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**Disparities in Knowledge about the Health Effects of Smoking among Adolescents
Following the Release of New Pictorial Health Warning Labels**

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ABSTRACT

This paper examined knowledge about the health effects of smoking among health equity groups following the 2012 introduction of refreshed pictorial health warning labels (HWLs) in Canada. Data are from the 2012/2013 Youth Smoking Survey a representative school-based survey of 47,203 adolescents in Grades 6-12 in nine provinces. Regression models examined overall knowledge about eight health effects of smoking included in the HWLs. Less than one-third of adolescents (32.2%) knew that smoking causes vision loss/blindness and 33.7% knew that smoking causes bladder cancer. Whereas knowledge was high for lung cancer (93.9%), knowledge about other health effects ranged from 52.9% for chronic bronchitis/emphysema to 77.6% for gum or mouth disease. Non-smoking adolescents who were: susceptible to future smoking, male, ethnic minorities, and who had less spending money were significantly less likely to be knowledgeable of the health effects of smoking. There were fewer disparities in knowledge about the health effects of smoking among smokers. Smokers who bought loose or bagged cigarettes rather than cigarettes in packages or cartons were significantly less likely to be knowledgeable about the health effects of smoking. There are significant disparities in knowledge about the health effects of smoking by health equity groups particularly among non-smoking adolescents. Warning labels have the potential to reduce disparities in knowledge about the health effects of smoking when exposure to the warning labels is universal. Complementary strategies such as mass media campaigns are needed to address disparities in knowledge.

Keywords: adolescent, youth, smoking, knowledge

Declaration of Interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

INTRODUCTION

Tobacco use is the leading cause of disease and premature death worldwide (World Health Organization, 2014). Adolescence is a critical period for tobacco-use initiation (U.S. Department of Health and Human Services, 2012), and therefore a public-health priority. On average, smokers report smoking their first cigarette at age 16, and start smoking regularly at age 18 (Janz, 2012). Although youth smoking is generally declining in developed countries (Eriksen et al., 2015), differences in smoking prevalence remain among youth by gender, socio-economic status (SES), and race/ethnicity. Smoking rates are higher among males than females (Reid et al., 2015). Individuals with lower SES smoke cigarettes at higher rates (Gupta et al., 2007; Reid et al., 2010a) and are disproportionately affected by the harms of tobacco use (Reid et al., 2010b). In 2011, approximately 12% of youth, aged 15-17, from lower-income households were smokers, compared to 7.0% of youth in higher-income households (Janz, 2012). Adolescents with European ancestry (Asbridge et al., 2005) and Indigenous youth also smoke at higher rates (Elton-Marshall et al., 2011; Lemstra et al., 2011).

One intervention to address smoking-related health disparities is pictorial health warning labels (HWLs) on tobacco packages. HWLs have broad reach and are a major source of health information, even for non-smokers (Hammond, 2011). Therefore, they have the potential to reduce disparities in access to information about the health effects of smoking (White et al., 2008). Evidence suggests that countries with pictorial HWLs have fewer disparities in health knowledge among adults across educational levels (Siahpush et al., 2006). Thus, pictorial warnings may be more effective than text-based warnings as they do not require the same level of literacy (Hammond, 2011). In 2001, Canada was the first country to implement pictorial HWLs on cigarette packages. Recent evidence suggests that adult smokers in Canada receive

most of their anti-smoking information from HWLs on cigarette packages (ITC Project, 2013). New HWLs were introduced in Canada in 2012, and covered 75% of the front and back of cigarette packages. The warnings were rotated with equal frequency. The labels featured new warnings about tobacco-related diseases by linking smoking to bladder cancer (Figure 1) and vision loss (Hammond, 2013).

Surveys of adult smokers have found that smokers are inadequately informed of the health effects of smoking, with lower-SES smokers being less knowledgeable (Siahpush et al., 2006). Although many adult smokers believe that smoking causes heart disease and lung cancer, fewer believe that smoking causes stroke, impotence (Hammond et al., 2006) or vision loss (Kennedy et al., 2012). In 2011, less than half of Canadian adult smokers knew that smoking causes breast cancer, bladder cancer, and blindness (ITC Project, 2013). Given that early detection is associated with more positive prognoses for these conditions, information about specific health effects of smoking is critical (Chapman and Liberman, 2005).



Figure 1: New HWL Introduced in 2012 in Canada

Existing research regarding knowledge about the health effects of smoking among Canadian adolescents is limited and largely descriptive (Chaiton et al., 2005; Morrison et al.,

2005; Wong and Manske). In 2004, it was reported that 97% of adolescents knew that smoking causes lung cancer, but fewer knew that smoking causes asthma (60%) or “heart problems” (70%) (Wong and Manske). It has further been found that most smokers begin smoking prior to age 18 (Janz, 2012; U.S. Department of Health and Human Services, 2014), and that this early initiation is associated with a greater likelihood of developing tobacco-related diseases (Huxley et al., 2012). Longitudinal research has demonstrated that adolescents who perceive more long-term health risks of smoking (e.g., getting lung cancer) are less likely to initiate smoking (Song et al., 2009). Research also suggests that adolescents are less likely to intend to smoke if they are exposed to anti-smoking messages that depict smoking-related disease and suffering (Pechmann and Reibling, 2006). It is therefore critical that tobacco-control prevention strategies ensure that adolescents are adequately informed about the health effects of smoking to reduce smoking prevalence.

Given that the current generation of Canadian adolescents have grown up with pictorial HWLs, we hypothesize that they will have considerable knowledge about the health effects of smoking as depicted in the HWLs. However, no research to date has examined knowledge about these health effects among Canadian adolescents since the implementation of the updated HWLs. Based on previous research of Canadian adolescents, we expect that there will also be sociodemographic differences, such that females and those in higher grades will be more knowledgeable (Morrison et al., 2005). The current study therefore examines knowledge about the health effects of smoking among a representative sample of adolescents in Canada following the introduction of new HWLs in 2012.

METHODS

Study Protocol

Data are from the 2012/2013 Youth Smoking Survey (YSS), a representative classroom-based survey. They were collected between November 2012 and June 2013. The target population was adolescents in Grades 6-12 attending private, public, and Catholic schools in nine Canadian provinces ($n=47,203$). Schools on First Nation Reserves; schools in the Yukon, Nunavut and Northwest Territories; and youth living in institutions or attending special schools or schools on military bases were not sampled. Manitoba did not participate in the 2012 YSS.

Research-ethics approval for this study was obtained from the University of Waterloo and local school boards. Further details about the YSS protocol, sampling, and survey-weight construction is available (Propel, 2013).

