade 9 students, Grade 11 (OR = 1.34, 95% CI: 1.31–1.37) and Grade 12 (OR = 1.62, 95% CI: 1.58–1.66) students were more likely to display current versus never alcohol use, while Grade 10 students were less likely to display current versus never alcohol use (OR = 0.93, 95% CI: 0.91–0.95). Compared to students with no weekly disposable income, students with more than $100 were more likely (OR = 1.87, 95% CI: 1.82–1.92) and students with $1 to $20 were less likely (OR = 0.78, 95% CI: 0.76–0.79) to report current versus never alcohol use. Compared to the baseline year of 2012/13, students were more likely to report current versus non-current alcohol use in 2013/14 (OR = 1.12, 95% CI: 1.09–1.15), and less likely to report current versus non-current alcohol use in 2015/16 (OR = 0.87, 95% CI: 0.85–0.90), 2016/17 (OR = 0.93, 95% CI: 0.90–0.95), and 2017/18 (OR = 0.96, 95% CI: 0.94–0.99).

We saw similar results for associations with non-current versus never alcohol use (Table 2). Compared to non-current users, current cannabis users were more likely to report non-current versus never alcohol use (OR = 1.69, 95% CI: 1.64–1.75). Current smokers were also more likely to report non-current versus never alcohol use, compared to non-smoking students (OR = 1.32, 95% CI: 1.26–1.39). Compared to students with no weekly disposable income, students with weekly disposable income of $21 to $100 (OR = 1.08, 95% CI: 1.05–1.11) and more than $100 (OR = 1.11, 95% CI: 1.08–1.15) were more likely to report non-current versus never alcohol use.

Factors associated with binge drinking

Compared to students reporting non-current cannabis use, students reporting current cannabis use were four times more likely to report current binge drinking versus never binge drinking (OR = 3.99, 95% CI: 3.92–4.06) (Table 2). Students who identified as current smokers were also more likely than non-smoking students to report current versus never binge drinking (OR = 2.52, 95% CI: 2.45–2.58). Compared to females, males were more likely to report current versus never binge drinking (OR = 1.02, 95% CI: 1.00–1.03), and non-White students were less likely than White students to report current versus never binge drinking (OR = 0.74, 95% CI: 0.73–0.75). Compared to Grade 9 students, Grade 11 (OR = 1.37, 95% CI:

TABLE 1
Demographics and substance use prevalence of student respondents in the COMPASS study, Canada, between the 2012/13 and 2017/18 school years

Characteristics		2012/13 (N[a] = 24 173)		2013/14 (N[a] = 45 298)		2014/15 (N[a] = 42 355)		2015/16 (N[a] = 40 436)		2016/17 (N[a] = 46 957)		2017/18 (N[a] = 66 501)	
		n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Sex	Girls	11 886	49.6 (49.0–50.2)	22 149	49.4 (48.9–49.9)	20 663	49.3 (48.8–49.8)	19 279	48.3 (47.8–48.8)	22 975	49.6 (49.1–50.1)	33 015	50.1 (49.7–50.5)
	Boys	12 076	50.4 (49.8–51.0)	22 712	50.6 (50.1–51.1)	21 263	50.7 (50.2–51.2)	20 601	51.7 (51.2–52.2)	23 319	50.4 (49.9–50.9)	32 923	49.9 (49.5–50.3)
Grade	9	6 305	26.2 (25.6–26.8)	11 793	26.2 (25.8–26.6)	11 070	26.3 (25.9–26.7)	10 585	26.3 (25.9–26.7)	11 945	27.1 (26.7–27.5)	15 950	27.8 (27.4–28.2)
	10	6 179	25.7 (25.2–26.3)	11 817	26.2 (25.8–26.6)	11 493	27.3 (26.9–27.7)	10 612	26.4 (26.0–26.8)	12 437	28.2 (27.8–28.6)	16 107	28.0 (27.6–28.4)
	11	5 894	24.5 (24.0–25.0)	11 229	24.9 (24.5–25.3)	10 489	24.9 (24.5–25.3)	10 179	25.3 (24.9–25.7)	11 238	25.4 (25.0–25.8)	15 291	26.6 (26.2–27.0)
	12	5 699	23.7 (23.2–24.2)	10 233	22.7 (22.3–23.1)	9 078	21.6 (21.2–22.0)	8 807	21.9 (21.5–22.3)	8 538	19.3 (18.9–19.7)	10 112	17.6 (17.3–17.9)

Continued on the following page

TABLE 1 (continued)
Demographics and substance use prevalence of student respondents in the COMPASS study, Canada, between the 2012/13 and 2017/18 school years

Characteristics		2012/13 (N[a] = 24 173)		2013/14 (N[a] = 45 298)		2014/15 (N[a] = 42 355)		2015/16 (N[a] = 40 436)		2016/17 (N[a] = 46 957)		2017/18 (N[a] = 66 501)	
		n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Ethnicity	White	17 124	70.8 (70.2–71.4)	33 414	73.8 (73.4–74.2)	30 836	72.8 (72.4–73.2)	28 641	70.8 (70.4–71.2)	32 993	70.3 (69.9–70.7)	43 510	65.4 (65.0–65.8)
	Black	1 102	4.6 (4.3–4.9)	1 785	3.9 (3.7–4.1)	1 892	4.5 (4.3–4.7)	1 991	4.9 (4.7–5.1)	1 936	4.1 (3.9–4.3)	2 593	3.9 (3.8–4.1)
	Asian	1 423	5.9 (5.6–6.2)	2 303	5.1 (4.9–5.3)	2 313	5.5 (5.3–5.7)	2 466	6.1 (5.9–6.3)	3 018	6.4 (6.2–6.6)	8 125	12.2 (12.0–12.5)
	Aboriginal	721	3.0 (2.9–3.2)	1 596	3.5 (3.3–3.7)	1 416	3.3 (3.1–3.5)	1 288	3.2 (3.0–3.4)	1 606	3.4 (3.2–3.6)	1 854	2.8 (2.7–2.9)
	Latino/ Hispanic	551	2.3 (2.1–2.5)	856	1.9 (1.8–2.0)	888	2.1 (2.0–2.2)	942	2.3 (2.2–2.5)	1 201	2.6 (2.5–2.8)	1 663	2.5 (2.4–2.6)
	Other/ mixed/ missing	3 252	13.5 (13.1–13.9)	5 344	11.8 (11.5–12.1)	5 010	11.8 (11.5–12.1)	5 108	12.6 (12.3–12.9)	6 203	13.2 (12.9–13.5)	8 756	13.2 (12.9–13.5)
Smoking status	Non-current	21 587	89.3 (88.9–89.7)	40 027	88.4 (88.1–88.7)	37 592	88.8 (88.5–89.1)	35 689	88.3 (88.0–88.6)	41 167	88.8 (88.5–89.1)	59 266	90.0 (89.8–90.2)
	Current	2 586	10.7 (10.3–11.1)	5 271	11.6 (11.3–11.9)	4 763	11.3 (11.0–11.6)	4 747	11.7 (11.4–12.0)	5 182	11.2 (10.9–11.5)	6 625	10.1 (9.9–10.3)
Cannabis use	Non-current	17 332	71.7 (71.1–72.3)	32 780	72.4 (72.0–72.8)	30 698	72.5 (72.1–72.9)	29 475	72.9 (72.5–73.3)	34 359	73.2 (72.8–73.6)	50 176	75.5 (75.2–75.8)
	Current	6 273	26.0 (25.5–26.6)	11 434	25.2 (24.8–25.6)	10 716	25.3 (24.9–25.7)	9 960	24.6 (24.2–25.0)	11 508	24.5 (24.1–24.9)	15 265	23.0 (22.7–23.3)
	Missing	568	2.3 (2.1–2.5)	1 084	2.2 (2.1–2.3)	941	2.2 (2.1–2.3)	1 001	2.5 (2.4–2.7)	1 090	2.3 (2.2–2.4)	1 060	1.6 (1.5–1.7)
Disposable income	$0	3 775	18.0 (17.5–18.5)	7 192	18.3 (17.9–18.7)	6 921	18.8 (18.4–19.2)	6 721	19.1 (18.7–19.5)	7 520	18.8 (18.4–19.2)	10 611	19.3 (19.0–19.6)
	$1–$20	7 325	34.9 (34.3–35.5)	12 911	32.8 (32.3–33.3)	11 836	32.1 (31.6–32.6)	10 781	30.6 (30.1–31.1)	12 345	30.8 (30.4–31.3)	16 628	30.2 (29.8–30.6)
	$21–$100	6 475	30.8 (30.2–31.4)	11 978	30.5 (30.0–31.0)	10 805	29.3 (28.8–29.8)	10 056	28.6 (28.1–29.1)	11 487	28.7 (28.3–29.1)	15 565	28.3 (27.9–28.7)
	More than $100	3 426	16.3 (15.8–16.8)	7 236	18.4 (18.0–18.8)	7 326	19.9 (19.5–20.3)	7 655	21.7 (21.3–22.1)	8 691	21.7 (21.3–22.1)	12 282	22.3 (22.0–22.7)
Any alcohol use	Never user	4 865	20.7 (20.2–21.2)	9 687	21.9 (21.5–22.3)	9 849	23.8 (23.4–24.2)	10 137	25.7 (25.3–26.1)	12 076	26.3 (25.9–26.7)	17 943	27.4 (27.1–27.7)
	Non-current user	5 535	23.6 (23.1–24.1)	9 108	20.6 (20.2–21.0)	8 624	20.8 (20.4–21.2)	8 060	20.4 (20.0–20.8)	9 114	19.9 (19.5–20.3)	13 794	21.1 (20.8–21.4)
	Current user	13 075	55.7 (55.1–56.3)	25 444	57.5 (57.0–58.0)	22 985	55.4 (54.9–55.9)	21 291	53.9 (53.4–54.4)	24 715	53.8 (53.3–54.3)	33 684	51.5 (51.1–51.9)
Binge drinking status	Never binger	12 539	52.1 (51.5–52.7)	22 766	50.4 (49.9–50.9)	22 201	52.6 (52.1–53.1)	21 934	54.5 (54.0–55.0)	25 700	55.0 (54.6–55.5)	38 776	58.5 (58.1–58.9)
	Non-current	2 058	8.6 (8.2–9.0)	4 075	9.0 (8.7–9.3)	3 705	8.8 (8.5–9.1)	3 383	8.4 (8.1–8. 7)	4 102	8.8 (8.5–9.1)	5 221	7.9 (7.7–8.1)
	Current binger	9 481	39.4 (38.8–40.0)	18 291	40.5 (40.1–41.0)	16 300	38.6 (38.1–39.1)	14 963	37.2 (36.7–37.7)	16 971	36.3 (35.9–36.7)	22 278	33.6 (33.2–34.0)

Abbreviations: CI, confidence interval; COMPASS, Cohort Study on Obesity, Marijuana Use, Physical Activity, Alcohol Use, Smoking and Sedentary Behaviour.

[a] Sampling frame.

TABLE 2
GEE multinomial logistic regression models examining micro-level factors associated with alcohol use and binge drinking among high school students in the COMPASS study, Canada, 2012/13 to 2017/18

Variable	Level[a]	Alcohol use				Binge drinking			
		OR	Lower	Upper	*p*-value	OR	Lower	Upper	*p*-value
Current vs. never									
Sex	Male	0.87	0.86	0.88	< .001	1.02	1.00	1.03	.008
Grade level	10	0.93	0.91	0.95	< .001	0.91	0.89	0.93	< .001
	11	1.34	1.31	1.37	< .001	1.37	1.34	1.40	< .001
	12	1.62	1.58	1.66	< .001	1.77	1.73	1.81	< .001
Ethnicity	Non-White	0.65	0.64	0.66	< .001	0.74	0.73	0.75	< .001
Smoking	Current	2.11	2.03	2.21	< .001	2.52	2.45	2.58	< .001
Cannabis use	Current	4.46	4.33	4.60	< .001	3.99	3.92	4.06	< .001
Disposable income	$1–$20	0.78	0.76	0.79	< .001	0.70	0.68	0.71	< .001
	$21–$100	1.35	1.32	1.37	< .001	1.42	1.39	1.45	< .001
	More than $100	1.87	1.82	1.92	< .001	2.14	2.09	2.19	< .001
Year of collection	2013/14	1.12	1.09	1.15	< .001	1.22	1.19	1.26	< .001
	2014/15	0.98	0.95	1.00	.097	1.06	1.03	1.09	< .001
	2015/16	0.87	0.85	0.90	< .001	0.93	0.90	0.96	< .001
	2016/17	0.93	0.90	0.95	< .001	0.91	0.89	0.94	< .001
	2017/18	0.96	0.94	0.99	.004	0.78	0.76	0.80	< .001
Concordance statistic		0.834				0.893			
Non-current vs. never									
Sex	Male	0.90	0.89	0.91	< .001	0.88	0.87	0.89	< .001
Grade level	10	0.99	0.97	1.02	.596	0.92	0.90	0.94	< .001
	11	1.04	1.01	1.07	.002	1.29	1.26	1.31	< .001
	12	1.04	1.01	1.07	.005	1.50	1.47	1.54	< .001
Ethnicity	Non-White	0.88	0.86	0.89	< .001	0.76	0.75	0.77	< .001
Smoking	Current	1.32	1.26	1.39	< .001	1.48	1.44	1.52	< .001
Cannabis use	Current	1.69	1.64	1.75	< .001	2.43	2.39	2.47	< .001
Disposable income	$1–$20	1.00	0.98	1.02	.937	0.84	0.82	0.86	< .001
	$21–$100	1.08	1.05	1.11	< .001	1.23	1.20	1.25	< .001
	More than $100	1.11	1.08	1.15	< .001	1.55	1.51	1.58	< .001
Year of collection	2013/14	1.06	1.03	1.09	< .001	1.10	1.07	1.13	< .001
	2014/15	0.98	0.95	1.01	.204	1.01	0.98	1.03	.605
	2015/16	0.90	0.87	0.93	< .001	0.94	0.92	0.97	< .001
	2016/17	0.88	0.86	0.91	< .001	0.98	0.96	1.01	.157
	2017/18	0.94	0.91	0.96	< .001	0.95	0.92	0.97	< .001
Concordance statistic		0.586				0.747			

Abbreviations: GEE, generalized estimating equations; OR, odds ratio.

