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Association between prenatal care and small for gestational age birth: an ecological study in Quebec, Canada

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This article has been peer reviewed.

Abstract

Background: In Quebec, women living on low income receive a number of additional prenatal care visits, determined by their area of residence, of both multi-component and food supplementation programs. We investigated whether increasing the number of visits reduces the odds of the main outcome of small for gestational age (SGA) birth (weight $< 10^{th}$ percentile on the Canadian scale).

Methods: In this ecological study, births were identified from Quebec's registry of demographic events between 2006 and 2008 (n = 156 404; 134 areas). Individual characteristics were extracted from the registry, and portraits of the general population were deduced from data on multi-component and food supplement interventions, the Canadian census and the Canadian Community Health Survey. Mothers without a high school diploma were eligible for the programs. Multilevel logistic regression models were fitted using generalized estimating equations to account for the correlation between individuals on the same territory. Potential confounders included sedentary behaviour and cigarette smoking. The odds ratios (ORs) were adjusted for mother's age, marital status, parity, program coverage and mean income in the area.

Results: Mothers eligible for the programs remain at a higher odds of SGA than non-eligible mothers (OR = 1.40; 95% confidence interval [CI]: 1.30–1.51). Further, areas that provide more visits to eligible mothers (4–6 food supplementation visits) seem more successful at reducing the frequency of SGA birth than those that provide 1–2 or 3 visits (OR = 0.86; 95% CI: 0.75–0.99).

Conclusions: Further studies that validate whether an increase in the number of prenatal care interventions reduces the odds of SGA birth in different populations and evaluate other potential benefits for the children should be done.

Keywords: *birth weight, gestational age, reproductive health, intervention, health behaviour*

Highlights

- This is the first observational study of Quebec's population – and one of the few worldwide – that explores the benefits of prenatal intervention along the gradient of intensity of available care.
- In Quebec, all pregnant women receive prenatal care. Women living on low income receive additional care through multi-component and food supplementation programs.
- Mothers eligible for the supplementation programs remain at a higher risk of small for gestational age (SGA) birth than non-eligible mothers.
- Prenatal care interventions provided to women living on low income are associated with lower odds of SGA birth.
- In addition, the authors observed a strengthening of the association with increasing number of interventions.

Introduction

Small for gestational age (SGA) birth is an indicator of fetal development[1] that takes into account fetal weight and length of gestation.[2] SGA is associated with neonatal death and chronic illness.[2,3] Determinants of this outcome include advanced maternal age, chronic disease of the mother, race/ethnicity, primiparity, nutritional status and lifestyle characteristics such as smoking, drug use and physical activity/workload.[2]

To date, participation in multi-component prenatal care programs has not been conclusively found to decrease risks of SGA birth, even among high-risk women.[4-8] However, participating in multi-component programs throughout pregnancy can improve parental behaviours and use of community-based resources.[5,9] Further, reducing use of tobacco—usually included in multi-component programs—is associated with decreased risks of low birthweight and preterm birth.[10]

Randomized controlled trials (RCTs) indicate that balanced energy and protein supplementation seem to reduce the

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occurrence of SGA birth.[11] However, what remains unclear is whether those results can be extrapolated to the whole population in a ''real world'' setting.[12-14] Indeed, compliance may be affected by researchers' investment in the intervention, and women participating in such studies may be more prone to changing their behaviour.[12-14] An observational design could be used to gain further insights on prenatal care intervention. Results from such a study should be adjusted for confounders such as age, poverty and availability of care because it does not include a randomization process that itself controls for confounding.[4,15]

In Quebec, standard prenatal care is provided by physicians, and additional support is provided by nurses, social workers and nutritionists as part of the integrated perinatal and toddler services multi-component care program (SIPPE)[16] and as part of the egg, milk and orange food supplementation program[17,18] (further information available on request from the authors). In-home multi-component visits include self-empowerment, emotional support and education to improve dietary habits and reduce sedentariness, tobacco use, alcohol consumption and recreational drug use.[16,*]

Both programs are standard care for women at a higher risk of pregnancy complications because they are young or living on low income.[16,17] The participants are mostly referred to additional care through their prenatal clinic, their medical clinic or their local community health centre, although some contact their local community health centre themselves to indicate their need for intervention.[17] The Centres locaux de services communautaires (local community service centres; CLSC) manage these programs.

RCTs suggest that multi-component interventions are effective at improving maternal diet, emotional support and mental health.[16] The intensity of the interventions (the number of visits provided) and program coverage (the proportion of high-risk mothers receiving effective intervention) has been identified as an important consideration when evaluating intervention.[19] However, what remains unknown is the intensity of the multi-component or food supplementation interventions required to lower the frequency of SGA birth.[20,21]

We speculated that increasing the number of visits reduces the odds of an SGA birth. To test this hypothesis, we investigated whether the average number of additional care visits in areas of residence in Quebec, Canada, had a dose–response association with SGA births.

Methods

Study population and setting

This is an observational study (ecological analytic multiple-group design) of the live singleton births registered in Quebec's registry of demographic events (Registre des événements démographiques du Québec) from April 2006 through March 2008 (n = 156 404 births).[22] Participants' areas of residence were determined from data on prenatal support interventions (n = 134 CLSCs), the Canadian census of 2001 and 2006 and the Canadian Community Health Survey (CCHS) of 2001, 2003, 2005, 2007 and 2008.[23] These years were chosen to build a portrait of the environment before and during pregnancy.

Quebec's registry of demographic events collects information on every live birth and on the mother (birth weight, gestational age, mother's age, academic degree and postal code). Between 2006 and 2008, 8.1% (99% confidence interval [CI]: 8.1–8.3) of births in Quebec were SGA whereas between 2009 and 2011 this proportion had risen to 8.6% (99% CI: 8.4–8.7).[24]

Data on prenatal support interventions available at the CLSC level (number of interventions provided by CLSC per year) can be found in the ''Info-CLSC'' system.[25] CLSCs vary in size (mean population: n = 46 727; mean births per year: n = 389).

The 2001 and 2006 censuses include data on mean income as well as information on the urbanity and rurality of neighbourhoods within areas. The CLSC portraits were built by pooling area data by the number of residents. Census area geographies were linked to CLSC geographies by merging the federal file ''Fichier de conversion des codes postaux plus'' (which included the dissemination area and postal code) to Quebec's health geography ''Référentiel territorial M34'' (postal code and CLSC territory) by postal code.

The CCHS includes information about food insecurity, tobacco use, sedentary behaviour and low social support. Data from Quebec's residents from the different cycles (2001, 2003, 2005, 2007 and 2008) were pooled and CLSC proportion-like values were built using the 100 832 CCHS responses.

The CLSC portraits of the general population were associated with the mothers' variables using their postal codes.[24] If a postal code did not exactly match a CLSC boundary (which occurred for fewer than 3% of the codes), it was associated with the CLSC territory that included the majority of the residents. Table 1 shows individually measured information and CLSC-level variables.

Excluded were births at less than 22 weeks gestational age or more than 43 weeks gestational age; with implausible weight for age (according to a criteria recommended by Alexander et al.[26]); with missing potential confounder information at the CLSC level (births from CLSCs of the Nord-du-Québec, Terres-Cries-de-la-Baie-James and Nunavik regions); and with missing data on prenatal care.

