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## Cannabis use among smokers and non-smokers: Results from the ITC Netherlands Gold Magic Survey

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## Abstract

Objectives: Existing evidence shows that co-occurring use of tobacco and cannabis is widespread. The legal environment around cannabis and tobacco use is also rapidly evolving, within countries and between countries. Patterns of co-use of tobacco and cannabis may change as more jurisdictions legalize medicinal and/or recreational cannabis sales. This study examined co-use of cannabis and tobacco in a context where cannabis use is tolerated.

Setting: 2015 International Tobacco Control (ITC) Netherlands – Gold Magic Survey, conducted between July and August 2015.

Participants: 1,599 participants in (1,003 current smokers, 283 former smokers, and 390 non-smokers).

Results: Past 30-day cannabis use was somewhat higher among current smokers ( $n=57/987=5.8\%$ ) than among former or never smokers ( $n=10/288=3.5\%$  and  $n=6/316=1.9\%$ , respectively). Joints were the most commonly used form of cannabis use for both current cigarette smokers (96.9%) and nonsmokers (76.5%). Among those who smoked cannabis joints, 95% current smokers and 67% of nonsmokers reported that they ‘always’ roll cannabis with tobacco.

Conclusions. Most cannabis use is done via smoking joints most often mixed with tobacco. This behavior may present unique health concerns for non-cigarette smoking cannabis users, as tobacco use could lead to nicotine dependence. Also, many non-cigarette smoking cannabis users appear to be misclassified as to their actual tobacco/nicotine exposure.

### Strengths and limitations of this study

- The study collected data from 1,599 participants, including current cigarette smokers, former cigarette smokers, and never cigarette smokers.
- The inclusion of non-cigarette smokers allowed for a measure of potential misclassification in terms of actual exposure to nicotine and tobacco smoke.
- The data collected did not include an extensive characterization of cannabis use patterns.

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## Introduction

Cannabis is a commonly used drug across the globe. In 2017 The World Health Organization estimated that there were 147 million consumers of cannabis, equivalent to 2.5% of the world's population.<sup>1</sup> The legal environment for use of cannabis, for either medicinal or recreational purposes, is rapidly evolving and in a number of jurisdictions, becoming less restrictive.

The long-term health impacts of chronic cannabis use are unclear.<sup>2</sup> A recent report by the National Academies of Science, Engineering, and Medicine (NASEM) suggests that there is substantial evidence that chronic cannabis smoking is linked to poorer respiratory health, lower birth weight of offspring born to mothers who smoke cannabis during pregnancy; in addition, there is a greater likelihood of the development of psychotic disorders among heavy users.<sup>3</sup> Risk factors for developing problematic cannabis use include earlier age of cannabis use, being male, and smoking tobacco cigarettes.<sup>3</sup>

With the rise in the number of jurisdictions, both subnational and national, in legalization of cannabis, it is important to measure and understand the interactions between cannabis and tobacco use (especially cigarettes). Existing evidence shows that co-occurring use of tobacco and cannabis ("co-use") is widespread, with as many as 90% of cannabis users reporting a history of tobacco smoking.<sup>4</sup> Co-use of these substances can take several forms, including concurrent use of tobacco and cannabis (i.e., "dual users" of both substances). Co-administration through use of "blunts" (cigar wrappers partially or fully emptied and replaced with cannabis), "spliffs"/"mulled cigarettes" (joints filled with tobacco and cannabis), or waterpipes is commonplace, with use of mulled cigarettes being significantly more common in areas outside of the U.S.<sup>5</sup> More recent reports suggest low-level prevalence of co-use occurs by the delivery of cannabis plant material and/or concentrates via personal vaporizers and electronic nicotine delivery systems (ENDS) such as e-cigarettes.<sup>6,7</sup> Chronic co-use is associated with greater dependence on both substances,<sup>5,8</sup> greater difficulty in quitting cannabis,<sup>5,8</sup> and potentially increased health risks.<sup>3,7</sup> As more jurisdictions permit medicinal and/or recreational cannabis sales, examining tobacco-cannabis associations and co-use becomes particularly relevant due to the prospect of increasing cannabis use<sup>9</sup> and potentially, tobacco product use. The current study examines the co-use of tobacco and cannabis in the context of a country where cannabis use is tolerated, drawing on an existing survey on tobacco product usage.