[a] Reference categories: Female; Grade 9; White; Non-smoker; Non-current cannabis user; $0; 2012/13.

1.34–1.40) and Grade 12 students (OR = 1.77, 95% CI: 1.73–1.81) were more likely to report current versus never binge drinking. Compared to students with no weekly disposable income, students with weekly disposable incomes of $21 to $100 (OR = 1.42, 95% CI: 1.39–1.45) and more than $100 (OR = 2.14, 95% CI: 2.09–2.19) were more likely to report current versus never binge drinking. Compared to the baseline year of 2012/13, students were more likely to report current versus never binge drinking in 2013/14 (OR = 1.22, 95% CI: 1.19–1.26) and in 2014/15 (OR = 1.06, 95% CI: 1.03–1.09), and less likely to report current versus never binge drinking in 2015/16 (OR = 0.93, 95% CI: 0.90–0.96), 2016/17 (OR = 0.91, 95% CI: 0.89–0.94), and in 2017/18 (OR = 0.78, 95% CI: 0.76–0.80).

Similar results were seen for associations with non-current versus never binge drinking (Table 2). Compared to non-current users, current cannabis users were more likely to report non-current versus never binge drinking (OR = 2.43, 95% CI:

2.39–2.47). Current smokers were also more likely to report non-current versus never binge drinking, compared to non-smoking students (OR = 1.48, 95% CI: 1.44–1.52). Compared to students with no weekly disposable income, students with weekly disposable income of $21 to $100 (OR = 1.23, 95% CI: 1.20–1.25) and more than $100 (OR = 1.55, 95% CI: 1.51–1.58) were more likely to report non-current versus never binge drinking.

Discussion

This paper shows distinct associations between micro-level factors and alcohol use and binge drinking among a large sample of Canadian high school students. Current cannabis use was associated with a four-fold increased likelihood of both alcohol use and binge drinking, while current smoking was associated with a two-fold increased likelihood of both behaviours. Data from the Canadian Alcohol and Drug Use Monitoring Survey (CADUMS) and the Canadian Community Health Survey (CCHS) showed significantly higher prevalence of binge drinking and problem drinking (based on the AUDIT scale) in current smokers versus non-smokers.[11,12] Using data from CADUMS and CCHS, Kirst and colleagues reported that the magnitude of association between current smoking and binge drinking was larger for adolescents aged between 12 and 17 years compared to those aged 18 years and older.[11] The difference in this association for the two age groups is striking and indicates a need for interventions among youth who use multiple substances. Taking all of this together, we suggest that youth may be negotiating use of various substances, perhaps driven by peer pressure and nonconforming attitudes displayed during adolescence.[4]

In terms of sex, girls were more likely to report current alcohol use compared to boys, while boys were slightly more likely to report current binge drinking than girls. These results can be juxtaposed with findings from the 2016-17 CSTADS, in which prevalence of alcohol use was similar for girls and boys at 44% for both groups, while prevalence of high-risk drinking (five or more drinks on one occasion) was 25% for boys and 23% for girls.[13] Moreover, McCarty and colleagues also showed that cannabis use in youth predicted harmful drinking into adulthood across sexes, and predicted binge drinking during adulthood for those who identified as males.[6]

We also saw differences in prevalence of alcohol use and binge drinking between ethnic groups. Non-White students were less likely to report current alcohol use and binge drinking compared to students who identified as White. Data from the Toronto Youth Crime and Victimization Survey showed that, compared to students who identified as South Asian and East Asian, the likelihood of weekly drinking was significantly higher for students who identified as Canadian, Western European, Eastern European, Southern European, South American or Chinese.[14] Taken together, these results indicate that cultural factors and traditional norms, along with the current social environment, may be influencing alcohol use among Canadian youth. Given that non-White students represented only 29% of the overall sample in our study, our findings may not be generalizable.

Alcohol use and binge drinking also varied by reported levels of weekly disposable income. Students reporting more than $100 of disposable income were approximately twice as likely to report alcohol use and binge drinking. Previous work has shown that family financial resources were a strong predictor of substance use in youth (mean age approximately 17 years); youth with high socioeconomic status were more likely to use alcohol than youth with low socioeconomic status.[15] Students with higher levels of disposable income may view drinking as an economically feasible activity. Moreover, data from the Canadian Community Health Survey showed that youth (aged 15–19 years) who worked longer hours were more likely to exhibit heavy episodic drinking, but this only applied to youth from families with moderate to high incomes.[16] While youth may work for various reasons, from obtaining living essentials to purchasing luxury items, minimum pricing strategies may serve as effective barriers against alcohol consumption among youth.[17]

The recruitment of schools from new geographical locations over the duration of the study resulted in fewer Grade 12 students in 2016/17 and 2017/18, along with fewer students who identified as White and more students who identified as Asian in 2017/18. Moderate decreases in overall prevalence of current alcohol use and current binge drinking in 2016/17 and 2017/18 were subsequently observed. These results highlight the need for a large and diverse sample of youth for future cohort studies.

Strengths and limitations

Data from COMPASS' student questionnaire are self-reported. The data collection procedures employed limit social desirability bias by use of an active-information, passive-consent permission approach, and further maintain confidentiality and minimize underreporting.[18] COMPASS also utilizes purposive sampling for recruitment of participating schools from different geographical locations—Ontario, Alberta, British Columbia, Quebec and Nunavut.[10] While the sampling approach may have impacted external validity, many of the findings presented here are comparable with other large-scale studies on alcohol use and binge drinking prevalence among Canadian youth, namely the Canadian Community Health Survey and the Canadian Alcohol and Drug Use Monitoring Survey (42% prevalence of alcohol use),[11] and the Canadian Student Tobacco, Alcohol and Drugs Survey (44% prevalence of alcohol use and 24% prevalence of high-risk drinking).[13]

Conclusion

This study provides insight on the associations of micro-level factors with alcohol use and binge drinking behaviour among Canadian youth. Cannabis use, smoking of tobacco products and higher disposable incomes were associated with reporting of current alcohol use and binge drinking among high school students in COMPASS. Results may inform polysubstance use prevention efforts that target youth.

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Conflicts of interest

The authors have no conflicts of interest to report.

Authors' contributions and statement

SH conceptualized the study and wrote the manuscript. WQ conducted the data analyses. SL designed the survey and collected the study data. All authors contributed to the interpretation of the findings, development of manuscript drafts, and approved the final version of the manuscript.

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Original quantitative research

Tobacco smoke exposure and sleep: estimating the association of urinary cotinine with sleep quality

Moe Zandy, MPH (1); Vicky Chang, MPH (1,2); Deepa P. Rao, PhD (1); Minh T. Do, PhD (1)

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Abstract

Introduction: A majority of studies on tobacco smoke exposure and sleep quality have relied on self-reported smoking, resulting in potential exposure misclassification and biases related to self-report. The objective of this study was to investigate associations between urinary cotinine, a biological marker of tobacco smoke exposure, and sleep quality measures, including sleep duration, sleep continuity or efficiency, sleep satisfaction and alertness during normal waking hours.

Methods: Using data on a national sample of 10 806 adults (aged 18–79 years) from the Canadian Health Measures Survey (2007–2013), we performed binary logistic regression analyses to estimate associations between urinary cotinine concentrations and sleep quality measures, while controlling for potential confounders. Additionally, we performed ordinal logistic regression to assess the association between urinary cotinine concentrations and increased number of sleep problems.

Results: Overall, 28.7% of adult Canadian survey respondents had urinary cotinine concentrations above the limit of detection (LOD), and the prevalence of each sleep problem ranged from 5.5% to 35.6%. Elevated urinary cotinine concentrations (quartile 4 vs. < LOD) were associated with significantly higher odds of short or long sleep duration (OR = 1.41; 95% CI: 1.02–1.95; *p*-trend = .021), trouble falling or staying asleep (OR = 1.71; 95% CI: 1.28–2.27; *p*-trend = .003), sleep dissatisfaction (OR = 1.87; 95% CI: 1.21–2.89; *p*-trend = .011), and increased number of sleep problems (OR = 1.64; 95% CI: 1.19–2.26; *p*-trend = .001). Stronger associations were observed among females compared to males.

Conclusion: Using a biological marker of tobacco smoke exposure, our study contributes to the body of literature of toxic environmental exposures on sleep quality by supporting an association between tobacco smoke exposure and poorer sleep quality. To address the limitations of a cross-sectional study design and to better assess the temporality of tobacco smoke exposure and sleep quality, longitudinal studies are recommended.

Keywords: *tobacco smoke exposure, urinary cotinine, sleep quality*

Highlights

- Over a quarter of study participants had detectable urinary cotinine levels, indicating that a large proportion of Canadian adults are likely exposed to tobacco smoke actively or passively.
- Poor sleep quality is a commonly reported problem, with approximately a third of adult survey respondents not meeting the recommended sleep duration guidelines.
- Elevated levels of urinary cotinine are associated with higher odds of short or long sleep duration, trouble falling or staying asleep, sleep dissatisfaction and overall increased sleep problems.
- The associations between increased urinary cotinine levels and poor sleep quality were stronger in females compared to males.

Introduction

Although the adverse health effects of tobacco smoke exposure, including cancer and cardiovascular and respiratory disease, have been well established,[1] there is a lack of comprehensive, population-based research on tobacco smoke exposure in relation to sleep quality using a biological marker of exposure. Tobacco smoke exposure includes first-hand smoke exposure in smokers, as well as second-hand smoke (SHS) exposure in both non-smokers and smokers. Recent estimates indicate that approximately 5.0 million (16.2%) Canadians aged 12 years or older reported being current smokers (daily or occasionally).[2] Among non-smokers, approximately 27% of Canadians aged 18 to 24 years have reported being exposed to SHS in a private vehicle or public place.[3] In 2012–2013, 11% of non-smoking Canadians with no reported SHS exposure and 34% of non-smoking Canadians with recent SHS exposure had detectable levels of cotinine (a biological marker of tobacco smoke exposure) in their urine.[4] Concurrently, 40% of Canadian adults reported symptoms of diminished sleep quality.[5] Sleep health has been defined as a multifaceted sleep-wakefulness cycle, reflective of an individual's physical and mental well-being.[6] As such, good sleep quality is

Author references:

1. Surveillance and Epidemiology Division, Public Health Agency of Canada, Ottawa, Ontario, Canada
2. Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada

Correspondence: Minh T. Do, Carleton University, 1125 Colonel By Drive, Ottawa, ON K1S 5B6; Tel: 613-797-7587; Email: minht.do@canada.ca

framed under five dimensions: adequate sleep duration; sustained daytime alertness; sleep continuity or efficiency, which entails the ease and latency of falling asleep or returning to sleep; appropriate timing of sleep; and subjective satisfaction with sleep quality.[6]

Smoking has been shown to increase the risk of poor sleep quality.[7] Consequently, sleep disturbances have been observed among nicotine-dependent individuals.[8-10] Short sleep duration has been linked with an increased risk of morbidity and mortality.[8,11-14] Based on self-reported smoking, current smokers have been found to have higher odds of short sleep duration and poor sleep quality compared to never-smokers.[15] Compared to never-smokers, current smokers have also been found to have significantly higher odds of self-reported sleep deficiency or discontinuity and daytime sleepiness.[15-18] In addition, studies have demonstrated a dose-response relationship between quantities of cigarettes smoked and poor sleep quality.[17] In a longitudinal study, self-reported smoking was found to be significantly associated with increased difficulty of initiating sleep and waking up.[19] At the same time, light smoking has also been reportedly associated with reduced sleep duration.[20] Furthermore, non-smokers without SHS exposure have been reported to have lower odds of a sleep disorder compared to smokers with detectable cotinine concentrations.[21]

Nicotine, a stimulant, has been linked with reduced sleep quality. Compared to non-smokers, smokers have been shown to have reduced availability of dopamine transporters in the striatal region of the brain.[22] This phenomenon has been found to be associated with lower sleep quality among healthy adults.[23] Smokers have also been reported to experience nocturnal cravings and nicotine withdrawals, possibly because serum nicotine levels decline during sleep.[24] Consequently, sleep quality is potentially diminished due to a biological dependence on nicotine. In fact, the reported prevalence of nocturnal smoking among heavy smokers is roughly 41%.[25] By promoting the release of neurotransmitters, nicotine yields a sense of arousal and wakefulness.[26] As such, an association between nicotine and poor sleep quality has been previously demonstrated.

