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Article *in* Drug and alcohol dependence · August 2012

DOI: 10.1016/j.drugalcdep.2012.08.008 · Source: PubMed

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Short communication

Epidemiology of adolescent *Salvia divinorum* use in Canada

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ARTICLE INFO

Article history:
Received 26 May 2012
Received in revised form 5 August 2012
Accepted 6 August 2012
Available online 8 September 2012

Keywords:
Salvia divinorum
Hallucinogen
Adolescent
Prevalence
Correlates
Canada

ABSTRACT

Background: Salvia divinorum is a potent, naturally occurring hallucinogen gaining popularity as a recreational drug in North America. To date, detailed epidemiologic information about the use of this substance among adolescents living outside the United States has been limited. This study provides information on the prevalence and correlates of *Salvia divinorum* use among adolesecents in Canada using a nationally representative sample.
Methods: Data were obtained from a representative sample of 42,179 Canadian adolescents aged 12–17 years living across all 10 provinces who completed the Youth Smoking Survey in 2008–09.
Results: Overall, 3.8% of adolescents reported using *Salvia* in the past year and 6.2% had used the substance in their lifetime. A conservative estimate suggests 23.2% of youth were repeat users. *Salvia* use was highest among youth in British Columbia and Quebec. Comparatively, the prevalence of 12-month *Salvia* use was higher than 12-month cocaine and amphetamine use but lower than 12-month ecstasy, cannabis, and other hallucinogen use. Correlates of *Salvia* use included older age, male gender, high available spending money, binge drinking, illicit drug use and smoking in fully adjusted models. Findings suggest low self-esteem may be an important correlate specific to the use of this substance among youth.
Conclusions: Salvia divinorum use is prevalent among Canadian adolescents. *Salvia* may be a significant public health issue in Canada given it is readily available, under limited regulation, and little is known about the abuse liability of the substance, interactions with other substances, and potential complications from use.

1. Introduction

Salvia divinorum is a potent naturally occurring hallucinogen gaining popularity as a recreational drug in North America. This species of sage was traditionally used in Mexican shamanistic ceremonies for its potent visionary effects (Babu et al., 2008). The active component of the plant, salvinorin A, is pharmacologically distinct from other hallucinogenics, with effects mediated by the kappa opioid (KOP) receptor in the spinal cord and brain rather than serotonin 2-A receptors (Roth et al., 2002; Cunningham et al., 2011).

Salvinorin A is absorbed through the buccal mucosa quickly, with effects occurring in seconds or minutes and persisting up to 1 h (Roth et al., 2002). Salvinorin A has pharmacological activity consistent with other KOP agonists including aversion, inhibition of GI transit and depressant effects; sweating, tachycardia, and nausea have also been reported, among other symptoms (González et al., 2006; Vohra et al., 2011). Although extended psychotic-type reactions are uncommon they are not unknown, with several reported in published case studies (Singh, 2007; Przekop and Lee, 2009; Breton et al., 2010).

Dose-response relationships have not been established as laboratories are seldom equipped to detect Salvinorin A and historical accounts are often unreliable due to the distribution of *Salvia* in concentrations (5×, 10×, 50×) subjectively determined by manufacturers without listed milligramme equivilants (Vohra et al., 2011).

Products containing *S. divinorum* or salvinorin A meet the definition of natural health products in Canada, are not licenced for sale, and subject to enforcement under the Food and Drugs Act (Health Canada, 2011a). Similar to governments in other countries, Health Canada (2011b) has announced intentions to move *Salvia* and salvinorin A to a category of the Controlled Drugs and Substances Act to protect the health and safety of Canadians. Currently Health Canada recommends products containing *Salvia* or its active ingredient Salvinorin A be avoided as little is known about the damage these substances may cause the body, including the brain (Health Canada, 2011a).

The recreational abuse liabilities of *Salvia* are unknown. Theoretically, they may be limited given KOP receptor agonists generally produce dysphoria rather than the euphora often produced by μ-opioid receptor agonists (Cunningham et al., 2011). However, research suggests that about half all youth who try *Salvia* plan to continue use (Albertson and Grubbs, 2009). Ease of access to *Salvia* through shops that sell drug use paraphernalia (i.e., head shops)

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http://dx.doi.org/10.1016/j.drugalcdep.2012.08.008

and via the Internet increase the likelihood for experimention and ongoing use. In the US, less than 1% of youth aged 12–17 report past year *Salvia* use, while 1.7% report lifetime use (Ford et al., 2011; Wu et al., 2011). There is little published information on the use of *Salvia* by youth outside the US. The purpose of this paper is to provide information on the prevalence and correlates of *Salvia* use among Canadians aged 12–17 using nationally representative data.