In 1976, the Netherlands was among the first countries to relax restrictions on cannabis use through revisions to its Opium Act, in conjunction with government decisions to discontinue prosecuting cannabis-related offenses under specific circumstances.<sup>10</sup> During this time, the Netherlands introduced its coffeeshop model, which permitted such establishments to sell

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3 cannabis in small quantities for personal consumption. Coffeeshops are subject to numerous  
4 restrictions, including bans on the sale of alcohol, hard drugs, advertising, youth sales, and  
5 restrictions on the quantity of cannabis sold per day as well as intolerance of public nuisances.<sup>11</sup>  
6 Use of tobacco is not permitted in coffeeshops.<sup>11</sup>  
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## 11 **Methods**

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14 *Sample.* Respondents to the baseline wave (W1) of the ITC Netherlands Gold Magic Survey  
15 were recruited by a commercial online survey research firm (TNS NIPO) in April 2014. The  
16 sampling frame was constructed to provide a nationally representative sample age 16 years and  
17 older in the Netherlands. The W1 survey was initiated around the expected launch of a very  
18 low nicotine content cigarette (VLNC) in the Netherlands (Gold Magic). The survey was re-  
19 fielded after approximately 1 year (W2), at which point questions on cannabis use were added  
20 to assess potential co-use of cannabis with VLNC. However, Gold Magic was never introduced  
21 into the marketplace, so we were not able to examine use of cannabis and VLNC. However, the  
22 inclusion of the cannabis questions in the W2 survey allowed us to examine cannabis use and  
23 its association with regular cigarette use, which in the Netherlands often includes use of roll-  
24 your-own tobacco. Participants were compensated via the survey firm's internal points  
25 redemption system. All procedures were approved by the Institutional Review Board at the  
26 University of Waterloo.  
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33 *Key items.* Participants were asked to report their current (past 30 day) use of cigarettes and  
34 cannabis. Cigarette smokers reported whether they primarily used factory made (FM) or roll-  
35 your-own (RYO) cigarettes. Those who reported any cannabis use in the last 30 days were  
36 asked in what form cannabis was used (smoked in a joint, smoked with waterpipe, vaped with  
37 e-cigarette). Those who smoked cannabis were asked how frequently the joint was rolled with  
38 tobacco (mulling).  
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43 *Data analysis.* Weighted data were analyzed among 1,599 participants in the ITC Netherlands-  
44 Gold Magic W2 survey (1,003 current smokers, 283 former smokers, and 390 non-smokers),  
45 conducted in July-August 2015. Chi-square and logistic regression were used to assess  
46 relationships among combustible tobacco and cannabis use. Model covariates are listed in Table  
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51 *Patient and public involvement.* No patients were involved in the development, design, and  
52 recruitment of this study.  
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## Results

*Past 30 Day Cannabis Use and Cigarette Smoking Status.* Cigarette use was split between primary FM (51.2%) and primary RYO (44.8%). Past 30 day use of cannabis use was substantially higher among current cigarette smokers ( $n=57/987=5.8\%$ ) than among former or never smokers ( $n=10/288=3.5\%$  and  $n=6/316=1.9\%$ , respectively) [ $X^2(2) = 9.22, p=.010$ ]. There was evidence for marginally higher cannabis use among FM compared to RYO smokers (7.3% vs. 4.3%,  $p=0.087$ ). Table 1 illustrates the factors independently associated with current cannabis use. Current cigarette smoking was the strongest predictor of cannabis use (OR=4.13). Older respondents (aged 25+) were less likely to use cannabis (OR=0.36). We saw no differences in use by sex, income, or education ( $ps<.08$ ).