Using self-report of smoking is a noninvasive method of measuring tobacco smoke exposure, yet this method of surveillance is prone to underreporting. This is due to the socially undesirable nature of smoking, especially under the current public scrutiny of active and passive tobacco smoke exposure. Although the assessment of tobacco smoke exposure through the collection of biological samples is limited by associated costs, biological measurements of exposure, including urinary cotinine, have demonstrated a higher degree of accuracy than self-reports of smoking.[27]

Most published research has been limited to self-reported active smoking and SHS exposure as a measure of tobacco smoke exposure. Furthermore, most population-based studies have independently assessed only one dimension of sleep as an overall measure of sleep quality. A review of the literature has demonstrated a trend of underestimation in the prevalence of tobacco smoke exposure in studies relying on self-report, compared to studies utilizing biological markers of exposure.[27] Accordingly, this study aimed to address these research gaps by using urinary cotinine as a measure of tobacco smoke exposure, minimizing potential biases due to nonrandom and random misclassification of tobacco smoke exposure. In addition, this study encompassed four dimensions of sleep quality, including sleep duration, sleep continuity, sleep satisfaction and daytime alertness, thus providing a comprehensive understanding of the link between tobacco smoke exposure and sleep health. We sought to evaluate the association between urinary cotinine levels and sleep quality measures among Canadian adults, overall and by sex.

Methods

Data source and study population

This study used data from the Canadian Health Measures Survey (CHMS), cycles 1 (2007–2009), 2 (2010–2011) and 3 (2012–2013). The CHMS is an ongoing cross-sectional health survey that collects data from Canadians aged 6 to 79 years (cycle 1) or 3 to 79 years (cycles 2 and 3). Persons living on reserves or other Aboriginal settlements, full-time members of the Canadian Forces, residents of the three territories and those residing in certain remote regions or institutions were excluded from the survey. The CHMS was designed to cover approximately 96.0% of the Canadian population in the target age range.[28] The overall response rate for the pooled cycles is 52.9%. Details on the CHMS survey design and sampling framework are available elsewhere.[28] The survey consists of a household interview designed to collect sociodemographic and health- and lifestyle-related characteristics, followed by direct physical measurements and collection of biological samples at a mobile examination centre (MEC).[29] The complex multistage randomized sampling design and sample survey weights allow researchers to make inferences about the Canadian population, assess the quality of data, evaluate sampling errors and adjust for response rates in analyses. Our analysis included adults aged 18 years and older. To enhance statistical power and sample size, data from cycle 1 (n = 3726), cycle 2 (n = 3873), and cycle 3 (n = 3397) were pooled together. Due to their accelerated metabolism of nicotine, pregnant females (n = 93) were excluded from the analysis. Respondents with missing data on urinary cotinine or creatinine (n = 97) were also excluded. The final sample size was 10 806.

Ethics and consent

Participation in the CHMS is voluntary; respondents could opt out of any part of the survey at any point during data collection. Written informed consent was obtained from all participating respondents. All processes related to the CHMS were approved by Health Canada and the Public Health Agency of Canada (PHAC) Research Ethics Board.

Exposure: free urinary cotinine

Single spot urine samples were collected from participants upon arrival to the MEC. Respondents were asked to refrain from smoking or consuming other tobacco- and nicotine-containing products for a period of 2 hours prior to their visit. Before shipment to laboratories for testing, urine samples were refrigerated and stored at the appropriate temperature.[30] Cotinine was recovered by solid-phase extraction in a 96-well plate format on an automated PerkinElmer JANUS robotic workstation (C-550).[31] The limit of detection (LOD) for urinary cotinine was 1.1 µg/L.[32]

For the purpose of this analysis, urinary cotinine concentrations were divided into < LOD (reference category) and the remainder categorized into four quartiles, based

on the distribution in the overall population with detectable cotinine levels. Urinary cotinine levels were therefore classified into the following five categories: < LOD (< 1.1 µg/L); quartile 1 (≥ 1.1–60 µg/L); quartile 2 (61–734 µg/L); quartile 3 (735–< 1408 µg/L); and quartile 4 (≥ 1408 µg/L). We did not calculate geometric mean of urinary cotinine concentrations, since 40% of the sample had urinary cotinine concentrations below LOD.[31] We corrected for urinary creatinine concentrations in the analysis by including it as a covariate in multivariable regression models. This inclusion adjusts for potential biases due to individual differences in creatinine concentrations across population demographics and health characteristics.[33]

Outcomes: sleep quality

Information on the four dimensions of sleep was collected during the household interview. Sleep duration was assessed by asking respondents "How many hours do you usually spend sleeping in a 24-hour period, excluding time spent resting?" and was reported to the nearest half hour. Responses were dichotomized into "not meeting sleep duration guidelines," i.e. short or long sleep duration (ages 18–64 years: < 7 or > 9 hours; ages 65 years and over: < 7 or > 8 hours) than recommended in the U.S. National Sleep Foundation's age-specific recommendations[34] (ages 18–64 years: 7–9 hours; ages 65 years and over: 7–8 hours), and "recommended duration" (i.e. meeting sleep duration guidelines). Sleep continuity or efficiency was assessed by asking respondents "How often do you have trouble going to sleep or staying asleep?" Responses were dichotomized into "most of the time or all the time" versus "never, rarely, or sometimes." Sleep satisfaction was assessed by asking respondents "How often do you find your sleep refreshing?" Responses were dichotomized into "never or rarely" versus "sometimes, most of the time, or all the time." Finally, alertness was assessed by asking respondents "How often do you find it difficult to stay awake during your normal waking hours when you want to?" Responses were dichotomized into "most of the time or all the time" versus "never, rarely, or sometimes." Survey questions about the sleep dimensions asked about sleep characteristics during periods ranging from two weeks to two years prior to the survey date. Each of the four dimensions of sleep was independently analyzed in relation to urinary cotinine. Additionally, for our secondary analyses, we derived a composite measure of sleep quality by summing up the number of sleep problems based on the four binary variables described above. Participants were categorized as having 0, 1 or ≥ 2 sleep problems.

Covariates

We identified potential confounders from existing studies on the association between tobacco smoke exposure and sleep quality. Sociodemographic covariates included age; sex; race/ethnicity; marital status; education level; employment status; and household income adequacy. Household income adequacy was categorized based on total annual household earnings and total number of people living in a household.[31] Due to the high percentage of missing data (approximately 20%), household income was imputed by Statistics Canada using the nearest neighbour imputation method.[35] Health status covariates included body mass index (BMI); self-perceived mental health status; and presence (yes/no) of one of the following chronic conditions: asthma, diabetes, chronic obstructive pulmonary disease, hypertension, heart disease, stroke or cancer. Covariates related to health behaviour included self-reported physical activity, based on daily energy expenditures during leisure-time activities; and frequency of alcohol consumption.

Statistical analysis

We performed descriptive analyses to assess the distribution of covariates overall and by urinary cotinine category. We also determined the prevalence of each sleep quality measure across urinary cotinine categories. We used the Rao-Scott modified chi-square test to assess significance across categories of responses. Statistical significance was assessed at $p < .05$ (two-sided tests). To account for the complex sampling design of the CHMS, we integrated survey weights into all of our descriptive and logistic regression analyses. Bootstrap methods were used to calculate sample variances.[28]

We used univariate binary logistic regression to assess unadjusted associations between urinary cotinine and each of the four sleep dimensions of interest. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported. We then applied a model building procedure, recommended by Hosmer and colleagues,[36] when selecting the final multivariable model for each sleep quality measure. The following covariates were included in all models regardless of statistical significance: age, sex and urinary creatinine concentrations. Other potential confounders identified from the literature (listed in the "Covariates" section, earlier) were included in the final multivariable model if they were significantly associated with the outcome (sleep quality measure) at $p < .05$, or if their inclusion resulted in a > 10% change in the beta coefficient of the main exposure (urinary cotinine). Furthermore, to assess whether there was a linear trend in the associations across increasing categories (< LOD and quartiles) of urinary cotinine, we calculated *p*-trend by modelling the median value within each cotinine quartile as a continuous variable.

Due to known sex differences in the metabolic processes of nicotine to cotinine,[37-39] we also performed separate analyses for males and females to explore potential effect modification of the association between cotinine and each sleep dimension by sex. A multiplicative interaction term between cotinine and sex was also tested in the models.

In our secondary analysis, using the same modelling approach described above, we performed ordinal logistic regression to assess the association between urinary cotinine concentrations and increased number of sleep problems (as defined in the "Outcomes: sleep quality" section, earlier). The increased sleep problems outcome was classified into three categories: zero sleep problems; 1 sleep problem; and ≥ 2 sleep problems. We assessed the validity of the proportional odds assumption. All analyses were performed using SAS EG version 5.1 (SAS Institute Inc., Cary, NC, USA).

Results

Sample characteristics across categories of urinary cotinine concentrations are presented in Table 1. Urinary cotinine was divided into five categories: < LOD; quartile 1; quartile 2; quartile 3; quartile 4. Accordingly, 28.7% of study participants had urinary cotinine concentrations above the LOD. Prevalence of the four sleep dimensions across levels of urinary cotinine concentrations is presented in Table 2. Among study participants, 35.6% had short

TABLE 1
Distribution of urinary cotinine concentrations (µg/L) across population characteristics, CHMS, Canada, 2007–2013

Characteristics	Cotinine levels (µg/L)						*p*-value[c]
	Total N (%)[a,b]	< LOD (< 1.1 µg/L) N = 7879 (71.3%)	Quartile 1 (1.1–60 µg/L) N = 704 (7.2%)	Quartile 2 (61–734 µg/L) N = 763 (7.1%)	Quartile 3 (735–<1408 µg/L) N = 763 (7.2%)	Quartile 4 (≥ 1408 µg/L) N = 743 (7.2%)	
Sociodemographics							
Age (N = 10 806)							
Young adults (18–25)	1296 (14.0)	786 (63.2)	190 (13.8)	155 (12.1)	94 (6.8)[d]	71 (4.1)[d]	< .0001
Adults (26–64)	7485 (72.8)	5401 (70.9)	427 (6.2)	509 (6.5)	534 (7.7)	614 (8.6)	
Older adults (≥ 65)	2025 (13.2)	1692 (82.2)	87 (5.2)	99 (4.9)	89 (4.6)	58 (3.1)[d]	
Sex (N = 10 806)							
Male	5162 (49.7)	3558 (67.2)	387 (8.2)	391 (7.5)	374 (8.3)	452 (8.8)	< .0001
Female	5644 (50.3)	4321 (75.4)	317 (6.2)	372 (6.7)	343 (6.0)	291 (5.7)	
Education (N = 10 688)							
Less than secondary school	1548 (12.9)	922 (57.2)	133 (8.7)	134 (9.6)	172 (11.8)	187 (12.7)	
Secondary school graduation or some post-secondary	2680 (26.6)	1832 (66.9)	233 (9.6)	229 (8.0)	176 (6.8)	219 (8.8)	< .0001
Post-secondary graduation	6460 (60.5)	5065 (76.9)	323 (5.6)	390 (6.1)	355 (6.0)	327 (5.4)	
Employment status (N = 10 806)							
Not employed	2183 (15.8)	1658 (72.4)	136 (7.4)	130 (7.5)	137 (7.0)	122 (5.7)	
Part-time employment (< 30 hours/week)	4469 (43.8)	3308 (72.3)	281 (6.4)	302 (7.0)	293 (7.6)	285 (6.8)	.48
Full-time employment (≥ 30 hours/week)	4154 (40.4)	2913 (69.9)	287 (7.9)	331 (7.0)	287 (6.8)	336 (8.4)	
Household income adequacy (N = 10 806)							
Lowest	723 (5.3)	377 (53.2)	69 (8.0)[d]	80 (12.3)[d]	87 (11.3)[d]	110 (15.2)	
Lower/upper middle	5215 (45.8)	3686 (67.9)	347 (7.5)	396 (8.2)	403 (7.9)	383 (8.6)	< .0001
Highest	4868 (48.9)	3816 (76.6)	288 (6.8)	287 (5.5)	227 (6.0)	250 (5.1)	
Race/ethnicity (N = 10 597)							
Non-White	2027 (21.7)	1581 (79.1)	126 (5.9)	142 (7.3)[d]	93 (4.2)	85 (3.5)[d]	< .0001
White	8773 (78.3)	6294 (69.2)	578 (7.5)	620 (7.1)	624 (8.0)	657 (8.3)	
Marital status (N = 10 800)							
Married or common-law	6607 (64.2)	5180 (75.8)	335 (5.8)	369 (5.7)	352 (6.2)	371 (6.5)	
Widowed, separated or divorced	1777 (11.3)	1229 (65.0)	96 (5.3)[d]	133 (8.0)	159 (9.9)	160 (11.7)	< .0001
Single or never married	2416 (24.4)	1465 (62.5)	272 (11.6)	261 (10.4)	206 (8.4)	212 (7.2)	
Health status							
BMI (N = 10 782)							
Underweight/normal	4041 (39.0)	2864 (69.9)	234 (6.8)	308 (7.1)	305 (8.2)	330 (8.0)	
Overweight	3895 (35.5)	2927 (72.7)	239 (6.6)	260 (7.4)	218 (6.0)	251 (7.2)	.30
Obese	3846 (25.5)	2074 (71.8)	230 (8.6)	194 (6.6)	189 (6.9)	159 (6.1)	