2. Methods

2.1. Study design and sample

Cross sectional data were obtained for a representative sample of 42,179 adolescents aged 12–17 who responded to the 2008–09 *Youth Smoking Survey* (YSS). The target population were youth attending public and private schools across Canada's 10 provinces. Youth residing in the Yukon Territory, Nunavut and the Northwest Territories, in Aboriginal communities, and or within institutions were excluded. Ethics approval was obtained from the University of Waterloo Human Research Ethics Committee and from local institutional review boards as required. Parental and student permission was obtained from all youth selected to participate. The response rate was 73%, 59%, and 84% at the student, school, and school board level, respectively. A stratified sampling design was used to select a representative sample of youth in each province. Students completed the questionniare by hand within each school. A full description of the survey design, data collection, and weighting is available elsewhere (University of Waterloo, 2009a).

2.2. Measures

Youth were asked if they had ever used or tried *Salvia* (Divine Sage, Magic Mint, Sally D) to get high in their lifetime. Respondents who endorsed *Salvia* use were asked at what age, and if they had "used or tried this in the last 12 months" (yes or no). Data were also collected on sociodemographic characteristics, involvement in other forms of substance use, self-esteem and bond to school. Internal consistency of the composite measures used to examine self-esteem ($\alpha = 0.70$) and bond to school ($\alpha = 0.80$) were acceptable. A detailed description of the measures used and how they were selected is available elsewhere (University of Waterloo, 2009a,b).

2.3. Statistical analysis

To reduce measurement error, youth who endorsed use of all 6 illicit drugs examined in the study as well as a fictitious drug included to identify those who may be exaggerating their drug use were removed from the analysis ($n = 199$ unweighted cases). Logistic regression analyses were used to explore potential correlates of lifetime *Salvia* use; adjusted odds ratios and 95% confidence intervals drawn from these analyses are reported. Bond to school and self-esteem scores were categorized into terciles and two groups were created (low and average to high scores) to determine whether low scores were associated with *Salvia* use. Approximately 9.5% and 0.6% of youth did not respond to the question when asked about lifetime and 12-month *Salvia* use, respectively. Missing data was handled using listwise deletion. All analyses were based on weighted data and run using SPSS 19.0.

3. Results

The prevalence of lifetime and 12-month *Salvia* use among youth was 6.2% and 3.8% respectively. Mean age at first use was 14.6 years. A conservative estimate of the number of youth who were repeat *Salvia* users was derived by subtracting the current age of 12-month *Salvia* users from their age at first use. Those who reported 12-month use and first used the substance two or more years ago were labelled 'repeat users'. Based on this conservative estimate at least 23.2% of youth who engaged in 12-month *Salvia* use were repeat users.

The 12-month use of *Salvia* among adolescents was more prevalent than the 12-month use of cocaine and amphetamines, but less prevalent than the 12-month use of ecstasy, cannabis, and other hallucinogens (Table 1). *Salvia* use was significantly higher among youth who engaged in other forms of substance use. For example, 1 in 4 youth reported 12-month cannabis use, and 23.5% of these individuals also used *Salvia* in that period. After adjustment for sociodemographic variables, the odds of *Salvia* use were elevated among older youth, males, youth in BC and Quebec, Aboriginal youth, and youth with more available spending money (Table 2). After adjustment for other forms of substance use the odds of lifetime *Salvia* use were highest among youth who had used cannabis and other hallucinogens in the past year. However, those who engaged in binge drinking, even infrequently, and smokers were also more likely to report *Salvia* use.

Low bond to school was no longer associated with *Salvia* use after adjustment for other substance use suggesting this relation may have been due to associations between low bond to school and other substances rather than *Salvia* use per se. In contrast, even in a fully controlled model students with low self-esteem were 16% more likely to engage in *Salvia* use than students with average to high self-esteem, suggesting this may be an important psychological correlate for the use of this novel substance.