Measures

Demographic variables

Respondents reported gender, grade (6-12), province, and race/ethnicity (White, Black, Asian, Aboriginal, Latin American/Hispanic, other) where a single minority group or a minority group and “White” was categorized by the minority group and two or more minority groups were “other”. Consistent with previous research (Elton-Marshall et al., 2011), spending-money was measured by: “About how much money do you usually get each week to spend on yourself or to save?” (\$0, \$1-\$20, \$21-\$100, \$100 or more, “don’t know/missing”).

Health Knowledge

Consistent with previous research (Yang et al., 2010), respondents were asked: “What health problems can people get if they smoke for many years? (mark all that apply)--asthma, premature or early death, lung cancer, heart disease, gum/mouth disease, chronic bronchitis/emphysema, bladder cancer, vision loss/blindness”. An additive index was created, ranging from 0 to 8 (higher scores indicating greater knowledge). The scale has demonstrated reliability (Cronbach's alpha=0.84).

Parent, Sibling, and Friend Smoking

Adolescents (including non-smokers) have greater exposure to cigarette-package HWLs if they have a parent or friend who smokes (White et al., 2008). Parent/sibling/friend smoking was therefore a covariate in analyses. Respondents were asked to indicate how many: (a) friends; (b) parents; (c) siblings smoke cigarettes ("yes" if ≥ 1 and "no" if "none", "I don't know" or "not applicable").

Cigarette packaging

Respondents were asked: "Thinking about the last time you bought cigarettes in the last 12 months, what did you buy?" Responses were categorized to compare packaged and unpackaged cigarettes ("did not buy cigarettes," "bought in the form of singles or loose tobacco," and "bought pack or carton").

Smoking status

We expect differences in exposure to knowledge about the health effects of smoking as a function of smoking status, because smokers likely have greater exposure to HWLs versus non-smokers (White et al., 2008). We examined differences by smoking status and defined smoking-status groups consistent with definitions from the YSS User Guide (Burkhalter et al., 2013). Current smokers had smoked at least 100 cigarettes in their lifetime, and smoked in the past 30 days. Former smokers had smoked at least 100 cigarettes in their lifetime but not in the past 30 days. Experimental smokers had smoked anywhere from less than one cigarette to less than 100 cigarettes in their lifetime. Non-smokers had never tried smoking.

Susceptibility to future smoking

Susceptibility was based on the algorithm developed by Pierce et al. (1996) and validated in Canadian-youth samples. Among non-smokers, susceptibility was measured by asking: "Do

you think in the future you might try smoking cigarettes?”, “If one of your best friends were to offer you a cigarette, would you smoke it?”, and “At any time during the next year do you think you will smoke a cigarette?” Response options were: definitely yes, probably yes, probably not, definitely not. Respondents were susceptible to future smoking if they responded positively to at least one item and not susceptible to smoking if they responded "definitely not" to all three questions (Pierce et al., 1996).

Data Analysis

Descriptive cross tabulation analyses were used to examine adolescent knowledge of the eight health effects of smoking by smoking status. Significance was assessed using the first-order Rao-Scott chi-square test (Rao and Scott, 1987). Logistic regression analyses were used to examine sociodemographic differences in knowledge about each health effect of smoking. Ordinary least squares (OLS) regression was used to examine factors associated with adolescents' overall knowledge (health knowledge index) of the health effects of smoking, with reported beta coefficients adjusted for covariates in the model. In all analyses, bootstrap survey weights were used to adjust for non-response. Analyses were conducted separately for each smoking-status group except former smokers due to small sample size ($n=343$). STATA 12.0 was used for all analyses.

RESULTS

Sample characteristics are presented in Table 1. Overall 29.7% of adolescent non-smokers were susceptible to future smoking. The majority of experimental smokers did not buy their cigarettes (82.1%) and few purchased cigarettes in packages/cartons (12.1%), whereas most current smokers purchased cigarettes in packages/cartons (83.3%).

Knowledge by Smoking Status

Figure 2 presents knowledge about the health effects of smoking for the overall sample and by smoking status. Most respondents linked smoking to lung cancer (93.9%). Fewer knew that smoking causes gum/mouth disease (77.6%), heart disease (67.9%), asthma (67.3%), premature/early death (63.4%), or chronic bronchitis/emphysema (52.9%). A minority of adolescents knew that smoking causes bladder cancer (33.7%) or vision loss/blindness (32.2%). The mean score for knowledge about the health effects of smoking was 4.89 out of 8.