**Table 1.** Predictors of Current Cannabis Use

Predictor Variable	% Current (past 30-day) Cannabis Users (N=73)	Odds Ratio	95% Confidence Interval		P-Value
			Lower Bound	Upper Bound	
<b>AGE</b>					
16-24 Years Old (N=561)	6.2	Ref.			0.024
25 + Years Old (N=1030)	3.7	<b>0.36</b>	0.19	0.66	
<b>SEX</b>					
Male (N=826)	4.5	Ref.			0.812
Female (N=766)	4.8	1.11	0.64	1.90	
<b>INCOME</b>					
Low (N=376)	6.1	Ref.			0.395
Moderate (N=366)	4.9	0.78	0.40	1.50	
High (N=423)	4.0	0.67	0.34	1.32	
<b>EDUCATION</b>					
Low (N=291)	3.1	Ref.			0.089
Moderate (N=674)	3.9	1.95	0.77	4.93	
High (N=608)	5.9	<b>2.52</b>	1.01	6.32	
<b>CIGARETTE SMOKING STATUS</b>					
Current Nonsmoker (N=604)	2.6	Ref.			0.004
Current Smoker (N=987)	5.8	<b>4.13</b>	1.97	8.69	

*Cannabis Consumption Methods and Cigarette Smoking Status.* Among cannabis users, joints were by far the most prevalent use method for both current cigarette smokers (96.9%) and nonsmokers (comprised of former and never smokers) (76.5%). Among cannabis users, waterpipe was the use method for 8.8% of current smokers and 12.5% of nonsmokers. Using a vaping product was the use method for 5.3% of smokers and 0% of nonsmokers. Among those who used joints, nearly all current smokers (94.6%) and 2/3 of nonsmokers (66.7%) reported “always” rolling cannabis with tobacco when they used cannabis (see Figure 1). We saw no evidence for a difference in between mostly factory made cigarette users and mostly roll your own users in terms of whether they “always” roll cannabis with tobacco for consumption (93.8% vs. 95.2%,  $p=0.903$ ).

**Figure 1.** % Reporting Rolling Cannabis with Tobacco Among Past 30 Day Cannabis Users (n=68)

Chi-Square = 8.70; p=0.013

[INSERT FIGURE ONE HERE]

## Discussion

This study found that most cannabis users in the Netherlands smoke joints, often mixed with tobacco. The practice of mixing cannabis with tobacco is consistent with data from other European countries.<sup>12-14</sup> The use of e-cigarettes to vape cannabis was relatively uncommon, and exclusive to smokers.

Although the sample size in this study was small, a high proportion of self-reported non-cigarette smokers reported always (66.7%) or sometimes (16.7%) mulling cannabis with combustible tobacco for consumption. This means that many non-cigarette smoking cannabis users are likely misclassified as to their actual tobacco/nicotine exposure in surveys. In terms of public health considerations, mixing tobacco with cannabis could more readily expose non-users to nicotine, as well as exposes users to tobacco-related toxicants. Qualitative work<sup>15</sup> has suggested as much as 50% of a mulled cigarette may contain tobacco, which could represent a significant opportunity for nicotine exposure among those who otherwise may not consider using tobacco or other nicotine-containing products to a substance with known addictive properties. Considering the relative differences in perceived harms<sup>15-17</sup> for smoking cannabis in contrast to smoking cigarettes, further studies should work to disentangle how such perceptions may influence co-use, as well as prospective sustained nicotine use, within varying policy contexts. Finally, further research is needed to examine how mixing tobacco and cannabis may impact the consequences of use, such as the development of nicotine dependence.

## Funding

The study examining consumer interest in using a very low nicotine cigarette was supported by a supplemental grant from the US National Cancer Institute (P01CA138389-06S2). Additional support was provided to Geoffrey T. Fong from a Senior Investigator Award from the Ontario Institute for Cancer Research and from a Foundation Grant from the Canadian Institutes of Health Research (FDN-148477). Dr. Heckman was supported by NIDA (K12 DA031794 and K23 DA041616).