Continued on the following page

TABLE 1 (continued)
Distribution of urinary cotinine concentrations (µg/L) across population characteristics, CHMS, Canada, 2007–2013

Characteristics	Cotinine levels (µg/L)						*p*-value[c]
	Total N (%)[a,b]	< LOD (< 1.1 µg/L) N = 7879 (71.3%)	Quartile 1 (1.1–60 µg/L) N = 704 (7.2%)	Quartile 2 (61–734 µg/L) N = 763 (7.1%)	Quartile 3 (735–<1408 µg/L) N = 763 (7.2%)	Quartile 4 (≥ 1408 µg/L) N = 743 (7.2%)	
Self-perceived mental health status (N = 10 772)							
Fair or poor	622 (6.0)	369 (56.3)	44 (7.8)	61 (8.0)	70 (15.1)	78 (12.8)	.0003
Good or very good	6561 (60.1)	4772 (71.7)	424 (7.4)	493 (7.5)	428 (6.7)	444 (6.6)	
Excellent	3589 (33.9)	2712 (73.3)	231 (6.6)	208 (6.3)	217 (6.3)	221 (7.5)	
Chronic comorbidities (N = 10 353)							
No	7333 (69.8)	5325 (72.0)	482 (7.0)	542 (7.4)	470 (6.5)	514 (7.0)	.23
Yes	3419 (30.2)	2523 (70.2)	221 (7.5)	215 (6.2)	236 (8.4)	224 (7.7)	
Health behaviours							
Alcohol consumption (N = 10 806)							
≤ once a month	4349 (39.6)	3271 (73.8)	242 (5.6)	242 (5.5)	282 (6.6)	312 (8.5)	< .0001
2–4 times a month	2652 (24.4)	1905 (71.5)	202 (9.0)	225 (7.8)	167 (6.1)	153 (5.5)	
2–6 times a week	2864 (26.9)	2060 (71.0)	200 (8.0)	226 (7.7)	184 (7.5)	194 (5.8)	
Everyday	941 (9.04)	643 (61.2)	60 (6.8)[d]	70 (10.2)[d]	84 (11.3)[d]	84 (10.5)[d]	
Physical activity (N = 10 789)							
Inactive (< 1.5 kcal/kg/day)	5710 (53.7)	3938 (66.3)	370 (7.6)	456 (8.4)	475 (8.9)	471 (8.8)	< .0001
Moderately active (1.5–2.9 kcal/kg/day)	2466 (21.8)	1884 (76.6)	174 (8.0)	154 (5.2)	126 (5.4)[d]	128 (4.8)	
Active (≥ 3 kcal/kg/day)	2630 (24.6)	2057 (77.6)	160 (5.6)	153 (6.0)[d]	116 (5.0)	144 (5.9)	
Self-reported smoking (N = 10 806)							
Daily	1744 (17.8)	NR	24 (0.22)[d]	415 (4.3)	615 (6.4)	680 (6.8)	< .0001
Occasionally	423 (4.0)	94 (0.87)[d]	100 (1.1)[d]	160 (1.4)	46 (0.44)[d]	NR	
Not at all	8639 (78.2)	7775 (70.3)	580 (5.9)	188 (1.4)[d]	56 (0.34)[d]	40 (0.30)[d]	

Data source: Canadian Health Measures Survey, Cycles 1–3.

Abbreviations: BMI, body mass index (kg/m^2); CHMS, Canadian Health Measures Survey; LOD, limit of detection; NR, not reportable.

[a] N represents unweighted number of respondents; percentages were weighted using sampling weights.

[b] Numbers may not sum up to totals due to missing data; percentages may not sum up to 100% due to rounding.

[c] Significance was calculated using the Rao-Scott modified chi-square test.

[d] Estimate is associated with high sampling variability (coefficient of variation is between 16.6% and 33.3%); to be interpreted with caution. NR: not reportable; estimate is associated with a very high sampling variability (coefficient of variation > 33.3%).

or long sleep duration and did not meet recommended sleep guidelines; 21.3% stated they had trouble falling or staying asleep; 15.7% of participants reported sleep dissatisfaction; and 5.5% of the participants had difficulty staying alert during normal waking hours. The proportion of short or long sleep duration (p = .004), trouble falling or staying asleep (p = .002), and sleep dissatisfaction (p < .0001) increased across higher quartiles of urinary cotinine concentrations. These differences were not significant across the urinary cotinine concentration quartiles for trouble staying alert during normal waking hours (p = .55). With the exception of sleep duration, the prevalence of poor sleep quality was higher in females compared to males. For example, female participants reported a 3.3% and 2.6% higher prevalence of trouble falling or staying asleep and sleep dissatisfaction, respectively (data not shown). The mean urinary cotinine concentrations were significantly higher among male study participants (308.9 µg/L; 95% CI: 274.0–343.8) compared to their female counterparts (209.3 µg/L; 95% CI: 179.7–238.9) (data not shown).

Urinary cotinine and sleep quality

Table 3 presents associations of urinary cotinine concentrations with the four dimensions of sleep quality, overall and by sex. Overall, compared to those with cotinine levels lower than the LOD (< 1.1 µg/L), those in quartile 4 had 1.41 (95% CI: 1.02–1.95; p-trend = .021) times the odds of short or long sleep duration (not meeting sleep duration guidelines); 1.71 (95% CI: 1.28–2.27; p-trend = .003) times the odds of trouble falling or staying asleep; and 1.87 (95% CI: 1.21–2.89; p-trend = .011) times the odds of sleep dissatisfaction. In addition, although not statistically significant, compared to those with cotinine levels below the LOD, those in quartile 4 had 1.30 (95% CI: 0.69–2.46; p-trend = .52) times the odds of difficulty staying awake during normal waking hours.

TABLE 2
Prevalence of sleep dimensions across urinary cotinine concentrations (µg/L), CHMS, Canada, 2007–2013

Sleep	Total N (%)[a,b]	Cotinine levels (µg/L)					*p*-value[c]
		< LOD (< 1.1 µg/L) N = 7879 (71.3%)	Quartile 1 (1.1–60 µg/L) N = 704 (7.2%)	Quartile 2 (61–734 µg/L) N = 763 (7.1%)	Quartile 3 (735–<1408 µg/L) N = 763 (7.2%)	Quartile 4 (≥ 1408 µg/L) N = 743 (7.2%)	
Sleep duration (N = 10 806)							
Short or long sleep duration (not meeting recommended sleep guidelines)	3 644 (35.6)	2 503 (33.6)	254 (38.6)	271 (35.9)	291 (41.9)	325 (45.0)	.004*
Recommended duration (meeting recommended sleep guidelines)	7 162 (64.4)	5 376 (66.4)	450 (61.4)	492 (64.1)	426 (58.1)	418 (55.0)	
Trouble falling or staying asleep (N = 10 796)							
Most of the time or all of the time	2 241 (21.3)	1 513 (19.9)	150 (20.6)	170 (19.5)	189 (26.7)	219 (32.5)	.002*
Never, rarely or sometimes	8 555 (78.7)	6 358 (80.1)	554 (79.4)	592 (80.5)	528 (74.3)	523 (67.5)	
Sleep satisfaction (N = 10 798)							
Never, rarely (sleep dissatisfaction)	1 651 (15.7)	1 057 (14.3)	114 (14.7)	138 (16.7)	156 (18.5)	186 (26.8)	< .0001*
Sometimes, most of the time or all of the time	9 147 (84.3)	6 816 (85.7)	590 (85.3)	624 (83.3)	561 (81.5)	556 (73.2)	
Difficulty staying alert during normal waking hours (N = 10 798)							
Most of the time or all of the time	529 (5.5)	350 (5.2)[d]	35 (5.4)[d]	34 (4.9)[d]	58 (6.8)[d]	52 (7.5)[d]	.55
Never, rarely or sometimes	10 269 (94.5)	7 523 (94.8)	669 (94.6)	728 (95.1)	659 (93.2)	690 (92.5)	

Abbreviations: CHMS, Canadian Health Measures Survey; LOD, limit of detection.

Note: Recommended sleep guidelines are from the U.S. National Sleep Foundation.[34]

[a] N represents unweighted number of respondents; percentages were weighted using sampling weights.

[b] Numbers may not sum up to totals due to missing data; percentages may not sum up to 100% due to rounding.

[c] Significance was calculated using the Rao-Scott modified chi-square test.

[d] Estimate is associated with high sampling variability (coefficient of variation is between 16.6 and 33.3%); to be interpreted with caution.

* Significant at $\alpha = .05$.

We examined the association between urinary cotinine levels and short sleep (< 7 hours) duration and long sleep (> 9 hours) duration (Table 3) and found that, compared to participants with cotinine levels below the LOD, those in quartile 4 had 1.41 (95% CI: 1.02–1.95; *p*-trend = .019) times the odds of short sleep duration. Furthermore, compared to participants with cotinine levels below the LOD, those in quartile 1 had 1.91 (95% CI: 1.22–3.01; *p*-trend = .73) times the odds of long sleep duration.

In sex-stratified analyses, we found stronger associations between increased urinary cotinine levels and poor sleep quality in females compared to males, although interaction terms were not statistically significant ($p > .05$). Specifically, elevated urinary cotinine levels were associated with significantly greater odds of short or long sleep duration, trouble falling or staying asleep and sleep dissatisfaction among females, with ORs (quartile 4 vs. < LOD) of 2.13 (95% CI: 1.29–3.51), 2.35 (95% CI: 1.43–3.84), and 2.72 (95% CI: 1.35–5.46) (all *p*-trend < .05), respectively (Table 3). The associations were weaker and not statistically significant among males.

Secondary analysis: urinary cotinine and increased number of sleep problems

Table 4 presents associations of urinary cotinine concentrations with increased number of sleep problems, overall and by sex. Compared to cotinine levels < LOD, the odds of having an increased number of sleep problems were significantly higher among those in the highest quartile of urinary cotinine (OR = 1.64; 95% CI: 1.19–2.26; *p*-trend = .001) Similar to analyses of individual sleep problems, the association between increased urinary cotinine levels and increased number of sleep problems was stronger among females (OR = 2.37; 95% CI: 1.80–2.94; *p*-trend = .007) compared to males (OR = 1.20; 95% CI: 0.86–1.54; *p*-trend = .28).