[*] Interventionists in the multi-component care programs are mostly nurses. They first evaluate whether the family's primary needs are met, paying special attention to nutrition, housing and security of every member of the family. If problems such as violence or drug abuse are present, additional help is provided. Nurses also inform families about community activities that might be of use.[15] Coupons for eggs, one litre of 3.25% milk, 125 millilitres of orange juice, and multivitamin and mineral supplements are provided to women on low income. A nurse or a nutritionist also visits the women as part of this program. Other professionals intervene when required.[16]

TABLE 1
Data sources and variables related to Quebec births, 2006–2008

Data		Variable
Explanatory variables		
CLSC level	Data on prenatal support, MSSS	Intensity of interventions: • non-eligible mother • mother eligible for both programs[a] Average number of food interventions per eligible woman: ○ lowest/1–2 visits from the food supplementation program ○ medium/3 visits ○ highest/4–6 visits
Potential confounders		
Individual-level	Registry of demographic events, MSSS[b]	Mother's country of birth
		Marital status
		Parity
		Academic qualification
CLSC level	Canadian Community Health Survey, Statistics Canada[c]	Percentage of residents with food insecurity in the past 12 months[d]
		% of residents with sedentary behaviour in the past 3 months[d]
		% of residents with low tangible social support on the Medical Outcome Study subscale[d]
		% of residents who smoke cigarettes daily[d]
	Canadian census, Statistics Canada[e]	Presence of urban neighbourhoods within the CLSC (exclusively urban; exclusively rural; urban and rural neighbourhoods)
		Mean income
Individual-level	Registry of demographic events, MSSS	Mother's age, years ($<$ 20; 20–24; 25–29; 30–34; $\geq$ 35)
CLSC level	Data on prenatal support, MSSS[e]	Programs coverage[f] (% of target population receiving food intervention)

Abbreviations: CLSC, Centres locaux de services communautaires (local community health centre territory); MSSS, Ministère de la Santé et des Services sociaux du Québec.

[a] Mother has $<$11 years of education.

[b] April 2006 through March 2008.

[c] Survey cycles were pooled (2000–01, 2003, 2005, 2007–08).

[d] Value calculated for $\geq$ 12-year-olds. Excludes survey cycle and data collection method effects.

[e] 2001 and 2006.

[f] This variable was incorporated in the definition of the "intensity of intervention."

Variables

Outcomes

The main outcome was SGA birth (weight below the 10th percentile of the Canadian reference scale).[1] The ''term births only'' population was used for sensitivity analyses (births were categorized as ''term births'' using the registry of demographic events).

Exposure

Both multi-component and food intervention programs targeted women in need. Mothers targeted by the food supplementation program had a family income below the Canadian cut-off.[†] Those targeted by multi-component interventions were less than 20 years old at the estimated time of birth, had no high school diploma or had a low family income.[16,18]

Mothers without a high school diploma were considered eligible for both the multi-component and the food programs, since this population has the lowest income (on average, in 2009, women with a high school diploma or less earned $20,400 per year, those with college degree earned $30,300 and those with a university degree earned $48,400[27]). We used a narrower definition of eligibility (mothers aged less than 20 years and without a high school diploma) for sensitivity analyses, as younger women are more likely to have a low household income.[28]

The intensity of the multi-component or food supplementation intervention received by eligible women was an area-level variable. It was neither directly measured for every woman nor based on whether they receive the intervention; it was based on whether mothers *could* receive the intervention. It corresponded to the average number of visits from the food supplementation program per eligible

[†]The low income cut-offs are income thresholds below which a family will likely spend a larger share of its income on the necessities of food, shelter and clothing than the average family. This approach essentially estimates an income threshold at which families are expected to spend 20 percentage points more than the average family on food, shelter and clothing. Twenty percentage points are used on the rationale that family spending 20 percentage points more than the average would be in "straitened circumstances."

woman living in the CLSC territory (those women also had between 2 and 8 multi-component visits). The number of visits from the food supplementation program were categorized into tertiles (lowest: 1 to 2 visits; medium: 3 visits and highest: 4 to 6 visits). Non-eligible mothers were given an intensity of exposure equal to zero and were included in the ''non-eligible for the program/reference'' category (Table 1).

Potential confounders

Potential confounders are program eligibility and individual maternal characteristics (age, country of birth, marital status, academic qualification and parity) at the individual-level and program coverage as well as variables portraying residents of the CLSC territories at the CLSC level.

CLSC defined program eligibility and program coverage variables as follows: mothers without a high school diploma were identified as eligible for the food supplementation program and the multi-component program. This variable was incorporated in the definition of the ''intensity of intervention.'' Program coverage was calculated as the proportion of eligible mothers receiving intervention on the CLSC territory. A categorical scale was used for univariate analyses (''non-eligible,'' ''lowest,'' ''medium'' and ''highest'').

Other CLSC ''portraits'' included the proportion of urban neighbourhoods within each CLSC territory (''exclusively urban neighbourhoods/reference,'' ''exclusively rural neighbourhoods'' and ''urban and rural neighbourhoods''); mean income (''lowest,'' ''medium'' and ''highest/reference''); proportion of residents with the following risk factors: food insecurity, sedentary behaviour, low tangible social support and daily tobacco use (using ''lowest/reference,'' ''medium'' and ''highest'' tertiles).

Source of data

Mothers and their babies were registered in the registry of demographic events by the Ministère de la Santé et des Services sociaux du Québec (April 2006 through March 2008). Their CLSCs were portrayed by the same dataset on prenatal support interventions, by data from the Canadian census from Statistics Canada (2001 and 2006) and by the CCHS from Statistics Canada (the 2001, 2003, 2005, 2007 and 2008 files were combined to achieve a reasonable number of respondents per CLSC).[22] CLSC portraits were associated with maternal variables using postal codes, as described elsewhere.[24] Table 1 shows additional information related to the variables used.

Statistical analysis

All data have a multilevel structure: the first level is the mother and the second is the local community health centre.[29] Multilevel logistic regression models were fitted using generalized estimating equations (GEE) to account for the correlation between individuals in the same CLSC territory. (The GEE method provides consistent odds ratio [OR] estimates for the population even though the correlation between mothers from the same CLSC is unknown.) We used independent working correlation structures throughout the univariate and multivariate analyses and obtained empirical robust standard error estimates.[30]

Univariate logistic regression models were fitted on every potential confounder and on exposure (dependent variable: SGA birth). Multivariate models were fitted on exposure. A full model was first adjusted with all the potential confounders listed in Table 2. Confounders that changed the effect estimate of the exposure by less than 5% were removed one at a time (change-in-estimate approach[31,32]), which resulted in the final adjusted model.

Sensitivity analyses were as follows: regressions of SGA on intensity using term births only (from 37 to 40 weeks of gestational age inclusively) and regressions of SGA on intensity using the narrower definition of eligibility for the programs (mothers aged less than 20 years without high school diploma). Both analyses were adjusted for confounders incorporated in the final model.

Analyses were carried out using SAS version 9.2 (GENMOD and REG procedures). Results were considered statistically significant at $p < .05$.

The Commission d'accès à l'information du Québec and Université Laval's Ethics Committee approved this research project.

Results

Participants

A total of 156 404 singleton births (134 CLSCs) were included. Most of the mothers were 25 to 29 years old, had a university degree, were born in Canada, were primiparous and unmarried (neither married nor in a common-law relationship) (Table 2). A total of 11.1% of the 10 742 eligible births and 8.1% of the non-eligible births were SGA. (Further information on program coverage is available from the authors on request.)

Univariate regression analyses

Mothers aged less than 20 years (OR = 1.46; 95% CI: 1.32–1.61) and 20 to 24 years (OR = 1.23; 95% CI: 1.17–1.29) have higher unadjusted odds of SGA while 30- to 34-year-old mothers have a lower odds (OR = 0.88; 95% CI: 0.85–0.92) compared to 25- to 29-year-old mothers (the reference category). Mothers with less than a high school diploma (OR = 1.31; 95% CI: 1.26–1.37) and those with a high school diploma (OR = 1.56; 95% CI: 1.44–1.69) had higher odds of SGA than mothers with a university degree. Mothers born outside Canada (OR = 1.18; 95% CI: 1.09–1.29), primiparous mothers (OR = 1.82; 95% CIs: 1.75–1.89) and unmarried mothers (OR = 1.14; 95% CIs: 1.06–1.23) also had higher odds of SGA compared to mothers from the reference categories.