## Competing Interests Statement

KMC has received consulting fees and grant support from Pfizer for his work in smoking cessation. He has also received fees as a paid expert witness in litigation filed against cigarette manufacturers.

## Contributorship Statement

KMC, RJO, MCW, GTF: conception and design of the work and acquisition of data.  
BVF, DMS, RJO, BWH, MCW, KMC, GTF: analysis and interpretation of the data.  
BVF, DMS, RJO, BWH, MCW, KMC, GTF: drafting the manuscript and revising it critically for content.  
All authors have granted final approval for the work published in this manuscript.

## Data Sharing Statement

No additional data is available.

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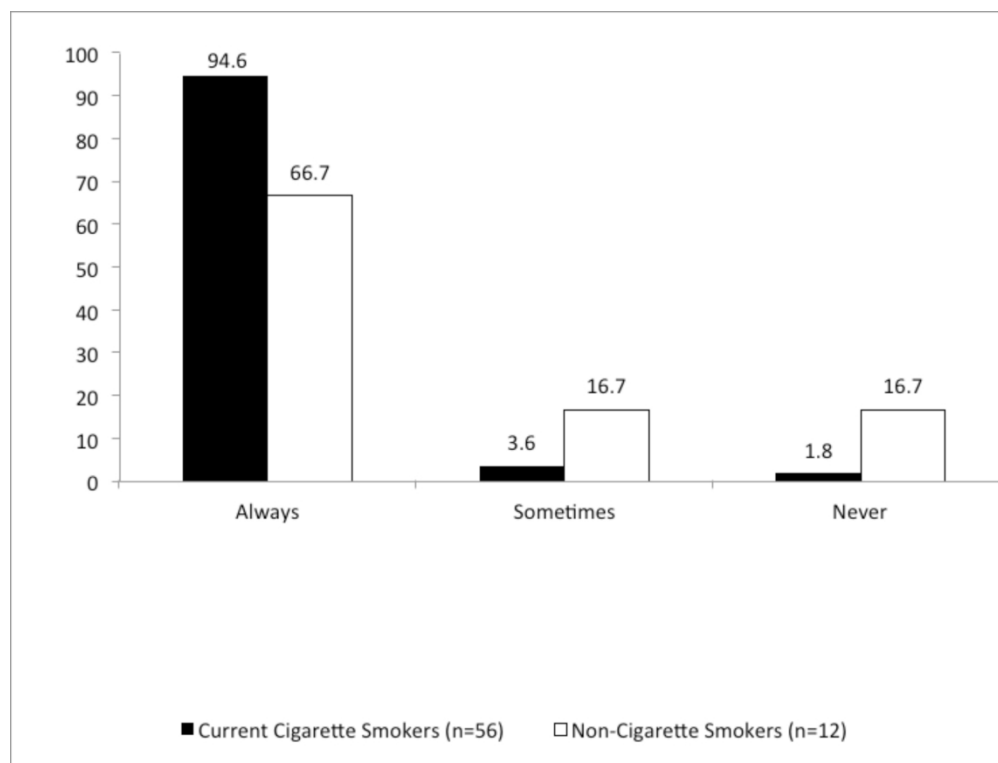


Figure 1. % Reporting Rolling Cannabis with Tobacco Among Past 30 Day Cannabis Users (n=68)

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## Abstract

Objectives: Existing evidence shows that co-occurring use of tobacco and cannabis is widespread. Patterns of co-use of tobacco and cannabis may change as more jurisdictions legalize medicinal and/or recreational cannabis sales. This analysis examined predictors of current cannabis use and characterized methods of consumption among smokers and non-smokers in a context where cannabis use is legal.

Setting: 2015 International Tobacco Control (ITC) Netherlands – Gold Magic Survey, conducted between July and August 2015.