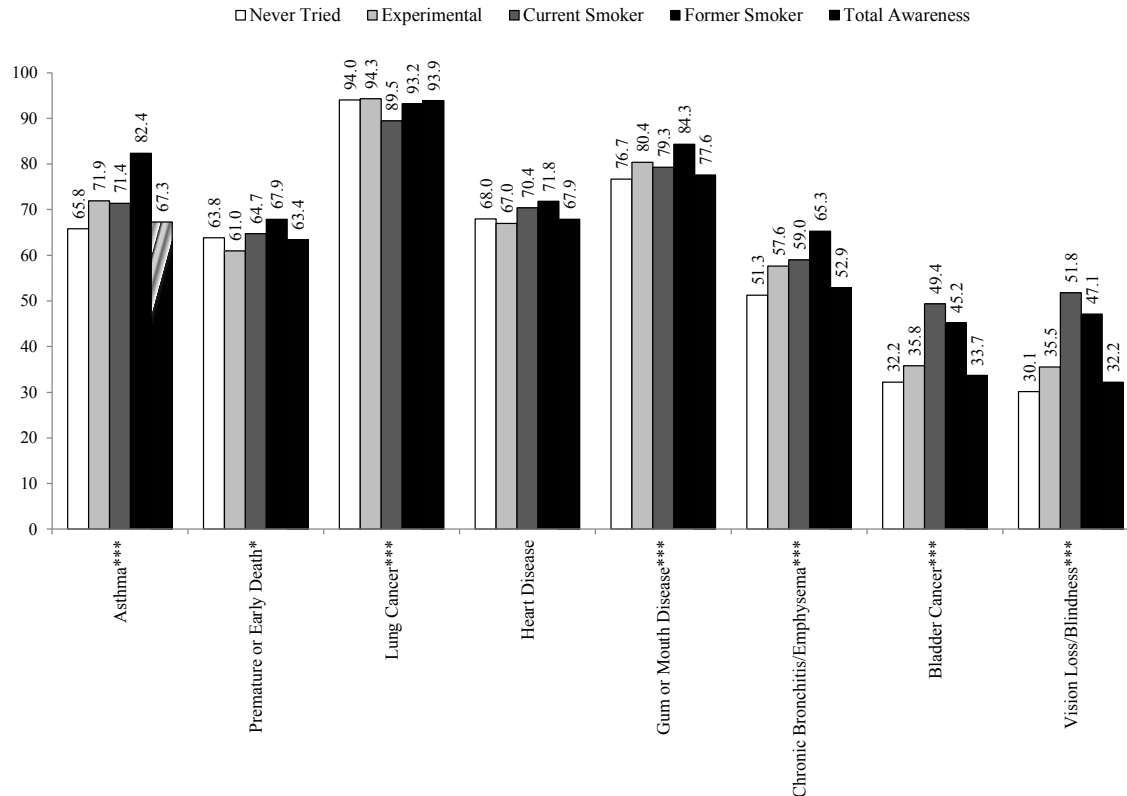
	Non-Smoker <i>n</i> = 35,134		Experimental <i>n</i> = 9,146		Current Smoker <i>n</i> = 2,580		Former Smoker <i>n</i> = 343		
	(<i>n</i>)*	Weighted (%), 95% CI	(<i>n</i>)*	Weighted (%), 95% CI	(<i>n</i>)*	Weighted (%), 95% CI	(<i>n</i>)*	Weighted (%), 95% CI	
Sex									
Female	18,323	49.9 (49.5, 50.3)	4,496	46.6 (44.9, 48.4)	1,034	38.6 (35.7, 41.7)	143	38.3 (31.2, 45.9)	
Male	16,811	50.1 (49.7, 50.5)	4,650	53.4 (51.6, 55.1)	1,546	61.4 (58.3, 64.4)	200	61.7 (54.1, 68.8)	
Total	35,134	Missing = 0	9,146	Missing = 0	2,580	Missing = 0	343	Missing = 0	
Grade									
6	5,907	16.1 (15.7, 16.5)	232	2.2 (1.8, 2.8)	†	†	†	†	
7	6,111	16.5 (16.1, 17.0)	639	6.6 (5.7, 7.7)	60	2.8 (1.6, 4.9)	†	†	
8	5,700	16.1(15.8, 16.5)	957	9.6 (8.6, 10.8)	152	6.8 (5.3, 8.8)	†	†	
9	5,239	15.0(14.6, 15.5)	1,431	15.5 (14.2, 16.9)	349	14.2 (10.9, 18.1)	47	12.9 (9.3, 17.6)	
10	5,040	13.6 (13.3, 13.9)	1,984	20.2 (19.1, 21.4)	586	17.6 (15.4, 20.1)	70	14.7 (10.8, 19.8)	
11	4,183	12.4 (11.8, 12.9)	2,130	23.0 (21.9, 24.2)	713	24.9 (21.7, 28.4)	88	23.1 (16.3, 31.8)	
12	2,954	10.3 (9.5, 11.2)	1,773	22.7 (20.9, 24.7)	714	33.5 (27.8, 39.6)	103	37.8 (29.0, 47.5)	
Total	35,134	Missing = 0	9,146	Missing = 0	2,580	Missing = 0	343	Missing = 0	
Race/Ethnicity									
White	25,049	64.5 (60.8, 69.7)	6,566	69.7 (65.4, 73.7)	1,699	63.9 (60.1, 71.0)	243	67.2 (62.0, 72.7)	
Aboriginal	1,497	3.0 (2.2, 4.3)	942	7.6 (4.8, 11.8)	342	11.7 (7.6, 18.7)	36	8.7 (4.7, 15.4)	
Black	1,257	6.7 (4.5, 9.7)	361	5.3 (3.6, 7.8)	125	5.4 (3.8, 7.0)	†	†	
Asian	3,836	13.5 (11.7, 15.4)	484	6.6 (4.9, 8.7)	86	5.1 (2.9, 6.6)	†	†	
Latin American	459	2.4 (1.8, 2.7)	157	3.2 (2.2, 4.5)	60	3.4 (1.9, 4.7)	†	†	
Other	2,366	9.9 (7.2, 11.7)	477	7.6 (6.0, 9.6)	187	10.4 (7.5, 12.4)	†	†	
Total	34,464	Missing = 670	8,987	Missing = 159	2,499	Missing = 81	339	Missing = 4	
Region									
Atlantic Canada	10,932	6.9 (6.7, 7.1)	2,961	7.3 (6.7, 8.0)	1,060	11.0 (9.0, 13.4)	153	11.3 (8.7, 14.5)	
Quebec	4,338	17.8 (16.7, 18.9)	1,471	26.7 (23.6, 29.9)	300	23.1 (17.7, 29.5)	49	25.3 (17.7, 35.0)	
Ontario	6,325	46.9 (45.7, 48.1)	1,349	40.8 (37.5, 44.3)	334	40.4 (31.8, 49.6)	40	37.5 (27.2, 49.2)	
Prairies	8,177	14.5 (14.0, 15.1)	2,442	14.7 (13.0, 16.5)	687	15.3 (12.1, 19.3)	75	16.2 (11.9, 21.7)	
British Columbia	5,362	13.9 (12.8, 15.1)	923	10.6 (7.4, 15.0)	199	10.2 (6.6, 15.4)	†	†	
Total	35,134	Missing = 0	9,146	Missing = 0	2,580	Missing = 0	343	Missing = 0	