Mothers from CLSCs with a medium (OR = 1.10; 95% CI: 1.00–1.21) or high proportion (OR = 1.19; 95% CI: 1.10–1.28) of residents experiencing food insecurity, a high proportion of sedentary residents (OR = 1.16; 95% CI: 1.06–1.27) and a high proportion of residents who smoke cigarettes (OR = 1.10; 95% CI: 1.01–1.21) have higher odds of SGA than mothers from CLSCs with low proportions of these variables. Mothers from

TABLE 2
Unadjusted odds ratios of SGA births, N = 156 404 births, 2006–2008, Quebec, Canada

Individual-level variable from Registry of demographic events	Number and proportion of live births, n (%)	Proportion of SGA births, %	Crude odds ratio (95% CI)	*p* value
Mother's age, years				< .01
< 20	4049 (2.6)	11.6	1.46 (1.32–1.61)	
20–24	23 767 (15.2)	10.0	1.23 (1.17–1.29)	
25–29 (reference category)	56 170 (35.9)	8.3	1.00	
30–34	48 981 (31.3)	7.4	0.88 (0.85–0.92)	
≥ 35	23 437 (15.0)	8.2	0.99 (0.93–1.05)	
Academic qualification				< .01
< High school	10 742 (6.9)	11.1	1.56 (1.44–1.69)	
High school diploma	46 660 (29.8)	9.5	1.31 (1.26–1.37)	
College	44 048 (28.2)	7.5	1.02 (0.98–1.06)	
≥ University (reference category)	54 954 (35.1)	7.4	1.00	
Mother's country of birth				
Other	31 350 (20.0)	9.4	1.18 (1.09–1.29)	
Canada (reference category)	125 054 (80.0)	8.1	1.00	
Parity				
Primiparous	72 792 (53.5)	10.8	1.82 (1.75–1.89)	
Multiparous (reference category)	83 612 (46.5)	6.2	1.00	
Marital status				
Married (reference category)	59 038 (37.8)	7.7	1.00	
Unmarried	97 366 (62.3)	8.7	1.14 (1.06–1.23)	

Abbreviations: CI, confidence interval; CLSC, Centres locaux de services communautaires (local community health centre territory); SGA, small for gestational age.

CLSCs with the lowest mean income have higher odds of SGA than mothers from CLSCs with the highest mean income (OR = 1.18; 95% CI: 1.09–1.28). Finally, mothers from CLSCs with both urban and rural neighbourhoods have lower odds of SGA than mothers from rural CLSCs (OR = 0.92; 95% CI: 0.84–1.00) (Table 3).

Crude OR estimates from regression on intensity indicate that eligible mothers from any of the ''lowest: 1 to 2 visits from the food supplementation program,'' ''medium: 3 visits'' and ''highest: 4 to 6 visits'' categories have higher odds of SGA than non-eligible mothers (OR = 1.40; 95% CI: 1.30–1.51; not shown in the table).

Multivariate regression analyses

Results of crude and adjusted odds ratios of SGA are shown in Table 4. The final adjusted model on intensity accounts for mothers' age, parity and marital status as well as program coverage and mean income in the CLSC. Women eligible for both multi-component and food intervention from any of the intensity groups had higher adjusted odds of SGA than non-eligible women (OR = 1.40; 95% CI: 1.30–1.51; data not shown). Moreover, the association with increasing intensity of interventions was attenuated: eligible women living in a territory that provided high-intensity interventions (4–6 visits of food intervention per eligible woman) had lower odds of SGA than women living in a territory that provides interventions of low or medium intensity (1–2 or 3 visits per eligible woman) (OR = 0.86; 95% CI: 0.75–0.99; data not shown). Estimates from the full models are similar to those from the adjusted models (not shown in the table).

Sensitivity analyses corroborate the main results. When the final models were fitted on term births only, mothers eligible for the programs had a greater odds of SGA than non-eligible mothers (OR: 1.43; 95% CI: 1.32–1.55; data not shown), while high exposure is associated with lower odds than low or medium exposure (OR = 0.90; 95% CI: 0.78–1.05; data not shown). Final results on data with the narrower definition of eligibility for intervention were also similar. The eligible mothers have a greater odds of SGA than the non-eligible (n = 147 156) mothers (OR = 1.48; 95% CI: 1.36–1.60; data not shown). There were fewer eligible mothers (n = 9248) when this definition is used than when the definition based on academic qualification alone (10 742 eligible mothers) was used. Final results are similar but non-significant (OR = 0.89; 95% CI: 0.76–1.04; data not shown).

Discussion

This is the first observational study of Quebec's population—and one of the few worldwide—that explores the benefits of prenatal intervention along the gradient of intensity of available care. We found that mothers living in Quebec who are eligible for supplemental prenatal care programs are at a higher odds of SGA than those who are non-eligible, and that prenatal care interventions provided to women living on low income are associated with lower odds of SGA birth. In

TABLE 3
Unadjusted odds ratios of SGA births, N = 156 404 births, 2006–2008 Quebec, Canada

CLSC level by tertile[a]		Population of live births, n (%)	Proportion of SGA births, %	Crude odds ratio (95 % CI)	*p* value
Proportion of the target population receiving food intervention[b]					<.01
Non-eligible mother (reference category)		145 662 (93.1)	8.1	1.00	
Lowest	0.0–100.0	4607 (3.0)	11.3	1.44 (1.28–1.61)	
Medium	100.0–200.0	3680 (2.4)	10.9	1.38 (1.25–1.52)	
Highest	200.0–700.0	2455 (1.6)	11.3	1.44 (1.28–1.61)	
Proportion of residents in the CLSC with food insecurity, %[c]					<.01
Lowest (reference category)	4.0–10.5	52 260 (33.4)	7.7	1.00	
Medium	10.6–15.1	57 488 (36.7)	8.4	1.10 (1.00[d]–1.21)	
Highest	15.2–36.4	46 656 (29.8)	9.0	1.19 (1.10–1.28)	
Proportion of sedentary residents, %[c]					
Lowest (reference category)	1.7–9.9	50 076 (32.0)	7.8	1.00	
Medium	9.9–14.4	48 360 (30.9)	8.2	1.06 (0.98–1.15)	
Highest	14.4–31.0	57 968 (37.1)	8.9	1.16 (1.06–1.27)	
Proportion of residents with low tangible social support, %[c]					.06
Lowest (reference category)	12.1–37.8	38 421 (24.6)	8.0	1.00	
Medium	37.8–47.2	65 141 (41.7)	8.8	1.11 (1.02–1.20)	
Highest	47.2–69.9	52 842 (33.8)	8.1	1.01 (0.93–1.10)	
Proportion of residents who smoke cigarettes daily, %[c]					.04
Lowest (reference category)	8.1–20.8	64 511 (41.3)	8.1	1.00	
Medium	20.8–25.9	51 439 (32.9)	8.2	1.02 (0.93–1.11)	
Highest	25.9–39.4	40 454 (25.9)	8.9	1.10 (1.01–1.21)	
Mean income[c]					<.01
Lowest	$16,144–$25,268	25 964 (16.6)	8.0	1.18 (1.09–1.28)	
Medium	$25,268–$28,797	53 052 (33.9)	8.3	1.04 (0.96–1.12)	
Highest (reference category)	$28,797–$47,610	77 388 (49.5)	9.3	1.00	
Presence of urban and rural neighbourhoods in the CLSC[c]					.05
Rural		32 246 (20.6)	8.3	1.00	
Urban and rural		35 346 (22.6)	7.7	0.92 (0.84–1.00[e])	
Urban		88 812 (56.8)	8.6	1.03 (0.96–1.11)	

Abbreviations: CI, confidence interval; CLSC, Centres locaux de services communautaires (local community health centre territory); SGA, small for gestational age.

[a] CLSC-level variables were linked to birth data by postal codes.

[b] 3% of the births were in the lowest tertile (0%–100%) and received 1 to 2 visits from the food supplementation program, 4% were in the medium tertile (100%–200%) receiving 3 visits, and 4% were on the highest tertile (200%–700%) receiving 4 to 6 visits. More than 57% of the eligible mothers were in a CLSC with a rate of access to food intervention equal to or above 100%. Those women also had access to the multi-component intervention.

[c] 134 CLSC territories were included.

[d] Value > 1.00.