Discussion

Among study participants, 28.7% were found to have tobacco smoke exposure,

TABLE 3
Binary logistic regression analyses for the associations between urinary cotinine concentrations and sleep quality measures, overall and stratified by sex, CHMS, Canada, 2007–2013

Urinary cotinine concentrations	Overall		Males	Females
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Short/long sleep duration (not meeting vs. meeting recommended guidelines)				
	(N = 10 806)	**(N = 10 572)[a]**	**(N = 5047)[a]**	**(N = 5525)[a]**
< LOD (< 1.1 µg/L)	Reference	Reference	Reference	Reference
Quartile 1 (≥ 1.1–60 µg/L)	1.24 (0.96–1.60)	1.25 (0.97–1.61)	1.00 (0.63–1.58)	1.75 (1.18–2.60)*
Quartile 2 (61–734 µg/L)	1.11 (0.84–1.46)	1.06 (0.80–1.40)	1.17 (0.75–1.82)	0.91 (0.66–1.26)
Quartile 3 (735–<1408 µg/L)	1.43 (1.04–1.95)*	1.23 (0.89–1.70)	1.15 (0.67–1.97)	1.64 (0.94–1.91)
Quartile 4 (≥ 1408 µg/L)	1.62 (1.20–2.18)*	1.41 (1.02–1.95)*	1.04 (0.70–1.56)	2.13 (1.29–3.51)*
p-trend[b]	.0001	.021	.66	.004
Short sleep duration (< 7 hours vs. 7–9 hours)				
	(N = 9975)	**(N = 9975)[a]**	**(N = 4795)[a]**	**(N = 5180)[a]**
< LOD (< 1.1 µg/L)	Reference	Reference	Reference	Reference
Quartile 1 (≥ 1.1–60 µg/L)	1.13 (0.87–1.48)	1.19 (0.91–1.55)	0.95 (0.56–1.60)	1.64 (1.05–2.57)
Quartile 2 (61–734 µg/L)	1.01 (0.76–1.34)	1.04 (0.78–1.38)	1.15 (0.75–1.78)	0.87 (0.60–1.24)
Quartile 3 (735–<1408 µg/L)	1.34 (0.96–1.86)	1.24 (0.88–1.77)	1.15 (0.66–2.01)	1.40 (0.92–2.13)
Quartile 4 (≥ 1408 µg/L)	1.55 (1.16–2.08)*	1.41 (1.02–1.95)*	1.08 (0.71–1.67)	2.06 (1.27–3.33)*
p-trend[b]	.001	.019	.53	.004
Long sleep duration (> 9 hours vs. 7–9 hours)				
	(N = 7418)	**(N = 7418)[a]**	**(N = 3466)[a]**	**(N = 3952)[a]**
< LOD (< 1.1 µg/L)	Reference	Reference	Reference	Reference
Quartile 1 (≥ 1.1–60 µg/L)	1.91 (1.28–2.87)*	1.91 (1.22–3.01)*	1.17 (0.61–2.26)	2.71 (1.42–5.12)*
Quartile 2 (61–734 µg/L)	1.20 (0.68–2.14)	1.16 (0.66–2.03)	1.07 (0.45–2.58)	1.16 (0.57–2.37)
Quartile 3 (735–<1408 µg/L)	1.30 (0.86–1.95)	1.17 (0.67–2.04)	0.79 (0.27–2.29)	1.63 (0.80–3.31)
Quartile 4 (≥ 1408 µg/L)	1.16 (0.63–2.16)	1.20 (0.61–2.35)	0.49 (0.19–1.29)	2.41 (0.84–6.92)
p-trend[b]	.55	.73	.093	.13
Trouble falling or staying asleep (most of the time/all of the time vs. never/rarely/sometimes)				
	(N = 10 796)	**(N = 10 563)[c]**	**(N = 5041)[c]**	**(N = 5522)[c]**
< LOD (< 1.1 µg/L)	Reference	Reference	Reference	Reference
Quartile 1 (≥ 1.1–60 µg/L)	1.04 (0.69–1.58)	1.00 (0.63–1.60)	0.92 (0.46–1.85)	1.08 (0.69–1.70)
Quartile 2 (61–734 µg/L)	0.98 (0.72–1.32)	0.90 (0.64–1.28)	0.76 (0.43–1.36)	1.03 (0.62–1.70)
Quartile 3 (735–<1408 µg/L)	1.39 (0.88–2.18)	1.01 (0.62–1.64)	1.18 (0.62–2.25)	0.77 (0.45–1.33)
Quartile 4 (≥ 1408 µg/L)	1.93 (1.54–2.43)*	1.71 (1.28–2.27)*	1.26 (0.84–1.90)	2.35 (1.43–3.84)*
p-trend[b]	< .0001	.003	.24	.006
Sleep satisfaction (never/rarely vs. sometimes/most of the time/all of the time)				
	(N = 10 806)	**(N = 10 566)[d]**	**(N = 5042)[d]**	**(N = 5524)[d]**
< LOD (< 1.1 µg/L)	Reference	Reference	Reference	Reference
Quartile 1 (≥ 1.1–60 µg/L)	1.03 (0.71–1.49)	0.92 (0.62–1.38)	0.82 (0.49–1.35)	0.99 (0.58–1.70)
Quartile 2 (61–734 µg/L)	1.20 (0.87–1.65)	1.11 (0.77–1.61)	1.14 (0.66–1.95)	1.04 (0.62–1.76)
Quartile 3 (735–<1408 µg/L)	1.35 (0.94–1.94)	0.85 (0.55–1.32)	0.61 (0.30–1.20)	1.24 (0.71–2.19)
Quartile 4 (≥ 1408 µg/L)	2.19 (1.52–3.16)*	1.87 (1.21–2.89)*	1.32 (0.70–2.26)	2.72 (1.35–5.46)*
p-trend[b]	< .0001	.011	.55	.004

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TABLE 3 (continued)
Binary logistic regression analyses for the associations between urinary cotinine concentrations and sleep quality measures, overall and stratified by sex, CHMS, Canada, 2007–2013

Urinary cotinine concentrations	Overall		Males	Females
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Difficulty staying alert during normal waking hours (most of the time/all of the time vs. never/rarely/sometimes)				
	(N = 10 798)	(N = 10 565)[e]	(N = 5043)[e]	(N = 5522)[e]
< LOD (< 1.1 µg/L)	Reference	Reference	Reference	Reference
Quartile 1 (≥ 1.1–60 µg/L)	1.03 (0.58–1.83)	0.78 (0.38–1.58)	0.65 (0.21–2.00)	0.92 (0.38–2.24)
Quartile 2 (61–734 µg/L)	0.94 (0.39–2.23)	0.77 (0.32–1.84)	0.73 (0.22–2.41)	0.86 (0.31–2.42)
Quartile 3 (735–<1408 µg/L)	1.32 (0.80–2.17)	0.91 (0.48–1.72)	0.75 (0.31–1.82)	1.32 (0.55–3.19)
Quartile 4 (≥ 1408 µg/L)	1.48 (0.86–2.52)	1.30 (0.69–2.46)	1.06 (0.40–2.80)	1.80 (0.79–4.11)
p-trend[b]	.13	.52	.99	.17

Abbreviations: CHMS, Canadian Health Measures Survey; CI, confidence interval; LOD, limit of detection; OR, odds ratio.

Notes: All multivariable models adjusted for age, sex (overall models only), education, alcohol consumption, perceived mental health status, physical activity and urinary creatinine concentrations. Recommended sleep guidelines are from the U.S. National Sleep Foundation.[34]

[a] Additionally adjusted for marital status, race/ethnicity and household income adequacy.

[b] *p*-value for test of increasing trend was calculated by modelling the median of each cotinine quartile as a continuous variable.

[c] Additionally adjusted for marital status, employment status, race/ethnicity, chronic comorbidities and body mass index.

[d] Additionally adjusted for employment status, household income adequacy, race/ethnicity, body mass index and chronic comorbidities.

[e] Additionally adjusted for employment status, race/ethnicity and chronic comorbidities.

* Statistically significant at $p < .05$.

with urinary cotinine concentrations above the LOD. This estimate is a larger proportion than the 16.1% of self-reported Canadians identifying as current smokers.[2] Consistent with other studies, our analyses confirm that a large number of Canadians are exposed to SHS.[3,4] Concurrently, the prevalence of sleep problems ranged from 5.5% to 35.6%. We found a positive association between increased levels of urinary cotinine concentrations and short or long sleep duration, trouble falling or staying asleep and sleep dissatisfaction. Elevated urinary cotinine concentrations were not found to be significantly associated with difficulty staying alert during normal waking hours. This finding is consistent with the previously described dose-dependent relationship between quantities of cigarettes smoked and diminished sleep quality.[17]

In our analyses, although the increasing trend between urinary cotinine levels and diminished sleep quality was evident, the association was only significant for the highest level of urinary cotinine (quartile 4 vs. < LOD) and not significant for lower levels (quartiles 1–3 vs. < LOD). Furthermore, elevated levels of urinary cotinine (quartile 4 vs. < LOD) were found to be significantly associated with higher odds of having an increased number of sleep problems. These findings indicate that active heavy smoking or excessive SHS exposure, with urinary cotinine concentrations of 1408 µg/L or higher, is strongly associated with increased odds of poor sleep quality. Accordingly, future public health campaigns targeting sleep problems should address active heavy smokers and those exposed to excessive amounts of SHS. It is

TABLE 4
Ordinal logistic regression analyses for the associations between urinary cotinine concentrations and increasing number of sleep problems, overall and stratified by sex, CHMS, Canada, 2007–2013

Urinary cotinine concentrations	Overall		Males	Females
	Unadjusted OR (95% CI)	Adjusted OR[a] (95% CI)	Adjusted OR[a] (95% CI)	Adjusted OR[a] (95% CI)
	(N = 10 794)	(N = 10 562)	(N = 5040)	(N = 5522)
< LOD (< 1.1 µg/L)	Reference	Reference	Reference	Reference
Quartile 1 (≥ 1.1–60 µg/L)	1.15 (0.87–1.54)	1.10 (0.82–1.48)	0.98 (0.55–1.42)	1.33 (0.98–1.68)
Quartile 2 (61–734 µg/L)	1.06 (0.83–1.37)	1.00 (0.76–1.32)	1.09 (0.67–1.50)	0.88 (0.50–1.26)
Quartile 3 (735–<1408 µg/L)	1.43 (1.01–2.04)*	1.14 (0.80–1.61)	1.12 (0.54–1.70)	1.15 (0.74–1.57)
Quartile 4 (≥ 1408 µg/L)	1.86 (1.41–2.45)*	1.64 (1.19–2.26)*	1.20 (0.86–1.54)	2.37 (1.80–2.94)*
p-trend[b]	< .0001	.001	.28	.007

Abbreviations: CHMS, Canadian Health Measures Survey; CI, confidence interval; LOD, limit of detection; OR, odds ratio.

[a] Additionally adjusted for age, sex (overall model only), household income adequacy, employment status, education, marital status, race, perceived mental health status, physical activity, chronic comorbidities, body mass index, alcohol consumption and urinary creatinine concentrations.

[b] *p*-value for test of increasing trend was calculated by modelling the median of each cotinine quartile as a continuous variable.

* Statistically significant at $p < .05$.

possible that some of the participants with urinary cotinine concentrations of 1408 µg/L or higher might not have followed survey instructions to refrain from smoking for 2 hours prior to the interview. The lack of association between urinary cotinine and difficulty staying alert during normal waking hours could be explained by the low prevalence of participants with this sleep problem, and potential residual confounding, as we were not able to control for factors such as caffeine intake and drug use.

Although the sex and urinary cotinine interaction terms in our models were not statistically significant, we found that the associations between urinary cotinine and measures of poor sleep quality were consistently stronger in females compared to males. This difference may be due to the fact that females tend to be more sensitive to the effects of nicotine.[40] Studies have demonstrated sex-based differences in the metabolization of cotinine; females have been found to have higher urinary cotinine levels, indicating faster cotinine metabolization rates.[41,42] Therefore, cotinine half-life among females is shorter compared to males. These sex differences in sensitivity and metabolization rate of nicotine can explain the stronger association between tobacco smoke exposure and poorer sleep quality among females compared to males. There are inconsistencies in the literature regarding sex differences in smoking or cotinine concentrations and sleep quality.[15,43] Such inconsistencies in study findings are potentially due to differences in population demographics and characteristics. Furthermore, discrepancies in definitions of the different sleep dimensions and tobacco smoke exposure assessment methods (self-reported vs. biological marker) could possibly yield inconsistent study conclusions. It has been reported that, compared with estimates based on urinary cotinine concentrations, smoking prevalence based on self-report was only 0.3% lower.[44]

Cotinine testing is widely accepted and used, despite costing more than other biomarkers or self-reported smoking or SHS. With the exception of nicotine replacement therapy use, cotinine is recognized as the most appropriate indicator of tobacco smoke exposure.[27] However, cotinine is a relevant indicator of short-term tobacco smoke exposure, and not of lifetime smoking habits. Cotinine could be measured in multiple mediums, including blood, saliva, urine and hair samples. A systematic review comparing cotinine estimates ascertained from multiple biological sources concluded that sensitivity values are consistently higher when cotinine is measured in saliva instead of blood or urine.[27]

Strengths and limitations

Our analyses were strengthened by the use of a national dataset with a large sample size, which allowed us to generate estimates with higher statistical precision and increase the generalizability of results. To our knowledge, this is the first Canadian study to examine the association between a biological marker of tobacco smoke exposure and sleep quality. The large sample size has increased the statistical power of our analyses. Furthermore, the use of urinary cotinine as a biomarker of tobacco smoke exposure, as an alternative to self-reported smoking status, reduced the chance of misclassification of exposure and biases such as the social desirability bias. Finally, our analyses provided a comprehensive understanding of the association between increased levels of urinary cotinine and sleep quality by simultaneously examining four dimensions of sleep quality.