	Non-Smoker <i>n</i> = 35,134		Experimental <i>n</i> = 9,146		Current Smoker <i>n</i> = 2,580		Former Smoker <i>n</i> = 343	
	(<i>n</i>)*	Weighted (%), 95% CI	(<i>n</i>)*	Weighted (%), 95% CI	(<i>n</i>)*	Weighted (%), 95% CI	(<i>n</i>)*	Weighted (%), 95% CI
Spending money								
\$0	7,419	23.4 (22.3, 24.6)	1,237	13.9 (13.1, 14.8)	229	11.0 (8.9, 13.5)	46	9.9 (6.9, 14.0)
\$1-\$20	12,257	33.6 (32.3, 34.9)	2,461	26.4 (24.5, 28.5)	546	20.1 (17.6, 22.9)	75	20.0 (15.5, 25.3)
\$21-\$100	5,943	15.6 (14.7, 16.6)	2,495	25.9 (24.3, 27.6)	790	29.7 (26.4, 33.3)	98	25.5 (19.5, 32.5)
\$100+	2,250	6.6 (5.9, 7.4)	1,550	17.5 (15.9, 19.2)	667	26.6 (23.3, 30.1)	72	24.6 (18.5, 31.8)
Don't know	7,265	20.8 (19.9, 21.6)	1,403	16.3 (15.1, 17.5)	348	12.6 (10.4, 15.3)	52	20.1 (13.9, 28.2)
Total	35,134	Missing = 0	9,146	Missing = 0	2,580	Missing = 0	343	Missing = 0
Parent(s) Smokes								
Yes	11,656	32.5 (30.8, 34.3)	4,772	52.7 (50.1, 55.4)	1,649	66.3 (62.9, 69.6)	201	59.5 (51.1, 67.3)
No	22,322	67.5 (65.7, 69.3)	3,911	47.3 (44.6, 49.9)	780	33.7 (30.4, 37.1)	122	40.6 (32.7, 49.0)
Total	33,978	Missing = 1,156	8,683	Missing = 463	2,429	Missing = 151	323	Missing = 20
Sibling(s) Smokes								
Yes	3,397	8.9 (8.1, 9.8)	2,498	27.0 (24.8, 29.3)	1,160	46.0 (42.2, 49.9)	133	43.0 (35.3, 51.0)
No	29,757	91.1 (90.2, 91.9)	5,870	73.1 (70.8, 75.2)	1,209	54.0 (50.1, 57.8)	178	57.0 (49.0, 64.7)
Total	33,154	Missing = 1,980	8,368	Missing = 778	2,369	Missing = 211	311	Missing = 32
Friend(s) Smokes								
Yes	5,186	14.8 (13.7, 16.0)	5,075	55.7 (53.4, 58.0)	2,136	86.0 (84.0, 87.8)	249	79.0 (70.9, 85.4)
No	28,094	85.2 (84.1, 86.3)	3,603	44.3 (42.0, 46.6)	357	14.0 (12.2, 16.0)	79	21.0 (14.6, 29.1)
Total	33,280	Missing = 1,854	8,678	Missing = 468	2,493	Missing = 87	328	Missing = 15
Susceptibility								
Yes	10,309	29.7 (28.5, 31.0)	N/A	N/A	N/A	N/A	N/A	N/A
No	24,825	70.3 (69.0, 71.5)	N/A	N/A	N/A	N/A	N/A	N/A
Total	35,134	Missing = 0						
Cigarette Packaging								
Did Not Buy	N/A	N/A	7,110	82.1 (80.8, 83.3)	202	9.3 (7.1, 12.0)	152	53.1 (42.9, 63.0)
Single/Loose/Bag	N/A	N/A	614	5.8 (5.0, 6.7)	195	7.4 (6.0, 9.0)	†	†
Pack/Carion	N/A	N/A	1,104	12.1 (11.1, 13.2)	1,935	83.3 (80.1, 86.1)	147	40.9 (31.8, 50.7)
Total			8,828	Missing = 318	2,332	Missing = 248	318	Missing = 25

* Unweighted sample size (*n*); † Suppressed due to low sample size

Table 1. Sample Characteristics

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* = $p \leq 0.05$, ** = $p \leq 0.01$, *** = $p \leq 0.001$

Figure 2: Knowledge about the Health Effects of Smoking by Smoker Status

Non-smokers were significantly less knowledgeable about the health effects of smoking compared to experimental, current and former smokers for most health effects, with the exception of lung cancer (Figure 2). Current smokers had the least awareness for lung cancer. Further, no significant differences between smoking-status groups existed in knowledge about heart disease.

Knowledge about the Specific Health Effects of Smoking

Logistic regression analyses were used to examine sociodemographic and other differences in knowledge about each health effect of smoking (Table 2). Although unadjusted prevalence rates indicated that non-smokers were less knowledgeable about many health effects

(Figure 2), this pattern differed after controlling for sociodemographic factors in regression models (Table 2). Current smokers were less knowledgeable of the effects of smoking on asthma, lung cancer, gum/mouth disease, and chronic bronchitis/emphysema compared to non-smokers, after controlling for sociodemographic factors. They were more knowledgeable than non-smokers about the effects of smoking on bladder cancer and vision loss/blindness. For example, current smokers were 1.46 times more knowledgeable about bladder cancer than non-smokers.

There were significant differences in knowledge about the health effects of smoking by health-equity groups. Ethnic minorities were consistently less likely to link smoking to each measured health effect compared to White adolescents. Specifically, Aboriginal and Black adolescents were significantly less likely to agree that smoking causes each of the health effects.

For most health effects, adolescents with more spending-money were more likely to agree that smoking causes each of the health outcomes compared to adolescents with less money. Females were also more likely to agree that smoking causes each of the health effects compared to males, with the exception of bladder cancer and vision loss/blindness. Adolescents in higher grades were more likely to agree that smoking causes each of the health effects than adolescents in lower grades.

Factors Associated with Overall Knowledge about the Health Effects of Smoking by Smoking Status

OLS regression was used to examine factors associated with overall knowledge about the health effects of smoking by smoking status (Table 3). Models were run separately for: non-smokers (Model 1), experimental smokers (Model 2), and current smokers (Model 3).

	Asthma‡	Premature or early death‡	Lung Cancer‡	Heart Disease‡	Gum or Mouth Disease‡	Chronic Bronchitis/ Emphysema‡	Bladder Cancer‡	Vision Loss/ Blindness‡
Sex								
Male	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Female	1.62 (1.52, 1.73)	1.19 (1.11, 1.28)	2.06 (1.79, 2.37)	1.16 (1.08, 1.25)	1.53 (1.41, 1.66)	1.22 (1.14, 1.30)	0.83 (0.79, 0.88)	0.88 (0.83, 0.94)
Grade	1.26 (1.22, 1.31)	1.16 (1.11, 1.22)	1.13 (1.08, 1.17)	1.04 (1.02, 1.07)	1.23 (1.17, 1.30)	1.35 (1.30, 1.40)	1.07 (1.04, 1.10)	1.06 (1.03, 1.09)
Race/Ethnicity								
White	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Aboriginal	0.78 (0.67, 0.91)	0.66 (0.60, 0.73)	0.70 (0.53, 0.92)	0.75 (0.67, 0.83)	0.65 (0.56, 0.74)	0.75 (0.67, 0.83)	0.79 (0.70, 0.89)	0.85 (0.75, 0.95)
Black	0.54 (0.42, 0.70)	0.45 (0.31, 0.66)	0.48 (0.38, 0.60)	0.62 (0.51, 0.74)	0.35 (0.25, 0.49)	0.50 (0.39, 0.65)	0.62 (0.48, 0.79)	0.61 (0.44, 0.84)
Asian	0.87 (0.74, 1.01)	0.84 (0.70, 0.99)	0.82 (0.65, 1.03)	0.86 (0.77, 0.97)	0.55 (0.45, 0.66)	0.59 (0.52, 0.68)	0.89 (0.78, 1.01)	0.79 (0.70, 0.89)
Latin American	0.92 (0.75, 1.13)	0.76 (0.61, 0.95)	0.68 (0.46, 1.02)	0.82 (0.68, 0.99)	0.63 (0.49, 0.81)	0.82 (0.65, 1.03)	0.91 (0.74, 1.12)	0.82 (0.70, 0.96)
Other	0.95 (0.87, 1.03)	0.82 (0.72, 0.93)	0.62 (0.51, 0.76)	0.96 (0.84, 1.10)	0.62 (0.51, 0.74)	0.82 (0.72, 0.93)	1.05 (0.94, 1.18)	0.95 (0.81, 1.11)
Region								
Ontario	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Atlantic	1.02 (0.89, 1.17)	1.05 (0.85, 1.32)	0.81 (0.64, 1.02)	1.00 (0.87, 1.14)	0.89 (0.71, 1.10)	1.09 (0.95, 1.25)	1.17 (1.03, 1.33)	1.20 (1.03, 1.39)
Quebec	1.23 (1.04, 1.46)	0.46 (0.36, 0.58)	1.31 (0.97, 1.78)	0.59 (0.50, 0.69)	0.61 (0.47, 0.77)	0.93 (0.75, 1.15)	0.57 (0.47, 0.69)	0.68 (0.57, 0.82)
Prairies	1.04 (0.90, 1.20)	1.04 (0.81, 1.35)	0.99 (0.79, 1.24)	1.02 (0.88, 1.18)	1.02 (0.81, 1.29)	1.24 (1.01, 1.53)	1.08 (0.96, 1.20)	1.09 (0.94, 1.26)
British Columbia	0.86 (0.74, 0.99)	0.94 (0.73, 1.21)	0.88 (0.73, 1.06)	0.92 (0.80, 1.05)	0.80 (0.62, 1.04)	0.80 (0.64, 1.01)	1.03 (0.86, 1.24)	1.00 (0.84, 1.19)
Spending Money								
\$0	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
\$1-\$20	1.05 (0.97, 1.12)	1.05 (0.96, 1.14)	1.04 (0.89, 1.22)	1.03 (0.94, 1.13)	0.93 (0.85, 1.02)	1.03 (0.94, 1.12)	1.02 (0.95, 1.10)	0.96 (0.87, 1.05)
\$21-\$100	1.22 (1.10, 1.35)	1.15 (1.05, 1.25)	1.55 (1.28, 1.89)	1.11 (0.97, 1.27)	1.12 (1.01, 1.25)	1.23 (1.14, 1.33)	1.24 (1.15, 1.33)	1.18 (1.06, 1.33)