Participants: Participants (N=1,599; 1,003 current smokers, 283 former smokers, and 390 non-smokers) were asked to report their current (past 30-day) use of cigarettes and cannabis. Cigarette smokers reported whether they primarily used factory made (FM) or roll-your-own (RYO) cigarettes. Those who reported any cannabis use in the last 30 days were asked about forms of cannabis used. Chi-square and logistic regression analyses were used to assess relationships among combustible tobacco and cannabis use.

Results: Past 30-day cannabis use was somewhat higher among current tobacco (or cigarette) smokers ( $n=57/987=5.8\%$ ) than among former or never smokers ( $n=10/288=3.5\%$  and  $n=6/316=1.9\%$ , respectively). Joints were the most commonly used form of cannabis use for both current cigarette smokers (96.9%) and nonsmokers (76.5%). Among those who smoked cannabis joints, 95% current smokers and 67% of nonsmokers reported that they 'always' roll cannabis with tobacco.

Conclusions. In the Netherlands, most cannabis is consumed via smoking joints, most often mixed with tobacco. This behavior may present unique health concerns for non-cigarette smoking cannabis users, since tobacco use could lead to nicotine dependence. Moreover, many non-cigarette smoking cannabis users appear to be misclassified as to their actual tobacco/nicotine exposure.

### Strengths and limitations of this study

- The study collected data from 1,599 participants, including current cigarette smokers, former cigarette smokers, and never cigarette smokers.
- The inclusion of non-cigarette smokers allowed for a measure of potential misclassification in terms of actual exposure to nicotine and tobacco smoke.
- The data collected did not include an extensive characterization of cannabis use patterns.

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## Introduction

Cannabis is a commonly used drug across the globe. In 2017, the World Health Organization estimated that there were 147 million consumers of cannabis, equivalent to 2.5% of the world's population.<sup>1</sup> The legal environment for use of cannabis, for either medicinal or recreational purposes, is rapidly evolving and in a number of jurisdictions, becoming less restrictive.

The long-term health impacts of chronic cannabis use are unclear.<sup>2</sup> A recent report by the National Academies of Science, Engineering, and Medicine (NASEM) suggests that there is substantial evidence that chronic cannabis smoking is linked to poorer respiratory health, lower birth weight of offspring born to mothers who smoke cannabis during pregnancy; in addition, there is a greater likelihood of the development of psychotic disorders among heavy users.<sup>3</sup> Risk factors for developing problematic cannabis use include earlier age of cannabis use, being male, and smoking tobacco cigarettes.<sup>3</sup>

With the rise in the number of jurisdictions, both subnational and national, in legalization of cannabis, it is important to measure and understand the interactions between cannabis and tobacco use (especially cigarettes). Existing evidence shows that co-occurring use of tobacco and cannabis ("co-use") is widespread, with as many as 90% of cannabis users reporting a history of tobacco smoking.<sup>4</sup> Co-use of these substances can take several forms, including concurrent use of tobacco and cannabis (i.e., "dual users" of both substances). Co-administration through use of "blunts" (cigar wrappers partially or fully emptied and replaced with cannabis), "spliffs"/"mulled cigarettes" (joints filled with tobacco and cannabis), or waterpipes is commonplace, with use of mulled cigarettes being significantly more common in areas outside of the U.S.<sup>5</sup> More recent reports suggest low-level prevalence of co-use occurs by the delivery of cannabis plant material and/or concentrates via personal vaporizers and electronic nicotine delivery systems (ENDS) such as e-cigarettes.<sup>6,7</sup> Chronic co-use is associated with greater dependence on both substances,<sup>5,8</sup> greater difficulty in quitting cannabis,<sup>5,8</sup> and potentially increased health risks.<sup>3,7</sup> As more jurisdictions permit medicinal and/or recreational cannabis sales, examining tobacco-cannabis associations and co-use becomes particularly relevant due to the prospect of increasing cannabis use<sup>9</sup> and potentially, tobacco product use and dependence.