[e] Value < 1.00.

addition, we observed a strengthening of the association with increasing intensity of the interventions. However, interventions do not counteract all of the effects associated with need; eligible mothers remain at higher odds of SGA than non-eligible mothers. Nevertheless, the interventions have some effect: areas that provide high-intensity intervention (4 to 6 visits from the food supplementation program) reduce the frequency of SGA birth more successfully than those that provide low- or medium-intensity intervention.

Though results from RCTs on the subject were encouraging, experimental studies on dietary changes have numerous limits[12-14] and an observational study provides needed confirmation. Our odds ratio of SGA for high- versus medium- or low-intensity intervention is similar to the pooled relative risk (RR) from RCTs on balanced energy/protein supplementation (6 studies; n = 3396; RR = 0.68; 95% CI: 0.56–0.84).[11]

Our findings on high- versus medium- or low-intensity interventions (OR = 0.86;

TABLE 4
Association of intensity of intervention with SGA births, N = 156 404 births, 2006–2008, Quebec, Canada

Intervention (CLSC level)[a]		Births, n (%)	Proportion of SGA births, %	Association of intensity of intervention	
				Crude OR (95% CI)	Adjusted OR[b] (95% CI)
Non-eligible mother[c]		145 662 (93.1)	8.1	1.00	1.00
Lowest tertile	(1–2 visits)	3611 (2.3)	11.7	1.50 (1.33–1.69)	1.49 (1.32–1.69)
Medium tertile	(3 visits)	4233 (2.7)	11.3	1.44 (1.30–1.60)	1.46 (1.32–1.61)
Highest tertile	(4–6 visits)	2898 (1.9)	10.2	1.29 (1.13–1.46)	1.27 (1.12–1.44)

Abbreviations: CI, confidence interval; CLSC, Centres locaux de services communautaires (local community health centre territory); SGA, small for gestational age.

[a] Number of visits is an area-level measure.

[b] Results account for mother's age, parity, marital status as well as food intervention program coverage (continuous) and mean income in the CLSC.

[c] Mothers with a high school degree are in the "non-eligible" category. They could still have received food intervention if their family income is low.

95% CI: 0.75–0.99) are comparable to those in more controlled studies compiled in a review of experimental and observational studies:[4] associations with low birth-weight were within the acceptable range (0.80–0.90). International meta-analyses of RCTs on the impacts of multi-component intervention among high-risk women indicate similar and non-significant improvement in low birth-weight (11 studies; n = 8681; RR = 0.92, 95% CI: 0.83–1.03).[7]

Strengths and limitations

This study has a number of important strengths. It included the entire population of mothers and single births in Quebec; in other words, all women eligible for the supplementation programs. To the best of our knowledge, this is the first population-based study that statistically tests for differences in benefits according to program eligibility and on the gradient of exposure to intervention. Further, this is the first investigation of prenatal programs that assesses the relevance of accounting for the contextual factors of income, food insecurity, social support, smoking and sedentary behaviour. In addition, the use of external survey data to incorporate such contextual variables has never been done in the field of intervention. Understanding the benefits of exposure to prenatal care programs on SGA births provides unique insights for tailoring further interventions.

Some limitations should be considered when interpreting the results, including three possible ways to misclassify exposure to intervention. First, eligibility status was determined by a proxy, academic qualification because information on income was unavailable. Moreover, all the eligible women did not necessarily use the interventions. However, this bias is likely to have only a small impact on the results since the sensitivity analysis with the narrower definition of eligibility status led to similar associations with SGA.

Second, we assumed that the need for prenatal care and the intensity of use within CLSC territories remained constant over the years. Most women were exposed to the intensity of care we attributed to them, as intensity was averaged for the duration of the study.

Finally, we did not have information about the exposure to intervention of mothers who relocated. These misclassifications contributed to small biases towards the null association. Confounding potentially brought some bias to the association, as individual information such as a mother's chronic disease was not accounted for. If there were more women with a chronic disease eligible for intervention in CLSC territories with high-intensity intervention than in territories with low-intensity intervention, there would be another bias towards the null effect.

Defining what constitutes "high" exposure and whether this level of exposure is sufficient is difficult, and definitions are likely to vary between jurisdictions. Nonetheless, the categories we use in this study are based on a scale that can be used in the absence of knowledge on the subject.[28]

In terms of limitations, associations based on aggregate data (information on intensity of intervention based on data from the CLSCs) are weakened by the potential for ecological fallacy.[22] In addition, it was not possible to compare our results to the occurrence of SGA before the beginning of the intervention in this population.

An alternative explanation of the results could be that the CLSCs that provide high-intensity interventions have similar resources for fewer targeted women. Quality and timing of interventions could thus be maximized and their impact on SGA could be greater.

Conclusion

Significant differences along the gradient of care suggest that strategies that provide pregnant women with high exposure to interventions are effective at reducing the risk of SGA. The results have important implications for continuing existing programs and developing new ones adapted to the different needs of mothers. Numerous other benefits might be identified, as interventions do not result only in increasing weight for gestational age at birth.

Although results are encouraging, further research is needed on other subpopulations that could benefit from interventions. Future studies might benefit from incorporating some measure of the quality of

interventions, use of standard prenatal care and use of additional prenatal support.

Conflict of interest

The authors declare that they have no competing interests.

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Characteristics of e-cigarette users and their perceptions of the benefits, harms and risks of e-cigarette use: survey results from a convenience sample in Ottawa, Canada

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Abstract

Introduction: Although e-cigarette use (''vaping'') is increasing in Canada, few attempts have been made to describe e-cigarette users (''vapers''). In this context, we conducted a study in Ottawa, Canada, to describe e-cigarette users' perceptions of the benefits, harms and risks of e-cigarettes. We also collected information on why, how and where they use e-cigarettes as well as information on side effects.

Methods: A 24-item online survey was administered to individuals who purchased e-cigarettes or e-cigarette-related supplies at one of Ottawa's 17 e-cigarette shops. Descriptive analyses characterized respondents, and logistic regression models were fitted to evaluate the relationship between respondents' characteristics and their perception of e-cigarette harms.

Results: The mean age of the 242 respondents was 38.1 years (range: 16–70 years); 66% were male. Nearly all had smoked 100 or more cigarettes in their lifetime (97.9%). More than 80% indicated that quitting smoking was a very important reason for starting to use e-cigarettes and 60% indicated that they intend to stop using e-cigarettes at some point. About 40% reported experiencing some side effects within 2 hours of using e-cigarettes. Those who did not report experiencing any of the listed side effects had approximately 3.2 times higher odds of perceiving e-cigarettes as harmless than those who reported having side effects (odds ratio = 3.17; 95% confidence interval: 1.75–5.73).

Conclusion: Our findings suggest that most e-cigarette users are using them to reduce or stop smoking cigarettes and perceive them as harmless. Due to our use of convenience sampling, the reader should be cautious in generalizing our findings to all Canadian e-cigarette users.

Keywords: *electronic cigarettes, smoking cessation, nicotine, cigarette smoking, tobacco products, perception*

Highlights

- This study describes e-cigarette users' perceptions of e-cigarettes, and information about users and side effects.
- Nearly all 242 survey respondents (about 98%) had smoked 100 or more cigarettes in their lifetime.
- More than 80% said that quitting smoking altogether or reducing the number of cigarettes they smoked were very important reasons for starting to use e-cigarettes.
- About 40% reported experiencing at least one side effect within 2 hours of using an e-cigarette.
- 60% believed that e-cigarettes are harmless.