	Asthma‡	Premature or early death‡	Lung Cancer‡	Heart Disease‡	Gum or Mouth Disease‡	Chronic Bronchitis/ Emphysema‡	Bladder Cancer‡	Vision Loss/ Blindness‡
\$100+	1.18 (1.03, 1.36)	1.25 (1.13, 1.39)	1.00 (0.82, 1.24)	1.32 (1.19, 1.46)	1.08 (0.88, 1.31)	1.29 (1.12, 1.49)	1.36 (1.23, 1.51)	1.40 (1.25, 1.55)
Don't know	0.89 (0.81, 0.99)	0.85 (0.76, 0.94)	0.54 (0.45, 0.64)	0.88 (0.81, 0.95)	0.70 (0.62, 0.78)	0.90 (0.79, 1.03)	1.04 (0.96, 1.12)	0.99 (0.87, 1.11)
Parent Smokes								
No	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Yes	0.93 (0.86, 1.00)	0.92 (0.85, 1.00)	0.99 (0.86, 1.14)	1.09 (1.01, 1.18)	1.19 (1.09, 1.29)	0.91 (0.86, 0.97)	1.09 (1.02, 1.16)	1.15 (1.08, 1.22)
Sibling(s) Smokes								
No	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Yes	0.86 (0.80, 0.92)	0.86 (0.80, 0.94)	0.82 (0.70, 0.96)	0.91 (0.83, 0.99)	0.87 (0.77, 0.98)	0.94 (0.87, 1.01)	0.97 (0.89, 1.05)	1.00 (0.92, 1.10)
Friend(s) Smokes								
No	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Yes	1.12 (1.01, 1.24)	1.07 (0.98, 1.17)	0.96 (0.84, 1.09)	1.14 (1.06, 1.22)	0.97 (0.85, 1.10)	1.05 (0.97, 1.15)	1.16 (1.09, 1.23)	1.21 (1.12, 1.31)
Smoking Status								
Non-Smoker	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Experimental Smoker	0.92 (0.85, 0.99)	0.76 (0.71, 0.82)	0.89 (0.74, 1.06)	0.87 (0.81, 0.95)	0.96 (0.89, 1.04)	0.81 (0.75, 0.88)	0.97 (0.90, 1.05)	1.01 (0.93, 1.10)
Current Smoker	0.82 (0.70, 0.96)	0.83 (0.69, 1.00)	0.48 (0.38, 0.59)	0.95 (0.83, 1.09)	0.81 (0.67, 0.98)	0.72 (0.60, 0.85)	1.46 (1.21, 1.76)	1.68 (1.43, 1.96)

‡ AOR = adjusted odds ratio and 95% CI = 95% confidence interval

Table 2. Logistic Regression Results of Knowledge about the Specific Health Effects of Smoking (Indicating that Smoking Causes...)

	Model 1 Non-Smoker			Model 2 Experimental			Model 3 Current Smoker		
	Coef.	95% CI	SE	Coef.	95% CI	SE	Coef.	95% CI	SE
Grade	0.22	0.18, 0.27	0.02	0.23	0.17, 0.29	0.03	0.37	0.24, 0.50	0.07
Female (ref. male)	0.26	0.18, 0.34	0.04	0.14	0.02, 0.27	0.06	0.31	0.03, 0.59	0.14
<i>Race/Ethnicity (ref. White)</i>									
Aboriginal	-0.51	-0.67, -0.36	0.08	-0.38	-0.60, -0.16	0.11	-0.31	-0.67, 0.04	0.18
Black	-1.02	-1.41, -0.64	0.20	-1.08	-1.77, -0.39	0.35	-0.21	-1.15, 0.72	0.48
Asian	-0.32	-0.48, -0.16	0.08	-0.91	-1.31, -0.51	0.20	-1.74	-2.72, -0.76	0.50
Latin American/Hispanic	-0.36	-0.59, -0.13	0.12	-0.03	-0.43, 0.37	0.21	-1.23	-2.18, -0.27	0.49
Other	-0.20	-0.38, -0.03	0.09	-0.20	-0.46, 0.07	0.14	-0.32	-1.00, 0.37	0.35
<i>Region (ref. Ontario)</i>									
Atlantic Canada	0.12	-0.10, 0.33	0.11	-0.01	-0.28, 0.27	0.14	0.11	-0.23, 0.45	0.17
Quebec	-0.52	-0.77, -0.28	0.13	-0.63	-0.95, -0.32	0.16	-0.22	-0.76, 0.31	0.27
Prairies	0.16	-0.08, 0.39	0.12	-0.09	-0.38, 0.21	0.15	0.07	-0.31, 0.46	0.20
British Columbia	-0.18	-0.43, 0.08	0.13	-0.04	-0.46, 0.37	0.21	0.11	-0.37, 0.59	0.24
Friend Smokes	0.12	-0.01, 0.24	0.06	0.20	0.06, 0.33	0.07	0.33	-0.19, 0.85	0.27
Parent Smokes	0.02	-0.07, 0.11	0.05	0.17	0.01, 0.32	0.08	-0.17	-0.50, 0.16	0.17
Sibling Smokes	-0.09	-0.20, 0.03	0.06	-0.16	-0.31, -0.02	0.07	-0.06	-0.40, 0.27	0.17
<i>Spending Money (ref. \$0)</i>									
\$1-\$20	0.01	-0.09, 0.11	0.05	-0.03	-0.25, 0.20	0.11	0.53	0.13, 0.93	0.20
\$21-\$100	0.23	0.09, 0.36	0.07	0.18	-0.08, 0.43	0.13	0.93	0.33, 1.54	0.31
\$100+	0.33	0.20, 0.45	0.07	0.33	0.08, 0.59	0.13	0.56	0.01, 1.12	0.28
Don't Know	-0.23	-0.38, -0.08	0.08	-0.09	-0.36, 0.17	0.13	-0.08	-0.61, 0.45	0.27
Susceptibility to Smoking	-0.14	-0.20, -0.07	0.03	N/A			N/A		
<i>Cigarette Packaging (ref. pack/carton)</i>									
Did Not Buy	N/A			0.10	-0.08, 0.27	0.09	-0.17	-0.62, 0.29	0.23
Singles/Loose/Bag	N/A			-0.32	-0.70, 0.05	0.19	-1.04	-1.71, -0.37	0.34
Constant	3.03	2.53, 3.53	0.26	2.78	2.11, 3.45	0.34	1.02	-0.31, 2.35	0.68