This study has some limitations. First, sleep quality was self-reported in the CHMS. The use of a validated measure of sleep quality such as the Pittsburgh Sleep Quality Index (PSQI) could potentially fortify the results from our analyses. A validated measure such as the PSQI could also address an additional dimension of sleep quality—the timing of sleep. Second, we could not address the timing of smoking (e.g. before sleep) in our analyses, which could be a confounder. Third, detection of urinary cotinine concentrations is limited by its half-life of an average of 16 to 19 hours.[30] Furthermore, considerable individual variability exists in the rate and pattern of nicotine metabolism.[28] This could possibly affect the assessment of urinary cotinine concentrations resulting from tobacco smoke exposure. We have addressed this variability by controlling for numerous potential confounders in our analyses, including age, sex and pregnancy. Due to the relative consistency of tobacco exposure patterns over time, measurement of urinary cotinine at one time point is representative of an average daily exposure.[32] Participants of the CHMS only report on general patterns. As such, our analyses are limited by the lack of time correspondence for the measurement of urinary cotinine and sleep quality. Finally, due to the cross-sectional nature of CHMS data, temporality between elevated level of urinary cotinine and sleep quality could not be established. However, the stimulating effects of nicotine and subsequent diminishment of sleep quality can be effectively captured cross-sectionally, considering the relatively rapid effects of nicotine on the human brain.[45] Therefore, capturing the association between tobacco smoke exposure and sleep quality at one point provides a sufficient understanding of the association between exposure and outcome of interest.

Conclusion

Using national survey data on Canadian adults and urinary cotinine as a biological marker of tobacco smoke exposure, our study provides support for a positive association between tobacco smoke exposure and diminished sleep quality. Considering the high prevalence of sleep problems, our study adds to the body of literature substantiating public health efforts to reduce the prevalence of smoking and exposure to SHS. To directly infer causality, future studies should investigate the association between urinary cotinine levels and sleep quality prospectively using a validated measure of sleep quality such as the PSQI or an objective method of measuring of sleep quality, such as actigraphy.

Conflicts of interest

The authors declare there are no conflicts of interest.

Authors' contributions and statement

MZ, VC, DPR and MTD were all involved in the conceptualization of the work, study design, and the analysis and interpretation of the data. MZ led the process of drafting and revising the final manuscript for submission. MZ reviewed the titles and abstracts of articles identified in the systematic search. MZ, the primary author, contributed to the design and conceptualization of the work, data analysis, interpretation of the data, and drafting and revising of the paper. VC and MTD also contributed to the acquisition of the data, design and conceptualization of the work, data analysis, interpretation and revising of the paper.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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At-a-glance

An update on positive mental health among youth in Canada

Mélanie Varin, MSc; Elia Palladino, BHSc; Tanya Lary, MA; Melissa Baker, PhD

Abstract

The Positive Mental Health Surveillance Indicator Framework (PMHSIF) provides estimates of positive mental health outcomes and associated risk and protective factors for youth aged 12 to 17 years in Canada. This study explored the relationship between sociodemographic factors and psychological and social well-being among youth in Canada using data from the Canadian Student Tobacco, Alcohol and Drugs Survey 2016–2017. Grade and province were significantly associated with psychological and social well-being.

Keywords: *positive mental health, youth, public health, Canada*

Highlights

- The Quick Stats table presents recent estimates of positive mental health outcomes and determinants among youth in Canada.
- Over three-quarters of youth have high relatedness (81.8%), a high level of happiness (79.3%), high competence (78.4%) and high self-rated mental health (75.9%).
- The majority of youth reported high autonomy (73.0%) and life satisfaction (61.0%).
- Students in middle school (Grades 7–8) were more likely to have higher psychological and social well-being compared to students in high school (Grades 9–12).

Introduction

In 2017, the Public Health Agency of Canada (PHAC) released the Positive Mental Health Surveillance Indicator Framework (PMHSIF) for youth, which identified five positive mental health (PMH) outcomes: self-rated mental health, happiness, life satisfaction, and psychological and social well-being.[1] The PMHSIF-Youth aims to address a gap in PMH surveillance, provide a snapshot of the state of PMH and inform mental health policy and programming in Canada.[2] This At-a-glance article includes updated positive mental health estimates and associated individual, familial, community and societal determinants for youth aged 12 to 17 years in Canada. Well-being is a crucial component of positive mental health, and as such is an important concept to promote.[3] To get a more complete picture of youth well-being in Canada, we also examined relationships between sociodemographic factors and three elements of psychological and social well-being: autonomy, competence and relatedness.

Methods

We explored the relationships between sex, grade and province and autonomy, competence and relatedness using the Canadian Student Tobacco, Alcohol and Drugs Survey (CSTADS) 2016–2017. Due to the complex survey design, estimates were weighted with the survey sampling weight and variance was estimated using the bootstrap method. We conducted three adjusted logistic regression models. All statistical analyses were executed using SAS Enterprise Guide version 7.1 (SAS Institute Inc., Cary, NC, USA).

Psychological well-being—CSTADS 2016–2017

Autonomy

Youth were asked to circle the response that best represented how they felt and how they thought others perceived them in the past week. The following six statements were included: 1) "I feel free to express myself at home"; 2) "I feel free to express myself with my friends"; 3) "I feel I have a choice about when and how to do my schoolwork"; 4) "I feel I have a choice about which activities to do with my friends"; 5) "I feel free to express myself at school"; and 6) "I feel like I have a choice about when and how to do my household chores."

Competence

Youth were asked to circle the response that best represented how they felt and how they thought others perceived them in the past week. The following six statements were included: 1) "I feel I do things well at school"; 2) "I feel my teachers think I am good at things"; 3) "I feel I do things well at home"; 4) "I feel my parents think that I am good at things"; 5) "I feel I do things well when I am with my friends"; and 6) "I feel my friends think I am good at things."

Social well-being—CSTADS 2016–2017

Relatedness

Youth were asked to circle the response that best represented how they felt and how they thought others perceived them in the past week. The following six statements were included: 1) "My teachers like me and care about me"; 2) "I like to spend time with my parents"; 3) "My parents like me and care about me"; 4) "I like to be with my teachers"; 5) "My friends like me and care about me"; and 6) "I like to spend time with my friends."

Author reference:

Public Health Agency of Canada, Ottawa, Ontario, Canada

Correspondence: Mélanie Varin, Public Health Agency of Canada, 785 Carling Avenue, Ottawa, ON K1S 5H4; Email: melanie.varin@canada.ca

Response options for autonomy, competence and relatedness questions were: "really false for me," "sort of false for me," "sort of true for me," and "really true for me." High autonomy, competence and relatedness were defined as having a mean score of 3 (response category "sort of true for me") or 4 (response category "really true for me") on a scale of 1 to 4.

Results

Main findings

Updated prevalence estimates can be found in Table 1. Of all youth in Canada, 75.9% reported high self-rated mental health and 61.0% reported high life satisfaction in 2017. In 2015, 79.3% of youth reported high happiness. In 2016/17, 73.0% of youths reported high autonomy, 78.4% reported high competence and 81.8% reported high relatedness. Due to significant changes that were made to the Canadian Community Health Survey (CCHS) methodology in 2015,[4] estimates presented in the previous edition (2017) of the youth PMHSIF,[1] which includes data from CCHS 2014, should not be compared to the numbers in this edition (2019).

Sociodemographic determinants and PMH outcomes

The odds ratios (ORs) for autonomy, competence and relatedness adjusted for sex, grade and province are displayed in Table 2.

Autonomy

The odds of Grade 12 students having high autonomy were 12% (adjusted odds ratio [aOR] = 1.12, 95% confidence interval [CI]: 1.07–1.17) greater than Grade 10 students. Similarly, the odds of Grade 7 students having high autonomy were 7% (aOR = 1.07, 95% CI: 1.01–1.14) greater than the odds of Grade 10 students having high autonomy. Youth in Quebec were approximately two times (aOR = 1.98, 95% CI: 1.92–2.04) more likely to report high autonomy compared to youth in Newfoundland and Labrador. Additional odds ratios for other provinces can be seen in Table 2.

Competence

Students in Grades 7 to 9 were more likely to have high competence compared to students in Grade 10, whereas students in Grade 11 were less likely. There was no significant difference in likelihood of competence for students in Grade 12. In comparison to youth in Newfoundland and Labrador, youth in Prince Edward Island, Ontario, British Columbia, Alberta, Nova Scotia, Manitoba, Saskatchewan and Quebec were more likely to have high competence. For instance, the odds of high competence for youth in Prince Edward Island were 1.40 times higher (aOR = 1.40, 95% CI: 1.35–1.46) compared to youth in Newfoundland and Labrador. Additional odds ratios for other provinces are provided in Table 2.

Relatedness

Males were less likely to report high relatedness compared to females (aOR = 0.83, 95% CI: 0.81–0.85). Overall, youth in Grades 7 to 9 and Grade 12 were more likely to report high relatedness compared to the Grade 10 reference group. However, the odds of Grade 7 and 8 students having high relatedness were greater than the other grades (Table 2). There was no significant difference in likelihood of relatedness for students in Grade 11. Similar to provincial differences observed with high autonomy and competence, the odds of high relatedness were greater for Quebec, Ontario, Prince Edward Island, British Columbia, Alberta, Manitoba, Nova Scotia and Saskatchewan compared to Newfoundland and Labrador (Table 2).

Conclusion

The PMHSIF-Youth is an evidence-based resource that provides information on the state of PMH among youth in Canada. Overall, the majority of youth in Canada have high positive mental health. Our findings also show that students in Grades 7 and 8 had significantly higher odds of competence and relatedness compared to high school students. Interestingly, we observed provincial differences in the odds of psychological and social well-being outcomes. Compared to other provinces, the association for autonomy and relatedness was strongest among youth in Quebec. However, youth in Quebec had the weakest association for competence compared to other provinces. The findings reported in this At-a-glance have the potential to inform mental health promotion initiatives, particularly among specific grades and provinces.

Conflicts of interest

The authors have no conflicts of interest to disclose.

Authors' contributions and statement

MV, EP, TL and MB drafted the At-a-glance. MV analyzed the prevalence estimates for the positive mental health outcomes and indicators, and conducted the logistic regression model analyses. All co-authors interpreted the data and reviewed or revised the At-a-glance.

The content and views expressed herein are those of the authors and do not necessarily reflect those of the Government of Canada.

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TABLE 1

POSITIVE MENTAL HEALTH SURVEILLANCE INDICATOR FRAMEWORK

QUICK STATS, YOUTH (12 TO 17 YEARS OF AGE), CANADA, 2019 EDITION

INDICATOR GROUP	INDICATOR MEASURE(S)	LATEST DATA	DATA SOURCE (YEAR)
POSITIVE MENTAL HEALTH OUTCOMES			
Self-rated mental health	% of population who self-rate their mental health as being "excellent" or "very good"	75.9%	CCHS (2017)
Happiness	% of population who report being usually "happy and interested in life"	79.3%	CCHS (2015)
Life satisfaction	% of population who report they are "very satisfied" with their life in general	61.0%	CCHS (2017)
	Mean life satisfaction rating (0–10 scale) among Grade 6–10 students	7.3	HBSC (2013–2014)
Psychological well-being	% of Grade 7–12 students who have high autonomy	73.0%	CSTADS (2016–2017)
	% of Grade 7–12 students who have high competence	78.4%	CSTADS (2016–2017)
Social well-being	% of Grade 7–12 students who have high relatedness	81.8%	CSTADS (2016–2017)
INDIVIDUAL DETERMINANTS			
Resilience	In development		
Coping	% of population aged 15–17 years who report a high level of coping	43.3%	CCHS – Mental Health (2012)
Nurturing childhood environment	% of Grade 6–10 students who report having dinner together with their family five or more times per week	69.8%	HBSC (2013–2014)
	% of Grade 6–10 students who report their family is willing to help them make decisions	74.2%	HBSC (2013–2014)
Control and self-efficacy	% of population aged 15–17 years who report a high level of perceived control over life chances	45.0%	GSS Social Networks (2008)
Violence	% of Grade 6–10 students who report they were in a physical fight at least once in the past 12 months	28.3%	HBSC (2013–2014)
	% of Grade 7–12 students who report they have been bullied by other students in the past 30 days	23.5%	CSTADS (2016–2017)
	% of Grade 7–12 students who report they have bullied other students in the past 30 days	13.2%	CSTADS (2016–2017)
Health status	% of population who self-rate their health as "excellent" or "very good"	75.6%	CCHS (2017)
	% of population with no or mild disability	70.7%	CCHS (2015)
Physical activity	% of population who meet physical activity recommendations by accumulating at least 60 minutes of moderate-to-vigorous physical activity per day	30.9%	CHMS (2016–2017)
Substance use	% of Grade 9 and 10 students who report they have had 5 or more drinks (4 or more for girls) on one occasion, once a month or more in the past year	17.7%	HBSC (2013–2014)
	% of Grade 6–10 students who report drinking alcohol every week or more	6.5%	HBSC (2013–2014)
	% of Grade 7–12 students who have used marijuana or cannabis in the past 12 months	16.7%	CSTADS (2016–2017)
Spirituality	% of population aged 15–17 years who report that religious or spiritual beliefs are "very important" or "somewhat important" in their daily life	45.7%	CCHS – Mental Health (2012)