Introduction

Electronic cigarettes (''e-cigarettes'') are battery-powered devices that heat a liquid solution into an aerosol mist that users (''vapers'') inhale, allowing them to imitate the act of smoking.[1] The liquid solution (referred to as ''e-liquid'') is typically composed of propylene glycol, glycerin, flavouring and nicotine.[2,3,4] Unlike cigarettes, e-cigarettes do not produce side-stream smoke,[5] and exposure studies suggest that they do not contain the same levels of harmful chemicals that cigarettes do.[2,4,5,6] However, the vapours produced from e-cigarettes may increase concentrations of fine particulate matter in indoor environments to levels that affect health.[7] The short- and long-term health effects for both the e-cigarette user and the bystander are not well understood, and addressing this research gap remains an important priority.[1,2,4,5,8]

The popularity and sale of e-cigarettes has increased dramatically since their introduction to North American markets in 2007.[9,10] There are concerns that never-smokers and youth could be introduced to cigarettes through e-cigarettes and that former smokers could be reintroduced to cigarettes.[1,11] To date, studies indicate that the majority of vapers are current or former cigarette smokers,[12-16] that they use e-cigarettes to

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reduce or eliminate cigarette consumption and that they perceive e-cigarettes as less harmful than cigarettes.[13,16,17] Even though there is evidence that e-cigarettes are effective in reducing or eliminating cigarette consumption, this finding is not consistent.[18,19]

Although e-cigarette awareness and use are increasing in Canada, there have been few attempts to describe e-cigarette users.[9,12,20,21] An online survey of 1188 young adults found that 43% were aware of e-cigarettes and 5.7% were current e-cigarette users.[12] This same study also revealed that 80% of current cigarette smokers reported an interest in trying e-cigarettes to help them quit smoking or to use in places where smoking is banned.[12] The 2013 *Canadian Tobacco, Alcohol and Drugs Survey* found that 8.5% of Canadians aged 15 years and older had tried an e-cigarette,[21] but Canadian data on why, where and how e-cigarettes are being used as well as the perceptions of e-cigarette users are limited.

The increase in use and awareness of e-cigarettes coupled with the lack of Canadian data on e-cigarette users underscores the need to better describe users. (At the time of our survey data on e-cigarette users in Ottawa were not available.) Having local data is important given the role of local jurisdictions in implementing policies on smoking and e-cigarette use.

In this study, we aim to describe the reasons for e-cigarette use, how and where they are used, and the perceptions of the benefits, harms and risks of e-cigarettes in a sample of Ottawa-area e-cigarette users. As vapers' perceptions of the harm caused by e-cigarettes may influence how much they use them and whether they use them around others, this study also evaluates to what extent characteristics of e-cigarette users varied by the perception that e-cigarettes are harmless.

Methods

We used a 24-item online survey (available from the authors on request) to collect information on e-cigarette users: who is using them; how, why and where they use them; and their perceptions of the benefits, harms and risks of e-cigarette use. Individuals who made a purchase at any one of Ottawa's 17 e-cigarette shops were eligible to participate. Recruiting respondents through Ottawa-area e-cigarette shops was the most feasible way to efficiently reach our target population: Ottawa-area residents who use e-cigarettes.

Respondents were recruited between 8 January and 2 March 2015 in two ways. First, 2364 business-card-like fliers containing a link to the online survey were distributed to those making purchase(s) in Ottawa-area e-cigarette shops. Second, these e-cigarette shops posted the survey link on their company Facebook webpages. Respondents were not required to disclose their coordinates, and IP addresses were not collected. Respondents who chose to provide their email address were entered into a draw for one of four $25.00 Tim Hortons gift cards.

This study received ethics approval from Carleton University Research Ethics Board.

Measures

The four-part survey was administered using Qualtrics survey software (http://www.qualtrics.com/research-suite).[22] The sociodemographic section asked respondents their age, sex, marital status, visible minority status, employment status, education attainment and household income.

The lifestyle section asked participants if they had smoked 100 or more cigarettes in their lifetime, years and number of cigarettes smoked (while a smoker), perceived general health, and frequency of alcohol consumption and exercise. The survey did not assess current cigarette smoking status. Many of the sociodemographic and lifestyle questions were adapted from the 2012 Canadian Community Health Survey.[23]

The e-cigarette use section asked how respondents first heard about e-cigarettes, when they started using them, how long they use their e-cigarettes in a single ''sitting,'' nicotine and e-liquid use, side effects, and type of e-cigarette used (open ended), if they hope to stop e-cigarette use at some point, graded reasons for starting to use e-cigarettes, and how often they use their e-cigarettes in particular places.

Perceptions of e-cigarette benefits, harms and risks were measured by having respondents indicate a level of agreement from 1 to 5, where 1 represented strong disagreement and 5 strong agreement, with eight statements such as ''E-cigarettes improved my health'' (benefit); ''E-cigarettes are harmless'' (harm); and ''It is okay to use e-cigarettes around non-smoking family/friends'' (risk).

Variables

Respondents were asked how many cigarettes they smoked per day while a smoker. These responses were categorized into less than or equal to 20, 21 to 40, and 41 or more. Based on a regular-sized cigarette pack containing 20 cigarettes, 41 or more cigarettes represented smoking more than 2 packs per day. Pack-years were calculated by taking the total number of cigarettes smoked per day while a smoker, dividing this number by 20 and then multiplying by years smoked. Respondents who reported smoking 20 or fewer cigarettes per day while a smoker were classified as ''light'' while those who smoked over 21 cigarettes per day were classified as ''heavy.'' Lifestyle characteristics and variables relating to e-cigarette use are shown for the total sample and stratified by whether the respondent was/is a light or heavy cigarette smoker. To ensure a sufficient number of responses in each category, the variables perceived general health, frequency of alcohol consumption and exercise were each collapsed into three levels.

To measure frequency of e-cigarette use, respondents were asked: ''On average how long does a bottle of e-liquid last?'' and ''What is the size of the bottle (in ml)?'' They were assigned a value for average daily e-liquid use by dividing the size of the bottle by the number of days taken to finish it.

Respondents were asked if they had experienced any of 14 listed side effects

within 2 hours of using an e-cigarette; the 14 side effects were based on an international survey of e-cigarette users.[16] Respondents were also asked to indicate whether they ''regularly,'' ''sometimes,'' ''rarely'' or ''never'' use e-cigarettes in particular places such as restaurants, and whether particular reasons for e-cigarette use applied to them by choosing from among ''very,'' ''somewhat,'' ''a little,'' ''not at all important'' or ''not applicable.''

To investigate whether characteristics varied by e-cigarette harm perceptions, participants' responses to the statement: ''E-cigarettes are harmless'' were assessed. Those who agreed or strongly agreed that e-cigarettes are harmless were labelled ''harmless'' and other responses were labelled ''harmful.'' To ensure a sufficient number of responses in each category, the variables education attainment, household income, perceived general health, frequency of alcohol consumption and exercise, and e-cigarette use at work or school were reduced to three or fewer levels prior to inclusion in the logistic regression.

Statistical analyses

To describe e-cigarette users, we tabulated frequencies, percentages, medians, means and 95% confidence intervals (CI) using SPSS version 22 software (IBM, Chicago, IL, USA).[24] Pearson chi-square tests and their 95% p values were calculated to determine any statistically significant differences between light and heavy smokers (while a smoker) in terms of their lifestyle characteristics, reasons for starting to use e-cigarettes, how they use e-cigarettes and where they use them. We fitted logistic regression models to evaluate the relationship between these characteristics and the perception that e-cigarette are harmless, and estimated odds ratios (OR) and their 95% CIs as well as unadjusted ORs and sex- and age-adjusted ORs.

Results

Of the 383 individuals who responded to the invitation to be surveyed, 141 answered ''no'' to the question asking if they had made a purchase at a local (Ottawa area) e-cigarette shop and were excluded from the analysis.

Of the 242 respondents, almost twice as many males (n = 159) as females (n = 83) completed the online survey. The mean age was 38.1 (range: 16–70 years) years. Over half were married/common law (56.9%); the majority were not visible minorities (89.0%); and two-thirds had completed post-secondary education (66.5%) (Table 1).

Almost all survey respondents had smoked 100 or more cigarettes in their lifetime (97.9%) (Table 1). The mean number of years smoking cigarettes was 20.2 (range: 2–50 years); the mean number of cigarettes smoked per day while a smoker was 21 (range: 1–75 cigarettes); and the mean number of pack-years was 23.9 (range: 0.20–122.85 pack-years).