Model 1 (Non-Smoker): $n=32,777$, $R^2=0.0711$, $F=43.80$, $\text{Prob} > F=0.0000$;

Model 2 (Experimental): $n=8,163$, $R^2=0.0761$, $F=22.86$, $\text{Prob} > F=0.0000$;

Model 3 (Current Smoker): $n=2,313$, $R^2=0.1072$, $F=16.82$, $\text{Prob} > F=0.0000$

Table 3. Ordinary Least Square Regression of Factors Associated with Overall Knowledge about the Health Effects of Smoking by Smoking Status

Among non-smokers (Model 1), racial/ethnic minorities were significantly less knowledgeable about the health effects of smoking than White adolescents while adolescents with more spending-money were significantly more knowledgeable. Non-smoking adolescents who were susceptible to smoking in the future knew significantly less about smoking health effects versus those who were not susceptible. Females, adolescents in higher grades, and adolescents in Quebec were also less knowledgeable compared to adolescents in Ontario. Having a friend, parent, or sibling that smokes was not significantly associated with increased knowledge about the health effects of smoking among non-smokers.

Among experimental smokers (Model 2), Aboriginal, Black, and Asian adolescents were less knowledgeable about the health effects of smoking than White adolescents. Adolescents with the most spending-money were more knowledgeable than those with the least. Females, adolescents in higher grades, and adolescents in Quebec were less knowledgeable about the health effects of smoking than adolescents in Ontario. Having a friend or parent who smokes was associated with greater knowledge about smoking health effects, whereas having a sibling who smokes was associated with less knowledge. Cigarette packaging was not a significant predictor of health knowledge for experimental smokers.

Among current smokers (Model 3), Asian and Latin American/Hispanic adolescents were significantly less knowledgeable about the health effects of smoking than White adolescents. Adolescents with more spending-money were significantly more knowledgeable versus those with less spending money. Females and those in higher grades were more knowledgeable about the health effects. Adolescent smokers who bought cigarettes in singles/loose bags knew significantly less about the health effects than adolescent smokers who bought cigarettes in

packs/cartons. There were no significant differences in knowledge among adolescent smokers who had a parent, friend or sibling who smokes compared to those who did not.

DISCUSSION

Adolescents in Canada are not equally knowledgeable about the health effects of smoking. Of particular concern is the pattern of disparities in knowledge. Across all smoking-status categories, knowledge was lowest among ethno-racial minorities relative to White adolescents, and was highest for adolescents with the most spending-money (a proxy for SES) relative to those with the least. Males were also less knowledgeable of the health effects than females. Additionally, non-smoking adolescents who were susceptible to future smoking were significantly less knowledgeable. Adolescents who perceive greater long-term health risks from smoking are significantly less likely to initiate smoking (Song et al., 2009). Therefore to mitigate tobacco-related health disparities, smoking prevention programming that also reaches marginalized populations are needed to increase knowledge about the health effects of smoking.

HWLs are the primary source for information about the health effects of smoking for smokers (ITC Project, 2013). Canada implemented new pictorial HWLs, and refreshed previous HWLs on cigarette packages with full implementation by June 2012. These HWLs included new messages that smoking causes bladder cancer, and vision loss/blindness. Our study was conducted 5-12 months after the implementation of the new HWLs in Canada. Results revealed that 32.2% of adolescents knew that smoking causes vision loss/blindness, and 33.7% knew it causes bladder cancer. Although knowledge about lung cancer was high, knowledge about other health effects ranged from 52.9% for chronic bronchitis/emphysema to 77.6% for gum/mouth disease. The limited knowledge about bladder cancer and vision loss/blindness may stem from the only recent addition of these health effects to HWLs compared to other health effects which

have long been the focus of media campaigns (Francis et al., 2017). Alternatively, people may have difficulty understanding the mechanisms by which smoking can impact certain health outcomes (e.g., vision loss) and therefore may be less likely to believe that they are related to smoking (Shanahan and Elliott, 2009).

Knowledge about bladder cancer and vision loss/blindness post HWL change among adolescent smokers was consistent with research among adult smokers conducted during a comparable time period (Swayampakala et al., 2015). Specifically, in this study, 49.4% of adolescent smokers agreed that smoking causes bladder cancer. Similarly, in 2012 and 2013, 38% and 51% of adult smokers endorsed this health link, respectively. In the current study, 51.8% of adolescent smokers stated that smoking yields vision loss/blindness. Among adult smokers, this percentage was 34% and 46% in 2012 and 2013, respectively. Although knowledge of bladder cancer and vision loss/impairment is low, it may ultimately be greater relative to the knowledge that existed prior to the HWL change in 2012 (Kennedy et al., 2012).