Continued on the following page

INDICATOR GROUP	INDICATOR MEASURE(S)	LATEST DATA	DATA SOURCE (YEAR)
FAMILY DETERMINANTS			
Family relationships	% of Grade 6–10 students who report it is "very easy" or "easy" to talk to their parents about things that really bother them	83.2%	HBSC (2013–2014)
	% of Grade 6–10 students who have high levels of communication in their family	58.3%	HBSC (2013–2014)
Parenting style	% of Grade 6–10 students who report their parents trust them	77.3%	HBSC (2013–2014)
	% of Grade 6–10 students who report their parents expect too much from them	28.7%	HBSC (2013–2014)
Family health status and substance use by family members	% of population aged 15–17 years with a family member who has problems with their emotions, mental health or use of alcohol or drugs	29.4%	CCHS – Mental Health (2012)
	% of population aged 15–17 years with a family member who has problems with their emotions, mental health or use of alcohol or drugs who report that their life is affected "a lot" or "some" by their family member's problems	26.5%	CCHS – Mental Health (2012)
Household composition	% of population living in a lone-parent household	18.7%	CCHS (2017)
	% of population living in a two-parent household	71.1%	CCHS (2017)
Household income	% of population under the age of 18 years who live below low-income cut-offs after tax	8.5%	CIS (2014)
COMMUNITY DETERMINANTS			
Community involvement	% of Grade 6–10 students who are involved in at least one club or organization	88.9%	HBSC (2013–2014)
Social networks	% of Grade 6–10 students who report they can count on their friends when things go wrong	74.3%	HBSC (2013–2014)
	% of Grade 6–10 students who have friends to share joys and sorrows with	79.2%	HBSC (2013–2014)
Social support	% of population aged 15–17 years with a high level of perceived social support	95.4%	CCHS – Mental Health (2012)
School environment	% of Grade 6–10 students who report they feel they belong at their school	63.2%	HBSC (2013–2014)
Neighbourhood social environment	% of Grade 6–10 students who report they trust the people in the area where they live	60.2%	HBSC (2013–2014)
	% of population aged 15–17 years who report that their neighbourhood is a place where neighbours help each other	90.4%	GSS Victimization (2014)
	% of population aged 15–17 years who report that social disorder in their neighbourhood is "a very big problem" or "a fairly big problem"	6.3%	GSS Victimization (2014)
Neighbourhood built environment	% of Grade 6–10 students who report there are places such as recreation centres, parks and shopping centres to spend free time in the area where they live	74.2%	HBSC (2013–2014)
SOCIETY DETERMINANTS			
Inequality	In development		
Discrimination and stigma	% of population who experienced unfair treatment at least once in the past year based on characteristics such as gender, race, age or appearance	39.1%	CCHS (2013) Discrimination Rapid Response

Abbreviations: CCHS, Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; CIS, Canadian Income Survey; CSTADS, Canadian Student Tobacco, Alcohol and Drugs Survey; GSS, General Social Survey; HBSC, Health Behaviour in School-Aged Children.

Note: "In development" refers to measures that are under development either because a data source is currently not available or because more research has to be done to identify a promising measure and data source.

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For questions or comments, please contact us at: phac.infobase.aspc@canada.ca

TABLE 2
Adjusted odds ratios of three positive mental health outcomes for youth, Canada, 2016–2017

Variable	Autonomy	Competence	Relatedness
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Sex			
Females	Ref	Ref	Ref
Males	0.98 (0.96–1.00)	1.02 (1.00–1.04)	0.83 (0.81–0.85)
Grade			
Grade 7	1.07 (1.01–1.14)	1.72 (1.64–1.81)	1.98 (1.88–2.09)
Grade 8	0.94 (0.89–0.99)	1.24 (1.19–1.30)	1.43 (1.37–1.49)
Grade 9	0.96 (0.92–1.01)	1.09 (1.05–1.14)	1.08 (1.03–1.13)
Grade 10	Ref	Ref	Ref
Grade 11	1.00 (0.95–1.05)	0.96 (0.93–0.99)	1.02 (0.98–1.06)
Grade 12	1.12 (1.07–1.17)	1.01 (0.95–1.06)	1.12 (1.07–1.17)
Province			
British Columbia	1.35 (1.31–1.40)	1.31 (1.26–1.37)	1.36 (1.30–1.43)
Alberta	1.27 (1.24–1.31)	1.29 (1.24–1.34)	1.27 (1.22–1.32)
Saskatchewan	1.25 (1.19–1.32)	1.18 (1.11–1.24)	1.07 (1.00–1.13)
Manitoba	1.37 (1.31–1.43)	1.24 (1.18–1.31)	1.19 (1.12–1.26)
Ontario	1.32 (1.28–1.35)	1.33 (1.28–1.37)	1.38 (1.33–1.43)
Quebec	1.98 (1.92–2.04)	1.05 (1.01–1.08)	1.54 (1.48–1.59)
Nova Scotia	1.15 (1.11–1.19)	1.25 (1.21–1.29)	1.16 (1.11–1.22)
Prince Edward Island	1.32 (1.28–1.36)	1.40 (1.35–1.46)	1.37 (1.32–1.43)
Newfoundland and Labrador	Ref	Ref	Ref

Data source: Canadian Student Tobacco, Alcohol and Drugs Survey 2016–2017.
Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; Ref, reference group.
Note: Logistic models adjusted for sex, grade and province.

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At-a-glance

An update on positive mental health among adults in Canada

Mélanie Varin, MSc; Elia Palladino, BHSc; Tanya Lary, MA; Melissa Baker, PhD

Abstract

This At-a-glance presents updated estimates for the Positive Mental Health Surveillance Indicator Framework for adults aged 18 years and older. Using data from the 2015 and 2017 Canadian Community Health Survey, we calculated the prevalence of positive mental health and associated determinants. Estimates for positive mental health outcomes for adults ranged from 68.1% to 87.1%. We also explored the associations between sociodemographic factors and positive mental health among adults in Canada. Our findings suggest sociodemographic differences in odds of self-rated mental health, happiness, life satisfaction, and psychological and social well-being.

Keywords: *positive mental health, adult, public health, Canada*

Highlights

- The Quick Stats table presents recent estimates of positive mental health outcomes and associated risk and protective factors among adults in Canada.
- The majority of adults in Canada have high positive mental health.
- Out of the five positive mental health outcomes, life satisfaction had the highest prevalence (87.1%) and social well-being the lowest (68.1%).
- Sociodemographic factors including sex, age group, income quintile, education level, province, urban/rural status and immigration status were significantly associated with positive mental health outcomes.

Introduction

According to the Public Health Agency of Canada (PHAC), mental health is "the capacity of each and all of us to feel, think, and act in ways that enhance our ability to enjoy life and deal with the challenges we face. It is a positive sense of emotional and spiritual well-being that respects the importance of culture, equity, social justice, interconnections and personal dignity."[1] This definition is consistent with other internationally recognized definitions of mental health.[2] PHAC recognizes that mental health promotion is essential to health and well-being and has identified it as a key priority area.[3] As such, the state of positive mental health (PMH) and well-being in Canada must be continuously monitored and updated.

In 2016, PHAC developed the Positive Mental Health Surveillance Indicator Framework[4] (PMHSIF) to monitor the state of PMH and well-being in Canada. The PMHSIF is based on the social ecological model, which takes into account the multifaceted levels of a social system.[2,3] This At-a-glance includes updated estimates for PMH outcomes, and associated risk and protective factors at the individual, family, community and society levels for adults aged 18 years and older.

Methods

We explored associations between sociodemographic factors and PMH outcomes using the Canadian Community Health Survey (CCHS) 2015 and 2017. To account for the complex survey design of the CCHS, we weighted estimates with the survey sampling weights provided by Statistics Canada and estimated variance using the bootstrap method. We ran five adjusted logistic regression models. All statistical analyses were performed using SAS Enterprise Guide version 7.1 (SAS Institute Inc., Cary, NC, USA).

The PMHSIF includes five PMH outcomes: self-rated mental health, happiness, life satisfaction, psychological well-being and social well-being.

Self-rated mental health

Self-rated mental health is measured using data from the CCHS 2017 – Annual Component. Respondents were asked, "In general, would you say your mental health is…?" Response options were: "excellent," "very good," "good," "fair" or "poor." For this study, high mental health is defined as reporting mental health as "excellent" or "very good."

Happiness

Happiness is measured using data from the CCHS 2015 – Annual Component. Respondents were asked, "In the past month, how often did you feel happy?" Response options were: "every day," "almost every day," "about 2 or 3 times a week," "about once a week," "once or twice" or "never." A high level of happiness is defined as reporting feeling happy "every day" or "almost every day" in the past month.

Life satisfaction

Life satisfaction is measured using data from the CCHS 2015 – Annual Component. Respondents were asked, "In the past month, how often did you feel satisfied with your life?" Response options were: "every day," "almost every day," "about 2 or 3 times a week," "about once a week," "once or twice" or "never." High life

Author reference:

Public Health Agency of Canada, Ottawa, Ontario, Canada

Correspondence: Mélanie Varin, Public Health Agency of Canada, 785 Carling Avenue, Ottawa, ON K1S 5H4; Email: melanie.varin@canada.ca

satisfaction is defined as reporting feeling happy "every day" or "almost every day" in the past month.

Psychological well-being

Psychological well-being is measured using six questions from the CCHS 2015 – Annual Component. Respondents were asked how often in the past month they 1) liked most aspects of their personality; 2) had experiences that challenged them to grow and become a better person; 3) felt their life had a sense of direction or meaning to it; 4) felt good at managing the responsibilities of their daily life; 5) felt confident to think or express their own ideas and opinions; and 6) felt that they had warm and trusting relationships with others. Response options were: "every day," "almost every day," "about 2 to 3 times a week," "about once a week," "once or twice" and "never." These response options were converted to number of days: "28 days," "20 days," "10 days," "4 days," "1.5 days" and "0 day." We added the number of days together for all six questions. High psychological well-being is defined as having a total of 20 or more days in the past month.

Social well-being

Social well-being is measured using data from the CCHS 2017 – Annual Component. Respondents were asked, "How would you describe your sense of belonging to your local community? Would you say it is...?" Response options were: "very strong," "somewhat strong," "somewhat weak" or "very weak." High social well-being is defined as reporting sense of belonging as "very strong" or "somewhat strong."

Results

Main findings

Table 1 displays the 2019 edition of the PMHSIF Quick Stats. Of adults aged 18 years and older in Canada, 69.9% reported high mental health, 85.9% reported high levels of happiness, 87.1% high life satisfaction, 75.2% high psychological well-being, and 68.1% reported high social well-being. These estimates should not be compared to those found in the 2016 edition of the PMHSIF Quick Stats,[4] as the CCHS – Annual Component underwent significant methodological changes that affect the data beginning with 2015.[5]

Sociodemographic determinants and PMH outcomes

Table 2 displays the odds ratios (ORs) for PMH outcomes, adjusted for sex, age, household income, education, province, urban/rural status and immigrant status.

Sex

Compared to all PMH outcomes, sex was only significantly associated with self-rated mental health. The odds of reporting high mental health were 18% greater for males compared to females (adjusted odds ratio [aOR] = 1.18, 95% confidence interval [CI]: 1.11–1.26).

Age

Overall, the population aged 65 years and older had greater odds of positive mental health compared to the adult population aged 18 to 64 years. They were more likely to have high self-rated mental health, happiness, life satisfaction, psychological well-being and social well-being (Table 2).

Income

As household income adequacy increased, the odds of having high self-rated mental health, happiness, life satisfaction, psychological and social well-being increased in a significant, stepwise fashion. For instance, the odds that adults in the highest income group (Q5) will have high life satisfaction are 3.07 times greater than adults in the lowest income group (Q1) (aOR = 3.07, 95% CI: 2.60–3.63). Additional odds ratios for other income groups can be seen in Table 2.

Education

Overall, postsecondary graduates were more likely to report high self-rated mental health, happiness and life satisfaction compared to high school graduates and the population with less than high school education. For instance, the odds of postsecondary graduates having high self-rated mental health are 75% greater than the odds of those with less than high school education (aOR = 1.75, 95% CI: 1.57–1.95). Similarly, the odds of high school graduates having high self-rated mental health are 35% greater than those who did not graduate from high school (aOR = 1.35, 95% CI: 1.19–1.53). There was no relationship between education level and psychological or social well-being. Additional odds ratios are presented in Table 2.