More light smokers than heavy smokers experienced one or more side effects within 2 hours of using an e-cigarette (48.0% vs. 35.0%, $p = .05$) (Table 2). Conversely, more heavy smokers drank alcoholic beverages rarely (a few times a year) or never (44.7% vs. 28.1% for light smokers, $p = .02$). More light smokers first found out about e-cigarettes via the Internet (18.8% vs. 7.8%, $p = .02$), while more heavy smokers first learned about e-cigarettes from an advertisement/other media (15.5% vs. 5.5%, $p = .02$)

The most important reasons for starting to use e-cigarettes were to quit smoking and reduce the number of cigarettes smoked. Respondents most commonly used e-cigarettes in their homes, and 63.8% indicated that they regularly or sometimes use their e-cigarettes at work or school (Table 2).

Almost all the respondents (96.6%) used nicotine in their e-cigarettes (Table 2). More than half did not report any of the listed side effects (58.5%). Side effects included a sore/dry mouth or throat (n = 71), a cough (n = 33), a headache (n = 23), and dizziness (n = 17) (data not shown). The less commonly reported side effects included sleeplessness (n = 10), mouth/tongue sores (n = 7), fatigue (n = 5), heart palpitations (n = 4), allergies (n = 4), chest pain (n = 3), breathing difficulties (n = 3), nose bleeding (n = 2), gum bleeding (n = 2) and stress (n = 1) (data not shown).

More than half of those surveyed (59.5%) indicated that they hope to stop using e-cigarettes at some point (Table 2).

The median amount of time spent using an e-cigarette in a single sitting was 5 minutes, and the median daily e-liquid use was 2.15 ml (data not shown). This means that it takes participants on average 14 days to finish a standard 30 ml bottle of e-liquid. Although the types of e-cigarette devices used varied substantially, medium-sized devices,''tank'' devices and Joyetech eGo-C devices that use e-liquid cartridges were used most often. Thirty-four respondents reported using a combination of e-cigarette components from different brands.

Three-quarters of respondents strongly agreed that e-cigarettes are an effective way to quit smoking (71.7%) and that e-cigarettes helped improve their health (75.5%); 60.1% agreed or strongly agreed that e-cigarettes are harmless (Table 3; some data not shown). Those who did not report any of the listed side effects had approximately 3 times higher odds of perceiving e-cigarettes as harmless as those who reported one or more side effects (OR = 3.17; 95% CI: 1.75–5.73) (Table 4).

Discussion

Some public health organizations, regulators and researchers have suggested that e-cigarette uptake among never-smokers and current smokers may undermine smoking cessation efforts.[1,11] They take the view that never-smokers who use e-cigarettes could be exposed to health risks they would not have had and that smokers who use e-cigarettes may not be reducing their risks to the extent they believe they have.

Consistent with other surveys, the majority of respondents had smoked cigarettes.[12-16] One recent study that recruited 19 414 respondents through a website

TABLE 1
Sociodemographic characteristics and smoking histories of survey respondents, N = 242, 2015, Ottawa, Canada

Sociodemographic characteristic	Number, n	Percentage, %
Sex		
Male	159	65.7
Female	83	34.3
Age, years		
< 25	40	16.5
25–34	71	29.3
35–44	50	20.7
45–54	47	19.4
≥ 55	34	14.1
Marital status[a]		
Single/never married	70	30.2
Separated/divorced/widowed	30	12.9
Married/common law	132	56.9
Visible minority[b]		
Yes	24	11.0
No	195	89.0
Employed[c]		
Yes	195	83.7
No	38	16.3
Education completed[c]		
< High school	3	1.3
High school	75	32.2
College certificate or university degree	141	60.5
Graduate degree	14	6.0
Household income, $[d]		
< 20,000	23	11.7
20,000–39,999	29	14.8
40,000–59,999	37	18.9
60,000–79,999	40	20.4
80,000–99,999	34	17.3
≥ 100,000	33	16.8
Smoked ≥ 100 cigarettes in lifetime[e]		
Yes	232	97.9
No	5	2.1
Cigarettes per day (while a smoker)[f]		
≤ 20 (1 pack)	128	54.2
21–40 (2 packs)	92	39.0
≥ 41 (≥ 2 packs)	11	4.7
Never smoker	5	2.1

[a] 10 responses missing.

[b] 23 responses missing or "prefer not to say."

[c] 9 responses missing.

[d] 46 responses missing or "prefer not to say."

[e] 5 responses missing.

[f] 6 responses missing.

emphasizing e-cigarette research found that 99.5% were current or former smokers.[16] Our study found that 97.9% of those surveyed were current or former smokers on the basis that they had smoked 100 or more cigarettes in their lifetime. However, our survey did not ascertain whether cigarette use occurred prior to initiating e-cigarette use or if it continued during e-cigarette use.

As e-cigarettes can be made up of several components, the brands, types and ways to modify them can vary substantially.[4] The availability of the numerous brands and modifications made it difficult to classify the type of e-cigarette devices the respondents used most often. Nevertheless, the device our study respondents reported using most often was the Joyetech eGo-C, the same as Dawkins et al.[13] found. In addition to the different types of devices and modifications, few regulations govern e-cigarette manufacturing which could result in quality control issues.[2] The variation observed in our smaller localized sample implies a larger potential variation among e-cigarette devices in general. This variation can make it difficult to draw conclusions about the safety of e-cigarette devices.[25]

Products that deliver nicotine are regulated under the *Food and Drugs Act* and require Health Canada's authorization prior to being advertised or sold.[26] Even though e-cigarette devices that deliver nicotine have not been approved in Canada, we found that 96.6% of survey respondents used an e-liquid that contained nicotine. While our results come from a convenience sample, larger studies found that 96% and higher proportions of their participants use an e-liquid with nicotine.[13,16] Recruiting respondents through local e-cigarette shops that, to our knowledge, do not sell disposable e-cigarettes may have influenced our result.

Our survey only captured information on current nicotine use. It is possible that people who vape to reduce or quit smoking also reduce or stop using nicotine in their e-cigarettes over time.

It has been noted that the labelled nicotine content is not always an accurate

TABLE 2
Lifestyle characteristics and e-cigarette use of survey respondents by light[a] and heavy[b] smoking status (while a smoker), N = 242[c], 2015, Ottawa, Canada

Characteristic	Total (n = 242)		Light[a] (n = 128)		Heavy[b] (n = 103)		*p* value
	n/N	%	n/N	%	n/N	%	
Perceived general health							
Fair/poor	30/237	12.7	14/128	10.9	16/103	15.5	.55
Good	98/237	41.4	55/128	43.0	40/103	38.9	
Excellent/very good	109/237	46.0	59/128	46.1	47/103	45.6	
Frequency of alcohol consumption							
≥ 2 times per week	72/237	30.4	45/128	35.2	24/103	23.3	.02
≤ 1 per week	82/237	34.6	47/128	36.7	33/103	32.0	
A few times a year or never	83/237	35.0	36/128	28.1	46/103	44.7	
Frequency of exercise							
< 1 per week	66/237	27.8	35/128	27.4	29/103	28.2	.44
1–3 times per week	109/237	46.0	63/128	49.2	43/103	41.7	
≥ 4 times per week	62/237	26.2	30/128	23.4	31/103	30.1	
First heard about e-cigarettes from[d]							
Family	124/242	51.2	20/128	15.6	19/103	18.5	.02
Friend/co-worker	40/242	16.5	66/128	51.6	54/103	52.4	
Advertisement or media	25/242	10.3	7/128	5.5	16/103	15.5	
Internet/Internet search	35/242	14.5	24/128	18.8	8/103	7.8	
Other[e]	18/242	7.5	11/128	8.6	6/103	5.8	
Year started e-cigarette use							
2014 or 2015	130/237	54.8	68/125	54.4	58/102	56.9	.61
2013	62/237	26.2	35/125	28.0	23/102	22.5	
2012 or earlier	45/237	19.0	22/125	17.6	21/102	20.6	
Nicotine content, mg/ml							
0	8/238	3.4	4/128	3.1	2/102	2.0	.20
1–6	93/238	39.1	56/128	43.8	33/102	32.3	
7–12	66/238	27.7	29/128	22.7	36/102	35.3	
13–18	56/238	23.5	30/128	23.4	26/102	25.5	
19–24	15/238	6.3	9/128	7.0	5/102	4.9	
Side effects							
Yes	100/241	41.5	61/127	48.0	36/103	35.0	.05
No	141/241	58.5	66/127	52.0	67/103	65.0	
Hope to stop e-cigarette use							
Yes	141/237	59.5	78/128	60.9	59/102	57.8	.64
No	96/237	40.5	50/128	39.1	43/102	42.2	
Very important reasons for starting use							
Quit smoking	190/233	81.5	101/124	81.5	82/100	82.0	.92
Reduce number of cigarettes	189/216	86.3	98/111	88.3	85/97	87.6	.88
Reduce family/friends exposure to cigarettes	133/209	63.6	66/110	60.0	62/91	68.1	.23
Save money	123/219	56.2	70/121	57.9	51/95	53.7	.54
Enjoy choice of flavours	86/219	39.3	48/119	40.3	34/90	37.8	.71
Encouragement from spouse/friend	57/182	31.3	33/96	34.4	22/80	27.5	.33
Avoid smoking bans in public places	40/214	18.7	23/117	19.7	16/89	18.0	.76
Regularly or sometimes use e-cigarette							
Inside my home	227/237	95.8	124/127	97.6	97/103	94.2	.18
Outside	221/235	94.0	118/127	92.9	97/102	95.1	.49