For health effects that had been included on previous HWLs, knowledge was lower among adolescent smokers compared to a study of adult smokers conducted during a comparable time period (Swayampakala et al., 2015). Among Canadian adult smokers, knowledge that smoking causes heart attacks ranged from 88% in 2012 to 85% in 2013, whereas 70.4% of adolescent smokers in this study agreed that smoking causes heart disease. These differences may stem from the manner in which heart problems were described across the studies (“heart attacks” vs. “heart disease”). Similar findings were noted for emphysema, with 59% of adolescent smokers recognizing it as a health effect, in comparison to 85% and 84% of adults smokers in 2012 and 2013, respectively. Additional research is needed to understand why adolescent smokers are less knowledgeable about health effects previously included in HWLs.

One possible interpretation is that adolescents have had less long-term exposure to the HWL information compared to adult smokers.

After controlling for sociodemographic factors, smokers were less knowledgeable about many health effects of smoking, consistent with previous research, demonstrating that smokers have an optimistic bias about the health risks of smoking (Weinstein, 1998; Weinstein et al., 2005). However, smokers were more knowledgeable of the health effects that were most recently added to the HWLs: bladder cancer and vision loss/blindness. This is likely attributable to greater exposure to HWL information.

Smokers who bought loose/bagged cigarettes rather than cigarettes in packages/cartons knew less about the health effects of smoking. Among experimental smokers, there were no significant differences in knowledge by cigarette packaging likely because few experimental smokers purchased their cigarettes. These findings demonstrate the potential importance of HWLs and pictorial warnings in particular, to educate adolescent smokers about the health effects of smoking, but only if adolescents are exposed to those HWLs.

Adolescent smokers with more spending-money were more knowledgeable about the health effects of smoking. This finding is consistent with previous research among adults demonstrating that low-SES smokers knew less about the health effects of smoking than high-SES smokers (Siahpush et al., 2006). A potential explanation for these findings is that higher-SES smokers may be more likely to purchase cigarettes in cartons/packages, therefore increasing their exposure to HWLs. Additional strategies are therefore needed to increase knowledge about the health effects of smoking, particularly by ensuring that smokers are exposed to health-warning information. This could include measures to address contraband tobacco use, and

implementation of HWLs on cigarette sticks, ensuring that messaging about smoking health effects is delivered even when cigarettes are not packaged (Hassan and Shiu, 2015).

This study highlights the importance of complementary strategies to deliver information about the health effects of smoking through additional channels beyond pictorial HWLs to reach all equity groups. A study examining the impact of the implementation of HWLs in Australia demonstrated that the HWLs yielded increased knowledge about the health effects of smoking across smoking-status groups such that there were no significant differences in knowledge between smokers and non-smokers (White et al., 2008). However, the HWLs were accompanied by a media campaign promoting the health-warning messages, which would have also reached non-smokers (White et al., 2008). Therefore, this study suggests that media campaigns may be necessary to target non-smokers, experimental smokers, and adolescents who may not as likely be exposed to HWLs, as part of a comprehensive tobacco-control strategy.

Limitations

Smoking is associated with examined health outcomes, therefore potentially increasing the likelihood of acquiescence bias. Additionally, we did not ask respondents to spontaneously list the health effects of smoking. It is therefore possible that results are conservative and overestimate awareness about the health effects of smoking among adolescents. However, this would suggest an even greater need to increase knowledge. Although examining changes in health knowledge is one way to measure effectiveness of HWLs (Hammond et al., 2007), the survey did not include direct measures of exposure to HWLs or anti-smoking measures. While we used a commonly employed threshold of 100 cigarettes for our smoking categories, we do acknowledge that this may be arbitrary (Bondy et al., 2009) as it is difficult to determine the qualitative difference for example between someone who smokes 99 cigarettes versus someone

who smokes 100 cigarettes. Finally, we did not have measures of other tobacco products such as e-cigarettes to also examine knowledge about the health effects of those products.

CONCLUSIONS

There are significant disparities in knowledge about the health effects of smoking by health-equity groups. HWLs are a population-level health intervention that has the potential to reduce disparities in knowledge about the health effects of smoking because access to health information is universal. However, some adolescents may avoid exposure to HWLs by buying loose cigarettes or receiving cigarettes from others. Measures to ensure that messaging is delivered even when cigarettes are not packaged may be warranted, and additional efforts to eliminate contraband tobacco availability are needed. Complementary prevention strategies are also needed to address disparities in knowledge for those not exposed to pictorial HWLs.

REFERENCES

- Asbridge, M., Tanner, J., Wortley, S., 2005. Ethno-specific patterns of adolescent tobacco use and the mediating role of acculturation, peer smoking, and sibling smoking. *Addiction* 100:1340-51.
- Bondy, S.J., Victor, J.C., Diemert, L.M., 2009. Origin and use of the 100 cigarette criterion in tobacco surveys. *Tob Control* 18:317-23. doi: 10.1136/tc.2008.027276
- Burkhalter, R., Cumming, T., Rynard, V., S., M., 2013. 2012/2013 Youth Smoking Survey Microdata User Guide. Propel Centre for Population Health Impact, University of Waterloo, Waterloo, Ontario.
- Chaiton, M., Cohen, J., Kaiserman, M.J., Leatherdale, S.T., 2005. Beliefs and Attitudes, in: Canada, H. (Ed.), 2002 Youth Smoking Survey Technical Report. Minister of Supply and Services Canada, Ottawa, pp. 177-215.
- Chapman, S., Liberman, J., 2005. Ensuring smokers are adequately informed: Reflections on consumer rights, manufacturer responsibilities, and policy implications. *Tob Control* 14:ii8-ii13. doi: 10.1136/tc.2005.012591
- Elton-Marshall, T., Leatherdale, S.T., Burkhalter, R., 2011. Tobacco, alcohol and illicit drug use among Aboriginal youth living off-reserve: Results from the Youth Smoking Survey. *CMAJ* 183:E480-E86. doi: 10.1503/cmaj.101913
- Eriksen, M.P., Mackay, J., Schluger, N., Islami, F., Drope, J., 2015. *The Tobacco Atlas 2015*, 5th ed. American Cancer Society.
- Francis, D.B., Noar, S.M., Kowitt, S.D., Jarman, K.L., Goldstein, A.O., 2017. Believability of new diseases reported in the 2014 Surgeon General's Report on smoking: Experimental

results from a national survey of US adults. *Prev Med* 99:94-98. doi:

10.1016/j.ypmed.2017.01.021

Gupta, R.P.S., de Wit, M.L., McKeown, D., 2007. The impact of poverty on the current and future health status of children. *Paediatrics & Child Health* 12:667-72.

Hammond, D., 2011. Health warning messages on tobacco products: A review. *Tob Control* 20:327-37. doi: 10.1136/tc.2010.037630

Hammond, D., 2013. Tobacco Labelling Resource Centre.