In 1976, the Netherlands was among the first countries to relax restrictions on cannabis use through revisions to its Opium Act, in conjunction with government decisions to discontinue prosecuting cannabis-related offenses under specific circumstances.<sup>10</sup> During this time, the Netherlands introduced its coffeeshop model, which permitted such establishments to sell cannabis in small quantities for personal consumption. Coffeeshops are subject to numerous restrictions, including bans on the sale of alcohol, hard drugs (such as heroin, cocaine, amphetamine, ecstasy and GHB), advertising, youth sales, and restrictions on the quantity of

cannabis sold per day as well as intolerance of public nuisances.<sup>11</sup> Use of tobacco is not permitted in coffeeshops, although most have a designated section where smoking is allowed, in accordance with the current Dutch tobacco law, which permits smoking in separately ventilated smoking sections in hospitality industry venues.<sup>11</sup>

This study examined co-use of cannabis and tobacco in a country where cannabis use is legal. The objectives were to examine predictors of current cannabis use and characterize methods of consumption among smokers and non-smokers.

## Methods

*Sample.* Respondents to the baseline wave (W1) of the ITC Netherlands Gold Magic Survey were recruited by a commercial online survey research firm (TNS NIPO) in April 2014. The sampling frame was constructed to provide a nationally representative sample of smokers and non-smokers age 16 years and older in the Netherlands. The W1 survey was initiated around the expected launch of a very low nicotine content cigarette (VLNC) in the Netherlands (Gold Magic). The survey was re-fielded after approximately 1 year (W2), at which point questions on cannabis use were added to assess potential co-use of cannabis with VLNC. However, Gold Magic was never introduced into the marketplace, so we were not able to examine use of cannabis and VLNC. However, the inclusion of the cannabis questions in the W2 survey allowed us to examine cannabis use and its association with regular cigarette use, which in the Netherlands often includes use of roll-your-own tobacco. Participants were compensated via the survey firm's internal points redemption system. Additional information about the survey questions, methods, and sample can be found in other papers published from the Gold Magic Survey and the survey's technical report.<sup>12, 13</sup> All procedures were approved by the Institutional Review Board at the University of Waterloo.

*Outcome measures.* Participants were asked to report their current (past 30 day) use of cigarettes and cannabis. Cigarette smokers reported whether they primarily used factory made (FM) or roll-your-own (RYO) cigarettes. Those who reported any cannabis use in the last 30 days were asked in what form cannabis was used (smoked in a joint, smoked with waterpipe, vaped with e-cigarette). Those who smoked cannabis were asked how frequently the joint was rolled with tobacco (mulling).

*Data analysis.* Weighted data were analyzed among 1,599 participants in the ITC Netherlands–Gold Magic W2 survey (1,003 current smokers, 283 former smokers, and 390 non-smokers), conducted in July–August 2015. Chi-square and logistic regression were used to assess relationships among combustible tobacco and cannabis use. Model covariates are listed in Table 1.

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3 *Patient and public involvement.* No patients were involved in the development, design, and  
4 recruitment of this study.  
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## 8 **Results**

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10 *Past 30 Day Cannabis Use and Cigarette Smoking Status.* Cigarette use was split between  
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12 substantially higher among current cigarette smokers (n=57/987=5.8%) than among former or  
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**Table 1.** Predictors of Current Cannabis Use (n=1591 respondents who answered the cannabis use questions)