Continued on the following page

TABLE 2 (continued)
Lifestyle characteristics and e-cigarette use of survey respondents by light[a] and heavy[b] smoking status (while a smoker), N = 242[c], 2015, Ottawa, Canada

Characteristic	Total (n = 242)		Light[a] (n = 128)		Heavy[b] (n = 103)		*p* value
	n/N	%	n/N	%	n/N	%	
Inside friend's homes	160/235	68.1	84/125	67.2	73/103	70.9	.55
Inside family's homes	150/234	64.1	77/126	61.1	70/101	69.3	.20
Work or school	146/229	63.8	79/124	63.7	65/99	65.7	.76
Bars/pubs/clubs	71/233	30.5	38/126	30.2	31/100	31.0	.89
Restaurants	42/235	17.9	20/126	15.9	20/102	19.6	.46
Public transportation	34/233	14.6	21/126	16.7	12/100	12.0	.32

[a] Respondents who reported smoking ≤ 20 cigarettes per day (while a smoker) were considered "light" smokers.

[b] Respondents who reported smoking ≥ 21 cigarettes per day (while a smoker) were considered "heavy" smokers.

[c] There were 11 missing or non-smokers for the question about number of cigarettes smoked per day (while a smoker).

[d] The denominator (N) for each of the variables excludes missing and not applicable responses.

[e] The category "Other" includes medical doctor, which had 3 responses each from light and heavy smokers (while a smoker).

reflection of the actual nicotine content of e-fluids.[2,4] Fieldwork in the e-cigarette retail space could provide important information on the extent to which e-liquid containing nicotine is available for sale.

Compared to a United States study of daily e-cigarette users where 71% vaped at work, 43% in bars or cafés and 15% on public transportation,[14] about 64% of our survey respondents reported regularly or sometimes using their e-cigarettes at work or school and 15% on public transit. The *Making Healthier Choices Act, 2015*, which received Royal Assent on 28 May, 2015, will regulate many aspects of e-cigarette use in Ontario, including where they can be used.[27] Our survey showed that e-cigarette use occurs in places where cigarette smoking is currently banned, potentially exposing bystanders to second-hand e-cigarette vapours. The regulations on use in public spaces defined in the *Electronic Cigarettes Act, 2015* have not yet come into force, but e-cigarette use in public spaces could change with the introduction and enforcement of those regulations. In the absence of those regulations, it is possible that organizations self-regulate e-cigarette use; however, we are unsure to what extent self-regulation is practiced, followed and enforced.

The side effects most commonly reported by those surveyed (e.g. sore/dry mouth or throat and cough) are often reported in the literature.[14,17,28,29] This finding is not surprising as aerosol propylene glycol and glycerin, the primary ingredients of e-liquid, are associated with mouth and throat irritation. It is possible that these side effects would eventually diminish (half the participants had been using e-cigarettes for at most 14 months at the time of the survey).[16,29] Some respondents reported potentially more serious health effects—4 noted heart palpitations and 3 reported chest pain. In a summary of adverse events potentially related to e-cigarettes, Chen[28] noted that chest pain and rapid heartbeat have been reported to the Food and Drug Administration.

Several studies reported that users generally do not perceive e-cigarettes as entirely harmless but as less harmful than cigarettes.[14,16,17] Over half of our sample (60.1%) perceived e-cigarettes as harmless, with female respondents more likely to do so (data not shown). Not surprisingly, those who reported none of the 14 listed side effects were more likely to perceive e-cigarettes as harmless

TABLE 3
Survey participants' perceptions of the benefits, harms and risks of e-cigarettes, n = 233,[a] 2015, Ottawa, Canada[28]

Perception statement	Mean (95% CI)[b]	Strongly agree, n (%)
E-cigarettes helped improve my health	4.58 (4.46–4.69)	176 (75.5)
E-cigarettes are an effective way to quit smoking	4.55 (4.43–4.66)	167 (71.7)
My family/friends are supportive of me using e-cigarettes	4.33 (4.20–4.46)	140 (60.1)
It is okay to use e-cigarettes around non-smoking family/friends[c]	3.74 (3.59–3.88)	70 (30.2)
E-cigarettes are harmless	3.67 (3.53–3.81)	56 (24.0)
It is okay to use e-cigarettes around children	2.86 (2.68–3.03)	38 (16.3)
E-cigarettes should have the same restrictions on them that tobacco cigarettes do	1.65 (1.50–1.81)	17 (7.3)
E-cigarettes are as harmful as tobacco cigarettes	1.19 (1.10–1.28)	4 (1.7)

Abbreviation: CI, confidence interval.

[a] n = 233 respondents answered the perceptions questions at the end of the survey.

[b] Mean perception on a scale of 1 to 5, where 1 represents strong disagreement and 5 represents strong agreement.

[c] 1 response missing for this variable.

TABLE 4
Odds ratios for select characteristics of those survey participants who perceived e-cigarettes as harmless, n = 233, 2015, Ottawa, Canada