4. Discussion

Nationally, it is estimated that 3.8% of youth in Canada had used *Salvia* in the past year, and 6.2% had used the substance in their lifetime in 2008–09. A conservative estimate suggests 23.2% are repeat users. Comparatively, less than 1% of same-aged American youth reported *Salvia* use in the past year, and 1.7% used the substance in their lifetime in 2008–09 (Ford et al., 2011; Wu et al., 2011). These findings suggest *Salvia* use may be more prevalent among youth in Canada. However, the role measurement differences may play in these findings cannot be ruled out. The survey used to derive US national estimates measured *Salvia* use as follows: 'Have you ever, even once, used *Salvia divinorum*?' In contrast *Salvia* use in Canada was assessed by providing non-medical synonyms for the substance and explicitly asking about use 'to get high'. Follow up studies are needed to determine if US and Canadian samples exhibit similar patterns using a standard measure.

That said, cannabis use is more prevalent among adolescents in Canada than other EOCD countries including the US (UNICEF, 2007). Given *Salvia* is often available at head shops in both countries (Health Canada, 2011a; Griffin et al., 2008), it may be that Canadian youth are more likely to come into contact with *Salvia* due to their increased involvement with cannabis. Indeed, the present findings indicate the odds of lifetime *Salvia* use was more than 50 times greater among monthly cannabis users, as compared to Canadian youth who did not use cannabis. Given it is currently illegal to sell *Salvia* under the Food and Drugs Act in Canada, increased monitoring of stores that may continue to sell *Salvia* despite this ban may be an important preventive strategy.

Consistent with US findings, *Salvia* use was elevated among older male youth, those with more available spending money, and those who engaged in other forms of substance use (Ford et al., 2011; Perron et al., 2012; Wu et al., 2011). In Canada, the prevalence of adolescent *Salvia* use was highest in BC and Quebec after adjustment for sociodemographic covariates. When other forms of substance use were controlled in statistical models the odds of *Salvia* use remained elevated in Quebec, but were no longer higher in BC relative to other parts of the country. Similarly, Aboriginal youth were no longer at heightened odds for *Salvia* use once other forms of substance use were statistically controlled. These findings suggest Aboriginal youth and youth in BC may have a higher propensity for substance use behaviour correlated with *Salvia* use, which has been corroborated by other reports (Health Canada, 2010; Elton-Marshall et al., 2011), rather than a specific proclivity for *Salvia* use per se. In contrast, youth in Quebec demonstrated higher odds for *Salvia* use than youth in other provinces after adjustment for general substance use, suggesting that if *Salvia* reduction policies are desired in Canada Quebec may be an important target, while policies that target the reduction of substance use more generally may be more effective for Aboriginal youth and youth in BC.

Other studies have shown that low self-esteem and low bond to school are important predictors of adolescent drug use (Currie and

Table 1
Sample description and prevalence of lifetime and 12-month *Salvia divinorum* use by sample characteristics.