Hammond, D., Fong, G.T., Borland, R., Cummings, K.M., McNeill, A., Driezen, P., 2007. Text and graphic warnings on cigarette packages: Findings from the International Tobacco Control Four Country Study. *Am J Prev Med* 32:202-09. doi: 10.1016/j.amepre.2006.11.011

Hammond, D., Fong, G.T., McNeill, A., Borland, R., Cummings, K.M., 2006. Effectiveness of cigarette warning labels in informing smokers about the risks of smoking: Findings from the International Tobacco Control (ITC) Four Country Survey. *Tob Control* 15:iii19-iii25. doi: 10.1136/tc.2005.012294

Hassan, L.M., Shiu, E., 2015. No place to hide: Two pilot studies assessing the effectiveness of adding a health warning to the cigarette stick. *Tob Control* 24:e3-3-5. doi:

10.1136/tobaccocontrol-2013-051238

Huxley, R.R., Yatsuya, H., Lutsey, P.L., Woodward, M., Alonso, A., Folsom, A.R., 2012.

Impact of age at smoking initiation, dosage, and time since quitting on cardiovascular disease in African Americans and whites. *Am J Epidemiol* 175:816-26. doi:

10.1093/aje/kwr391

- ITC Project, 2013. ITC Canada National Report. Findings from the Wave 1 to 8 Surveys (2002-2011). University of Waterloo, Waterloo, Ontario Canada.
- Janz, T., 2012. Health at a Glance. Current smoking trends. Statistics Canada, Ottawa, ON.
- Kennedy, R.D., Spafford, M.M., Behm, I., Hammond, D., Fong, G.T., Borland, R., 2012. Positive impact of Australian 'blindness' tobacco warning labels: Findings from the ITC four country survey. *Clin Exp Optom* 95:590-98. doi: 10.1111/j.1444-0938.2012.00789.x
- Lemstra, M., Rogers, M., Thompson, A., Moraros, J., Tempier, R., 2011. Prevalence and risk indicators of smoking among on-reserve First Nations youth. *Paediatrics & Child Health* 16:e71-e77.
- Morrison, W., Doucet, C., Diener, A., 2005. Knowledge of Health Risks, in: Canada, H. (Ed.), 2002 Youth Smoking Survey Technical Report. Minister of Supply and Services Canada, Ottawa, pp. 215-56.
- Pechmann, C., Reibling, E.T., 2006. Antismoking advertisements for youths: An independent evaluation of health, counter-industry, and industry approaches. *American Journal of Public Health* 96:906-13. doi: 10.2105/AJPH.2004.05727
- Pierce, J.P., Choi, W.S., Gilpin, E.A., Farkas, A.J., Merritt, R.K., 1996. Validation of susceptibility as a predictor of which adolescents take up smoking in the United States. *Health Psychol* 15:355-61. doi: 10.1037/0278-6133.15.5.355
- Propel, 2013. 2012/2013 Youth Smoking Survey Microdata User Guide.
- Rao, J.N.K., Scott, A.J., 1987. On Simple Adjustments to Chi-Square Tests with Sample Survey Data. *The Annals of Statistics* 15:385-97.
- Reid, J.L., Hammond, D., Boudreau, C., Fong, G.T., Siahpush, M., Collaboration, I.T.C., 2010a. Socioeconomic disparities in quit intentions, quit attempts, and smoking abstinence among

- smokers in four western countries: Findings from the International Tobacco Control Four Country Survey. *Nicotine Tob Res* 12 S20-S33. doi: 10.1093/ntr/ntq051
- Reid, J.L., Hammond, D., Driezen, P., 2010b. Socio-economic status and smoking in Canada, 1999-2006: Has there been any progress on disparities in tobacco use? *Canadian Journal of Public Health* 101:73-78.
- Reid, J.L., Hammond, D., Rynard, V.L., Burkhalter, R., 2015. Tobacco use in Canada: Patterns and trends. Propel Centre for Population Health Impact, University of Waterloo, Waterloo, ON.
- Shanahan, P., Elliott, D., 2009. Evaluation of the Effectiveness of the Graphic Health Warnings on Tobacco Product Packaging 2008. Australian Government Department of Health and Ageing, Canberra, Australia.
- Siahpush, M., McNeill, A., Hammond, D., Fong, G.T., 2006. Socioeconomic and country variations in knowledge of health risks of tobacco smoking and toxic constituents of smoke: Results from the 2002 International Tobacco Control (ITC) Four Country Survey. *Tob Control* 15 iii65-iii70. doi: 10.1136/tc.2005.013276
- Song, A.V., Morrell, H.E.R., Cornell, J.L., Ramos, M.E., Biehl, M., Kropp, R.Y., Halpern-Feisher, B.L., 2009. Perceptions of smoking-related risks and benefits as predictors of adolescent smoking initiation. *Am J Public Health* 99:487-92. doi: 10.2105/AJPH.2008.137679
- Swayampakala, K., Thrasher, J.F., Hammond, D., Yong, H.H., Bansal-Travers, M., Krugman, D., Brown, A., Borland, R., Hardin, J., 2015. Pictorial health warning label content and smokers' understanding of smoking-related risks--a cross-country comparison. *Health Educ Res* 30:35-45. doi: 10.1093/her/cyu022

- U.S. Department of Health and Human Services, 2012. Preventing Tobacco Use Among Youth and Young Adults A Report of the Surgeon General Executive Summary. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, Atlanta, GA.
- U.S. Department of Health and Human Services, 2014. The health consequences of smoking-50 years of progress: A report of the Surgeon General. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, Atlanta.
- Weinstein, N.D., 1998. Accuracy of smokers' risk perceptions. *Ann Behav Med* 20:135-40.
- Weinstein, N.D., Marcus, S.E., Moser, R.P., 2005. Smokers' unrealistic optimism about their risk. *Tob Control* 14:55-59. doi: 10.1136/tc.2004.008375
- White, V., Webster, B., Wakefield, M., 2008. Do graphic health warning labels have an impact on adolescents' smoking-related beliefs and behaviours? *Addiction* 103:1562-71. doi: 10.1111/j.1360-0443.2008.02294.x
- Wong, K., Manske, S., 2004-2005 smoking statistics and trends in Canada. *You Smoking Survey* 2006-2007. University of Waterloo.
- World Health Organization, 2014. Parties to the WHO Framework Convention on Tobacco Control.
- Yang, J., Hammond, D., Driezen, P., Fong, G.T., Jiang, Y., 2010. Health knowledge and perception of risks among Chinese smokers and non-smokers: Findings from the Wave 1 ITC China Survey. *Tob Control* 19 i18-i23. doi: 10.1136/tc.2009.029710

Highlights

- The study examines adolescent knowledge about health effects of smoking in Canada
- Data collected following the introduction of new pictorial health warning labels
- Among non-smokers disparities in knowledge were found by health equity groups
- There were fewer disparities in knowledge among smokers
- Strategies needed to ensure health warnings reach those less likely to be exposed

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