Characteristics	Respondents who perceived e-cigarettes as		OR	95% CI	AOR[b]	95% CI
	Harmless[a] n = 140 n (%)	Harmful[a] n = 93 n (%)				
Sex						
Male	85 (60.7)	68 (73.1)	1.00	—	1.00	—
Female	55 (39.3)	25 (26.9)	1.76	1.0–3.11	1.61	0.88–2.95
Age, years						
< 25	28 (70.0)	12 (30.0)	1.00	—	1.00	—
25–34	30 (42.3)	41 (57.7)	0.31	0.14–0.72	0.31	0.14–0.72
35–44	29 (61.7)	18 (38.3)	0.69	0.28–1.69	0.68	0.28–1.68
45–54	30 (69.8)	13 (30.2)	0.99	0.39–2.52	0.99	0.39–2.54
≥ 55	23 (71.9)	9 (28.1)	1.10	0.39–3.05	0.93	0.32–2.65
Marital status[c]						
Single/never married	43 (61.4)	27 (38.6)	1.00	—	1.00	—
Separated/divorced/widowed	15 (50.0)	15 (50.0)	0.63	0.27–1.49	0.25	0.08–0.76
Married/common law	81 (61.4)	51 (38.6)	1.00	0.55–1.81	0.85	0.42–1.74
Employed						
Yes	118 (84.3)	77 (82.8)	1.00	—	1.00	—
No	22 (15.7)	16 (17.2)	0.90	0.44–1.82	0.61	0.28–1.31
Education attainment						
Less than post-secondary	45 (32.1)	33 (35.5)	1.00	—	1.00	—
Post-secondary	95 (67.9)	60 (64.5)	1.16	0.67–2.02	1.28	0.71–2.29
Household income, $[d]						
< 40,000	31 (27.0)	21 (25.9)	1.00	—	1.00	—
40,000–79,999	46 (40.0)	31 (38.3)	1.01	0.49–2.06	1.66	0.73–3.79
≥ 80,000	38 (33.0)	29 (35.8)	0.89	0.43–1.85	1.36	0.58–3.21
Perceived general health						
Fair/poor	14 (10.0)	15 (16.1)	1.00	—	1.00	—
Good	55 (39.3)	41 (44.1)	1.44	0.63–3.31	1.59	0.66–3.85
Excellent/very good	71 (50.7)	37 (39.8)	2.06	0.90–4.70	2.11	0.88–5.05
Frequency of alcohol consumption						
≥ 2 times per week	41 (29.3)	28 (30.1)	1.00	—	1.00	—
≤ 1 times per week	47 (33.6)	34 (36.6)	0.94	0.49–1.81	1.03	0.52–2.03
A few times a year or never	52 (37.1)	31 (33.3)	1.15	0.60–2.21	1.08	0.54–2.17
Frequency of exercise (times per week)						
< 1	39 (60.0)	26 (40.0)	1.00	—	1.00	—
1–3	65 (59.6)	44 (40.4)	0.99	0.53–1.84	1.17	0.60–2.25
≥ 4	36 (61.0)	23 (39.0)	1.04	0.51–2.15	1.14	0.53–2.41
Side effects[c]						
Yes	94 (67.6)	39 (41.9)	1.00	—	1.00	—
No	45 (32.4)	54 (58.1)	2.89	1.68–4.98	3.17	1.75–5.73
Regular use at work or school[e]						
Yes	55 (40.1)	37 (42.0)	1.00	—	1.00	—
No	82 (59.9)	51 (58.0)	0.93	0.54–1.59	0.79	0.44–1.41
Hope to stop e-cigarette use[c]						
Yes	70 (51.1)	67 (48.9)	1.00	—	1.00	—
No	70 (73.7)	25 (26.3)	2.68	1.52–4.72	2.82	1.55–5.12

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio.

[a] Respondents who "agreed" or "strongly agreed" that e-cigarettes are harmless were classified as "harmless" and other responses were classified as "harmful."

[b] Age- and sex-adjusted odds ratios.

[c] 1 response missing.

[d] 37 responses missing or "prefer not to say."

[e] 8 responses missing.

(Table 4). Perceiving e-cigarettes as harmless may play a role in whether individuals use e-cigarettes and the extent to which they use e-cigarettes around others.

Strengths and limitations

This study contributes to the limited literature on e-cigarette user characteristics by providing detailed information on how and where e-cigarettes are used and perceptions of e-cigarette users. This survey provides some insights that, alongside other studies, can inform future research directions and priorities for policy makers. It can also be used to inform future survey work involving e-cigarette users.

Our ability to generalize the characteristics and perceptions of survey respondents is limited due to our relatively small sample size (n = 242). It is possible that the characteristics of individuals who purchased e-cigarettes in a shop in Ottawa differ from those who purchase e-cigarettes elsewhere (e.g. gas stations, online, etc.) and from those e-cigarette users residing in different regions. Our use of convenience sampling limits the generalizability of the findings to Canadian e-cigarette users; therefore the findings should be interpreted with caution.

Respondent bias may be present as those who have more positive perceptions of e-cigarettes may have been more motivated to complete a survey emphasizing e-cigarettes than those with less favourable perceptions. As the survey was delivered in the first two months of the year, it may have captured a disproportionate number of those who had resolved to quit smoking in the New Year. In addition, the survey was administered in English, which may mean that those whose dominant language is not English are less well represented, and required an Internet connection to participate (although this was likely not a substantial barrier).

Although the survey collected information on respondents' smoking histories, it did not capture current smoking status, and so we did not assess the dual (concurrent) use of e-cigarettes and cigarettes.

Conclusions

Despite these limitations, this survey provided several insights into the vaping population in the Ottawa area. We found that the majority of respondents within this convenience sample of e-cigarette users had a history of smoking, used e-liquid containing nicotine in their e-cigarettes, and had favourable perceptions of e-cigarettes. Reducing or eliminating cigarette consumption were considered very important reasons to start using e-cigarettes, and more than half of respondents indicated that they hope to stop using e-cigarettes at some point. Additional surveys are needed to characterize the profile of e-cigarette users in other Canadian regions and across sociodemographic and cultural factors. We hope that our findings can help inform future surveys on e-cigarette use and assist policy makers in developing priorities for further exploration.

Acknowledgements

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Erratum

This erratum is being published to correct two errors that appeared in the following article:

Crain J, McFaull S, Thompson W, et al. Status Report – The Canadian Hospitals Injury Reporting and Preventive Program: a dynamic and innovative injury surveillance system. Health Promot Chronic Dis Prev Can. 2016;36(6):112-7.

- The affiliation of author S. Mukhi should read Winnipeg, Manitoba.

Before correction
2 Canadian Network for Public Health Intelligence, Public Health Agency of Canada, Ottawa, Ontario, Canada

After correction
2 Canadian Network for Public Health Intelligence, Public Health Agency of Canada, Winnipeg, Manitoba, Canada

- In the Limitations section, the Children's Hospital of Eastern Ontario is missing a word.

Before correction
Like all injury surveillance systems, the CHIRPP is not without limitations. As the program comprises a sample of Canada's hospital EDs, the data should not be used to draw conclusions about injury patterns across the entire Canadian population. However, some studies, have shown CHIRPP data to be representative of the profile of injuries in sports and recreation in Calgary, compared to regional health administrative data;[34,35] injury cases at Montreal Children's Hospital that did not require admission, did not present to the ED overnight, or were not poisonings;[21] and children with severe injuries and younger children presenting at the Children's Hospital of Ontario.[36]

After correction
Like all injury surveillance systems, the CHIRPP is not without limitations. As the program comprises a sample of Canada's hospital EDs, the data should not be used to draw conclusions about injury patterns across the entire Canadian population. However, some studies, have shown CHIRPP data to be representative of the profile of injuries in sports and recreation in Calgary, compared to regional health administrative data;[34,35] injury cases at Montreal Children's Hospital that did not require admission, did not present to the ED overnight, or were not poisonings;[21] and children with severe injuries and younger children presenting at the Children's Hospital of Eastern Ontario.[36]

Other PHAC publications

Researchers from the Public Health Agency of Canada also contribute to work published in other journals. Look for the following articles published in 2015 and 2016:

Gilbert NL, Gilmour H, Dubé È, Wilson SE, **Laroche J**. Estimates and determinants of HPV non-vaccination and vaccine refusal in girls 12 to 14 y of age in Canada: results from the Childhood National Immunization Coverage Survey, 2013. Hum Vaccin Immunother. 2016:1-7. [Epub ahead of print]

Jefferies AL, Lacaze-Masmonteil T, Newhook LA, […] **León JA**, et al. Retinopathy of prematurity: an update on screening and management. Paediatr Child Health. 2016;21(2):101-8.

Maar M, Wakewich P, Wood B, **Severini A**, et al. Strategies for increasing cervical cancer screening amongst First Nations communities in northwest Ontario, Canada. Health Care Woman Int. 2016;37(4):478-95. doi: 10.1080/07399332.2014.959168.

McKelvie RS, Heckman GA, Blais C, […] **Dai S**, et al. Canadian Cardiovascular Society quality indicators for heart failure. Can J Cardiol. 2015. doi: 10.1016/j.cjca.2015.12.027.

Toor J, **Crain J**, Kelly C, Verchere C, Fish J. Pediatric burns from glass-fronted fireplaces in Canada: a growing issue over the past 20 years. J Burn Care Res. 2016. [Epub ahead of print]

Wen SW, Guo Y, Rodger M, White RR, **Yang Q**, et al. Folic acid supplementation in pregnancy and the risk of pre-eclampsia—A cohort study. PLoS ONE. 2016;11(2):e0149818. doi: 10.1371/journal.pone.0149818.