Sociodemographic characteristic	Sample description %	Lifetime *Salvia* use prevalence (95% CI)	12-month *Salvia* use prevalence (95% CI)	Age *Salvia* first used mean (SD)
Total	100	6.16 (6.12–6.19)	3.75 (3.72–3.77)	14.6 (1.6)
Gender				
Male	51.4	8.10 (8.04–8.15)	4.92 (4.88–4.96)	14.6 (1.7)
Female	49.2	4.20 (4.16–4.24)	2.55 (2.52–2.58)	14.7 (1.5)
Age				
12–14	48.6	1.9 (1.88–1.94)	1.21 (1.19–1.23)	12.8 (1.2)
15–17	51.4	9.47 (9.42–9.53)	5.86 (5.82–5.91)	14.6 (1.5)
Region				
Atlantic	7.2	4.35 (4.24–4.45)	2.59 (2.51–2.67)	14.7 (1.7)
Quebec	21.0	7.21 (7.13–7.29)	4.74 (4.68–4.80)	14.4 (1.5)
Ontario	39.1	5.77 (5.72–5.83)	3.41 (3.38–3.45)	14.7 (1.5)
Manitoba	3.9	3.17 (3.04–3.29)	1.76 (1.67–1.85)	14.5 (1.8)
Saskatchewan	3.3	5.35 (5.17–5.52)	3.44 (3.31–3.57)	14.6 (1.6)
Alberta	11.7	3.61 (3.53–3.68)	1.66 (1.61–1.71)	14.7 (1.0)
BC	13.8	9.79 (9.67–9.90)	6.23 (6.15–6.32)	14.7 (1.9)
Aboriginal status				
Non Aboriginal	92.6	5.99 (5.95–6.02)	3.65 (3.63–3.68)	14.7 (1.6)
First Nation	4.1	8.25 (8.05–8.45)	4.19 (4.06–4.33)	13.9 (1.9)
Metis	2.8	9.99 (9.73–10.24)	7.23 (7.02–7.43)	14.8 (1.4)
Inuit	0.4	9.79 (9.08–10.51)	5.12 (4.64–5.60)	13.3 (1.4)
Weekly spending, $				
0	20.5	3.04 (2.98–3.10)	1.69 (1.65–1.73)	14.0 (2.0)
$1–$20	39.8	3.67 (3.63–3.72)	2.29 (2.25–2.32)	14.4 (1.6)
>$20	39.6	10.87 (10.79–10.94)	6.89 (6.84–6.95)	14.8 (1.6)
Self-esteem				
Low	34.0	6.56 (6.50–6.62)	4.26 (4.22–4.31)	14.7 (1.6)
Average	35.2	5.54 (5.49–5.59)	3.37 (3.33–3.41)	14.7 (1.6)
High	30.8	6.43 (6.37–6.49)	3.62 (3.58–3.67)	14.5 (1.7)
Bond to school				
Low	32.0	8.39 (8.32–8.46)	5.09 (5.04–5.15)	14.4 (1.6)
Average	26.9	5.03 (4.98–5.09)	3.25 (3.21–3.30)	15.1 (1.4)
High	41.0	4.75 (4.71–4.80)	2.91 (2.87–2.94)	14.6 (1.7)
Smoking status				
Current	6.9	40.21 (39.96–40.46)	24.8 (24.6–25.0)	
Former	0.9	15.02 (14.51–15.52)	8.41 (8.04–8.79)	
Never smoked	92.2	3.35 (3.33–3.38)	2.08 (2.06–2.10)	
Binge drinking				
≥monthly	44.1	19.98 (19.86–20.09)	13.01 (12.91–13.11)	
<monthly	21.6	7.61 (7.50–7.72)	4.71 (4.62–4.80)	
Never	34.3	1.48 (1.44–1.52)	0.85 (0.82–0.88)	
Cannabis				
≥monthly	17.2	30.76 (30.60–30.91)	20.48 (20.34–20.61)	
<monthly	8.0	6.18 (6.06–6.30)	3.36 (3.28–3.45)	
Never	74.8	0.56 (0.55–0.58)	0.22 (0.21–0.23)	
Other hallucinogens				
Yes	5.3	52.93 (52.64–53.23)	42.88 (42.59–43.17)	
No	94.7	2.88 (2.86–2.90)	1.43 (1.41–1.45)	
MDMA (Ecstasy)				
Yes	4.8	3.40 (3.38–3.43)	38.72 (38.42–39.02)	
No	95.2	40.29 (49.98–50.60)	1.93 (1.91–1.95)	
Cocaine				
Yes	2.1	60.87 (60.42–61.33)	46.42 (45.97–46.87)	
No	97.9	4.55 (4.52–4.58)	2.73 (2.71–2.75)	
Amphetamines				
Yes	2.1	51.88 (51.41–52.34)	40.36 (39.91–40.80)	
No	97.9	4.81 (4.78–4.84)	2.87 (2.85–2.89)	
Inhalants				
Yes	1.7	34.40 (33.91–34.89)	29.42 (28.96–29.88)	
No	98.3	5.41 (5.38–5.45)	3.30 (3.27–3.32)	
Heroin				
Yes	0.7	64.60 (63.83–65.37)	52.15 (51.38–52.93)	
No	99.3	5.49 (5.46–5.52)	3.35 (3.33–3.38)	

Wild, 2012; McNeely et al., 2002; Taylor et al., 2006). The present findings suggest low self-esteem, but not low bond to school, may be an important correlate specific to adolescent *Salvia* use. It may be that adolescents with low self-esteem find it more difficult to reject peer pressure to try this novel substance, given that having *Salvia* using peers is a strong predictor of personal use (Albertson and Grubbs, 2009; Ford et al., 2011; Miller et al., 2011). Further research is needed to shed light on motives for *Salvia* use among adolescents with low self-esteem.

4.1. Limitations

This study used a cross sectional design and self-report measures which may have introduced response bias. Steps were taken to reduce response bias by removing youth who appeared to be exaggerating their drug use from the analysis; however, the extent to which youth may be underreporting *Salvia* use cannot be determined and a sizable number did not respond when asked about lifetime *Salvia* use (9.5%). Data were not collected in

Table 2
Adjusted odds ratios (AOR) of lifetime *Salvia divinorum* use for Canadian adolescents aged 12–17 years by sociodemographic characteristics and other legal and illegal substances ($N = 42,179$).