Province

There were a few provincial differences in odds of PMH outcomes. In comparison to adults in Nova Scotia, adults in British Columbia, Alberta, Saskatchewan, Ontario, Quebec, New Brunswick and Prince Edward Island were more likely to have high happiness (Table 2). Similarly, Saskatchewan (aOR = 1.43, 95% CI: 1.03–1.97), Quebec (aOR = 1.57, 95% CI: 1.25–1.97) and Prince Edward Island (aOR = 1.68, 95% CI: 1.17–2.40) had significantly higher odds of reporting high life satisfaction compared to Nova Scotia. Adults in Newfoundland and Labrador had the greatest odds of reporting high self-rated mental health (aOR = 1.22, 95% CI: 1.01–1.48) and high social well-being (aOR = 1.50, 95% CI: 1.20–1.87). Additional odds ratios are presented in Table 2.

Urban/rural status

Urban/rural status was significantly associated with happiness, life satisfaction and psychological and social well-being. Individuals living in a rural area had greater odds of reporting high levels of happiness (aOR = 1.26, 95% CI: 1.14–1.40), high life satisfaction (aOR = 1.26, 95% CI: 1.12–1.41), high psychological well-being (aOR = 1.10, 95% CI: 1.01–1.20) and high social well-being (aOR = 1.11, 95% CI: 1.03–1.19) compared to those living in an urban area. There was no association between urban/rural status and self-rated mental health.

Immigrants

Immigrants had greater odds of high self-rated mental health (aOR = 1.39, 95% CI: 1.27–1.51) and high social well-being (aOR = 1.34, 95% CI: 1.22–1.48) compared to non-immigrants. However, immigrants were less likely to report high happiness (aOR = 0.76, 95% CI: 0.66–0.86). There was no relationship between immigrant status and high life satisfaction or high psychological well-being.

Conclusion

This At-a-glance article includes prevalence estimates from the 2019 edition of PMHSIF – Adult. Based on our results, older age and the highest income quintile were associated with all five positive mental health outcomes. Adults with a postsecondary education and those living in a rural area had a greater likelihood of happiness, life satisfaction, psychological well-being and social well-being. Immigrants

and males were more likely to have high self-rated mental health compared to non-immigrants and females. Identifying socio-demographic differences in PMH outcomes has the potential to further a greater understanding of adult positive mental health.

Conflicts of interest

The authors have no conflicts of interest to disclose.

Authors' contributions and statement

MV, EP, TL and MB drafted the At-a-glance. MV analyzed the prevalence estimates for self-rated mental health and conducted the logistic regression model analyses. All co-authors interpreted the data and reviewed and/or revised the At-a-glance.

The content and views expressed in this At-a-glance are those of the authors and do not necessarily reflect those of the Government of Canada.

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TABLE 1

POSITIVE MENTAL HEALTH SURVEILLANCE INDICATOR FRAMEWORK

QUICK STATS, ADULTS (18 YEARS OR OLDER), CANADA, 2019 EDITION

INDICATOR GROUP	INDICATOR MEASURE(S)	LATEST DATA	DATA SOURCE (YEAR)
POSITIVE MENTAL HEALTH OUTCOMES			
Self-rated mental health	% of population who self-rate their mental health as being "excellent" or "very good"	69.9%	CCHS (2017)
Happiness	% of population who report being happy "every day" or "almost every day"	85.9%	CCHS (2015)
Life satisfaction	% of population who report being satisfied with life "every day" or "almost every day"	87.1%	CCHS (2015)
	Mean life satisfaction rating (0–10 scale)	8.1	CCHS (2017)
Psychological well-being	% of population who have high psychological well-being	75.2%	CCHS (2015)
Social well-being	% of population who report that they "very strongly" or "somewhat strongly" belong to their local community	68.1%	CCHS (2017)
INDIVIDUAL DETERMINANTS			
Resilience	In development		
Coping	% of population who report a high level of coping	56.9%	CCHS – Mental Health (2012)
Control and self-efficacy	% of population who report a high level of perceived control over life chances	41.6%	GSS Social Networks (2008)
Violence	% of the population who report experiencing, before age 15 years, any of these three types of childhood violence: physical or sexual abuse by an adult and/or exposure to violence by parents or guardians	34.0%	GSS Victimization (2014)
	% of population who report being the victim of physical or sexual abuse in the past 12 months	3.9%	GSS Victimization (2014)
	% of population who report being the victim of spousal violence in the past 5 years	2.7%	GSS Victimization (2014)
Health status	% of population who self-rate their health as "excellent" or "very good"	59.9%	CCHS (2017)
	% of population with no or mild disability	68.5%	CCHS (2015)
Physical activity	% of population who are "active" or "moderately active" during their leisure-time based on self-reported data	69.4%	CCHS (2017)
	% of population aged 18–79 years who meet physical activity guidelines by accumulating at least 150 minutes of moderate-to-vigorous physical activity each week, in bouts of 10 minutes or more	16.4%	CHMS (2016–2017)
Substance use	% of population whose reported alcohol consumption falls within the low-risk alcohol drinking guidelines	83.4%	CTADS (2017)
Spirituality	% of population who report that religious or spiritual beliefs are "very important" or "somewhat important" in their daily life	62.7%	CCHS – Mental Health (2012)
FAMILY DETERMINANTS			
Family relationships	In development		
Family health status and substance use by family members	% of population with a family member who has problems with their emotions, mental health or use of alcohol or drugs	39.8%	CCHS – Mental Health (2012)
	% of population with a family member who has problems with their emotions, mental health or use of alcohol or drugs, who report that their life is affected "a lot" or "some" by their family member's problems	35.6%	CCHS – Mental Health (2012)
Household composition	% of population living with a spouse or partner	70.5%	CCHS (2017)
	% of population living in a lone-parent household	8.8%	CCHS (2017)
	% of population living alone	16.1%	CCHS (2017)
Household income	% of the total Canadian population below low-income cut-offs after tax	8.8%	SLID (2011)

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INDICATOR GROUP	INDICATOR MEASURE(S)	LATEST DATA	DATA SOURCE (YEAR)
COMMUNITY DETERMINANTS			
Community involvement	% of population that are members of or participate in at least one recreational or professional organization, group, association or club	63.4%	GSS Social Identity (2013)
Social networks	% of population who report having no close friends or family members	6.1%	GSS Social Identity (2013)
	% of population who report having between 1 and 5 close friends or family members	57.1%	GSS Social Identity (2013)
	% of population who report having 6 or more close friends or family members	36.8%	GSS Social Identity (2013)
Social support	% of population who report a high level of perceived social support	94.2%	CCHS – Mental Health (2012)
Workplace environment	% of employed population aged 18–75 years experiencing high job strain	14.8%	CCHS – Mental Health (2012)
Neighbourhood social environment	% of population who report that their neighbourhood is a place where neighbours help each other	88.5%	GSS Victimization (2014)
	% of population who report that social disorder in their neighbourhood is "a very big problem" or "a fairly big problem"	5.3%	GSS Victimization (2014)
Neighbourhood built environment	In development		
SOCIETY DETERMINANTS			
Inequality	In development		
Discrimination and stigma	% of population who experienced unfair treatment at least once in the past 5 years based on characteristics such as gender, race, age or appearance	11.5%	GSS Victimization (2014)
	% of population with a mental health problem who report having been affected by negative opinions or unfair treatment, due to their mental health problem	21.0%	CCHS – Mental Health (2012)
Political participation	% of registered electors who voted in the 2015 federal election	68.3%	Elections Canada (2015)

Abbreviations: CCHS, Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; CTADS, Canadian Tobacco, Alcohol and Drug Survey; GSS, General Social Survey; SLID, Survey of Labour and Income Dynamics.

Note: "In development" refers to measures that are under development either because a data source is currently not available or because more research has to be done to identify a promising measure and data source.

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TABLE 2
Adjusted odds ratio of positive mental health outcomes, adults aged 18 years and older, Canada, 2015 and 2017

Variable	SRMH[a]	Happiness[b]	Life satisfaction[b]	Psychological well-being[b]	Social well-being[a]
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Sex					
Females	Ref	Ref	Ref	Ref	Ref
Males	1.18 (1.11–1.26)	0.95 (0.86–1.04)	0.98 (0.89–1.09)	1.05 (0.98–1.14)	0.95 (0.89–1.02)
Age					
18–24	0.85 (0.74–0.97)	1.40 (1.16–1.70)	1.07 (0.89–1.28)	0.84 (0.73–0.96)	0.94 (0.82–1.07)
25–44	1.00 (0.92–1.09)	1.31 (1.16–1.49)	1.04 (0.91–1.18)	0.97 (0.88–1.08)	0.87 (0.80–0.94)
45–64	Ref	Ref	Ref	Ref	Ref
65+	1.32 (1.22–1.44)	1.61 (1.42–1.83)	1.88 (1.62–2.18)	1.34 (1.20–1.50)	1.67 (1.54–1.82)
Household income adequacy					
Q1 (lowest)	Ref	Ref	Ref	Ref	Ref
Q2	1.29 (1.17–1.42)	1.34 (1.15–1.56)	1.30 (1.11–1.52)	1.04 (0.91–1.18)	1.13 (1.01–1.25)
Q3	1.56 (1.41–1.72)	1.96 (1.68–2.28)	2.09 (1.78–2.45)	1.17 (1.03–1.32)	1.29 (1.15–1.43)
Q4	1.81 (1.62–2.01)	2.19 (1.88–2.55)	2.34 (1.98–2.77)	1.42 (1.25–1.61)	1.28 (1.15–1.42)
Q5 (highest)	2.28 (2.05–2.54)	2.67 (2.29–3.11)	3.07 (2.60–3.63)	1.60 (1.40–1.82)	1.31 (1.17–1.46)
Highest level of education household					
Less than high school	Ref	Ref	Ref	Ref	Ref
High school graduate	1.35 (1.19–1.53)	1.23 (1.03–1.47)	0.96 (0.81–1.14)	1.03 (0.89–1.21)	0.96 (0.83–1.10)
Postsecondary graduate	1.75 (1.57–1.95)	1.37 (1.16–1.63)	1.24 (1.06–1.46)	1.11 (0.96–1.28)	1.09 (0.97–1.23)
Province					
British Columbia	0.96 (0.83–1.11)	1.34 (1.08–1.65)	0.96 (0.75–1.22)	0.93 (0.76–1.13)	1.02 (0.87–1.20)
Alberta	1.00 (0.87–1.16)	1.26 (1.02–1.56)	1.07 (0.85–1.34)	1.02 (0.85–1.24)	0.92 (0.78–1.08)
Saskatchewan	0.97 (0.81–1.17)	1.41 (1.07–1.87)	1.43 (1.03–1.97)	0.96 (0.77–1.20)	1.21 (0.99–1.48)
Manitoba	1.09 (0.91–1.31)	1.25 (0.98–1.61)	1.23 (0.91–1.65)	1.02 (0.82–1.27)	1.13 (0.94–1.36)
Ontario	1.04 (0.91–1.18)	1.29 (1.06–1.58)	1.19 (0.95–1.49)	0.95 (0.79–1.14)	1.04 (0.89–1.21)
Quebec	1.42 (1.24–1.62)	1.37 (1.12–1.68)	1.57 (1.25–1.97)	0.89 (0.75–1.07)	0.69 (0.59–0.80)
New Brunswick	1.03 (0.85–1.24)	1.44 (1.08–1.92)	1.24 (0.92–1.68)	1.08 (0.86–1.37)	1.37 (1.10–1.70)
Nova Scotia	Ref	Ref	Ref	Ref	Ref
Prince Edward Island	1.05 (0.85–1.31)	1.68 (1.20–2.36)	1.68 (1.17–2.40)	1.59 (1.21–2.09)	1.34 (1.06–1.70)
Newfoundland and Labrador	1.22 (1.01–1.48)	1.18 (0.91–1.54)	1.27 (0.94–1.71)	1.41 (1.11–1.78)	1.50 (1.20–1.87)
Urban/rural status					
Rural	1.01 (0.94–1.08)	1.26 (1.14–1.40)	1.26 (1.12–1.41)	1.10 (1.01–1.20)	1.11 (1.03–1.19)
Urban	Ref	Ref	Ref	Ref	Ref
Immigrant status					
Yes	1.39 (1.27–1.51)	0.76 (0.66–0.86)	0.91 (0.79–1.06)	1.02 (0.91–1.15)	1.34 (1.22–1.48)
No	Ref	Ref	Ref	Ref	Ref

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; Q, quintile; Ref, reference group; SRMH, self-rated mental health.

Note: Logistic models adjusted for sex, age, province, urban/rural dwelling, education, household income and immigrant status.

[a] All of these estimates are from CCHS 2017 data.

[b] All of these estimates are from CCHS 2015 data.

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