Predictor Variable	% Current (past 30-day) Cannabis Users (N=73)	Odds Ratio	95% Confidence Interval		P-Value
			Lower Bound	Upper Bound	
<b>AGE</b>					
16-24 Years Old (N=561)	6.2	Ref.			0.024
25 + Years Old (N=1030)	3.7	<b>0.36</b>	0.19	0.66	
<b>SEX</b>					
Male (N=826)	4.5	Ref.			0.812
Female (N=766)	4.8	1.11	0.64	1.90	
<b>INCOME</b>					
Low (N=376)	6.1	Ref.			0.395
Moderate (N=366)	4.9	0.78	0.40	1.50	
High (N=423)	4.0	0.67	0.34	1.32	
<b>EDUCATION</b>					
Low (N=291)	3.1	Ref.			0.089
Moderate (N=674)	3.9	1.95	0.77	4.93	
High (N=608)	5.9	<b>2.52</b>	1.01	6.32	
<b>CIGARETTE SMOKING STATUS</b>					
Current Nonsmoker (N=604)	2.6	Ref.			0.004
Current Smoker (N=987)	5.8	<b>4.13</b>	1.97	8.69	

*Cannabis Consumption Methods and Cigarette Smoking Status.* Among cannabis users, joints were by far the most prevalent use method for both current tobacco (or cigarette) smokers (96.9%) and nonsmokers (comprised of former and never smokers) (76.5%). Among cannabis users, waterpipe was the use method for 8.8% of current smokers and 12.5% of nonsmokers. Using a vaping product was the use method for 5.3% of smokers and 0% of nonsmokers. Among those who used joints, nearly all current smokers (94.6%) and 2/3 of nonsmokers (66.7%) reported “always” rolling cannabis with tobacco when they used cannabis (see Figure 1). There was no difference between mostly factory made cigarette users and mostly roll your own users in whether they “always” roll tobacco with cannabis (93.8% vs. 95.2%, respectively; p=0.903).

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3 **Figure 1.** % Reporting Rolling Tobacco with Cannabis Among Past 30-Day Cannabis Users (n=68)  
4 Chi-Square = 8.70; p=0.013  
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11 **[INSERT FIGURE ONE HERE]**  
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## 18 **Discussion**

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20 This study collected data from 1,599 participants, including current cigarette smokers, former  
21 cigarette smokers, and never cigarette smokers, which allowed for a measure of potential  
22 misclassification in terms of accrual exposure to nicotine and tobacco smoke. The results  
23 indicate that most cannabis users in the Netherlands consume cannabis via smoking joints,  
24 most often mixed with tobacco. The practice of mixing cannabis with tobacco is consistent with  
25 data from other European countries.<sup>14-16</sup> This behavior may present unique health concerns for  
26 non-cigarette smoking cannabis users, since they are being exposed to tobacco, and that  
27 exposure could lead to nicotine dependence. Moreover, many non-cigarette smoking cannabis  
28 users appear to be misclassified as to their actual tobacco/nicotine exposure.  
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36 Although the sample size in this study was small, a high proportion of self-reported non-  
37 cigarette smokers reported always (66.7%) or sometimes (16.7%) rolling cannabis with  
38 combustible tobacco for consumption. This means that many non-cigarette smoking cannabis  
39 users are likely misclassified as to their actual tobacco/nicotine exposure in surveys. This has  
40 importance in terms of future research when considering the precision with which we measure  
41 tobacco use and cannabis use separately and together. Future studies should take into account  
42 the potential that cannabis users are being exposed to tobacco through joints but might not  
43 identify as tobacco users in a survey.  
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48 With respect to public health considerations, mixing tobacco with cannabis increases tobacco  
49 smoking among current cigarette smokers and might work to promote tobacco related toxicant  
50 exposure and nicotine dependence among non-cigarette smokers. Qualitative work<sup>15</sup> has  
51 suggested as much as 50% of a mulled cigarette consists of tobacco, which represents a  
52 significant opportunity for nicotine exposure among those who otherwise may not consider  
53 using tobacco or other nicotine-containing products to a substance with known addictive  
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3 properties. Considering the relative differences in perceived harms <sup>17,18</sup> for smoking cannabis in  
4 contrast to smoking cigarettes, further studies should work to disentangle how such  
5 perceptions may influence co-use and design studies that would allow for a more precise  
6 measurement of exposure and dependence among cigarette smokers and non-cigarette  
7 smokers who engage in this type of consumption in various policy contexts.  
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11 A limitation of this study is the low sample size of overall past 30 day cannabis users and non-  
12 cigarette smoking cannabis users limits the generalizability of the results, as well as the ability  
13 to conduct more sophisticated data analysis in terms of consumption methods and use  
14 patterns.  
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17 Further research is needed to examine the impact of mixing tobacco and cannabis on important  
18 outcomes such as the development of nicotine dependence and prospective sustained tobacco  
19 consumption.  
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## Competing Interests Statement