Characteristic	AOR1[a] (95% CI)	AOR2[b] (95% CI)
Gender		
Male	1.99 (1.96–2.13)	2.17 (2.13–2.22)
Female	1.0 [Reference]	1.0 [Reference]
Age		
12–14	1.0 [Reference]	1.0 [Reference]
15–17	4.18 (4.10–4.26)	1.70 (1.66–1.75)
Region		
Atlantic	0.67 (0.65–0.69)	0.49 (0.47–0.51)
Quebec	1.28 (1.26–1.30)	1.07 (1.04–1.10)
Ontario	1.0 [Reference]	1.0 [Reference]
Manitoba	0.44 (0.42–0.46)	0.42 (0.39–0.46)
Saskatchewan	0.74 (0.71–0.77)	0.55 (0.52–0.58)
Alberta	0.60 (0.58–0.61)	0.80 (0.77–0.83)
BC	1.71 (1.68–1.74)	0.49 (0.48–0.50)
Aboriginal status		
Non Aboriginal	1.0 [Reference]	1.0 [Reference]
First Nation	1.28 (1.24–1.32)	0.46 (0.44–0.49)
Metis	1.79 (1.73–1.85)	0.94 (0.90–0.99)
Inuit	1.36 (1.24–1.49)	0.73 (0.64–0.83)
Weekly spending, $		
0	1.0 [Reference]	1.0 [Reference]
$1–$20	1.29 (1.26–1.32)	1.03 (0.99–1.07)
>$20	2.99 (2.93–3.06)	1.58 (1.53–1.64)
Self-esteem		
Low	1.30 (1.29–1.31)	1.16 (1.15–1.18)
Average or high	1.0 [Reference]	1.0 [Reference]
Bond to school		
Low	1.43 (1.42–1.44)	1.02 (1.00–1.04)
Average or high	1.0 [Reference]	1.0 [Reference]
Smoking status		
Current	13.16 (12.96–13.36)	2.16 (2.11–2.21)
Former	4.31 (4.11–4.52)	1.45 (1.35–1.55)
Never smoked	1.0 [Reference]	1.0 [Reference]
Binge drinking		
More than monthly	13.45 (13.04–13.87)	3.41 (3.26–3.56)
Less than monthly	5.00 (4.82–5.16)	3.64 (3.49–3.79)
Never	1.0 [Reference]	1.0 [Reference]
Cannabis		
More than monthly	53.37 (52.05–54.72)	7.67 (7.43–7.92)
Less than monthly	8.28 (8.02–8.55)	2.71 (2.61–2.81)
Never	1.0 [Reference]	1.0 [Reference]
Other hallucinogens		
Yes	31.62 (31.07–32.18)	4.88 (4.77–4.99)
No	1.0 [Reference]	1.0 [Reference]
Other illicit drug use		
Yes	21.57 (21.22–21.92)	2.78 (2.72–2.84)
No	1.0 [Reference]	1.0 [Reference]

[a] Adjusted for sociodemographic variables (gender, age, province, Aboriginal status, spending money per week).
[b] Adjusted for sociodemographic variables (gender, age, province, Aboriginal status, spending money per week) and smoking, binge drinking, cannabis use, hallucinogen use and other forms of substance use (MDMA, illicit amphetamines, cocaine, heroin, and/or inhalants).

Aboriginal communities or northern Canada and may not represent youth living in these areas. Information about how *Salvia* is procured by adolescents, frequency of use, and other potential correlates of use were not collected and would be useful in future studies.

5. Conclusions

Salvia use is prevalent among Canadian adolescents, particularly those residing in BC and Quebec. *Salvia* may be a significant public health issue in Canada given it is readily available, under limited regulation, and little is known about the abuse liability of the substance, its interactions with other substances, and potential complications from use.

Role of funding source

The 2008–09 Youth Smoking Survey is a product of a pan-Canadian capacity-building project that includes Canadian researchers from all provinces. Production of this paper was made possible through a financial contribution from Health Canada. The views expressed herein do not necessarily represent the views of Health Canada.

Contributors

Dr. Currie was responsible for the manuscript concept and design, literature review, statistical analysis strategy and execution, drafting of the manuscript and manuscript revision.

Conflict of interest

No conflict declared.

Acknowledgements

Dr. Currie was supported by stipend awards from Alberta Innovates: Health Solutions and the Alberta Centre for Child, Family and Community during the course of this research. The author would like to thank the Propel Centre for Population Health Impact for providing support for this project.

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