KMC has received consulting fees and grant support from Pfizer for his work in smoking cessation. He has also received fees as a paid expert witness in litigation filed against cigarette manufacturers.

## Contributorship Statement

KMC, RJO, MCW, GTF: conception and design of the work and acquisition of data.  
BVF, DMS, RJO, BWH, MCW, KMC, GTF: analysis and interpretation of the data.  
BVF, DMS, RJO, BWH, MCW, KMC, GTF: drafting the manuscript and revising it critically for content.  
All authors have granted final approval for the work published in this manuscript.

## Data Sharing Statement

All data relevant to the study are included in the article or uploaded as supplementary information.

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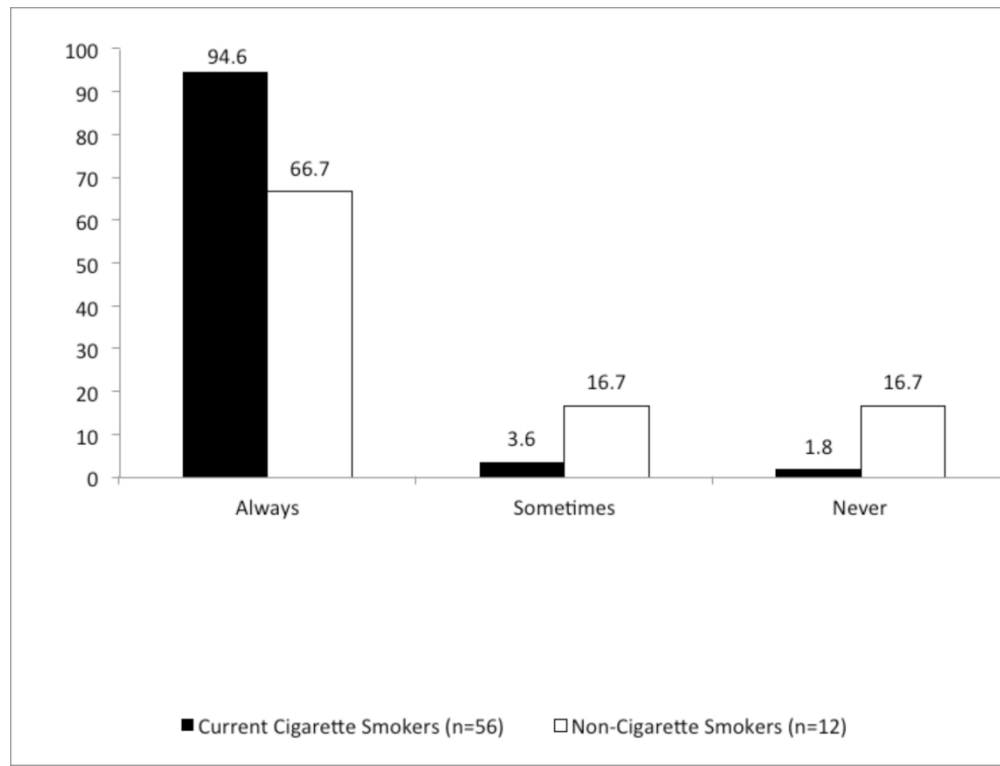


Figure 1. % Reporting Rolling Cannabis with Tobacco Among Past 30 Day Cannabis Users (n=68)

261x198mm (300 x 300 DPI)

## Cannabis use among smokers and non-smokers: Results from the ITC Netherlands Gold Magic Survey

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Reported on page #
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	4
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls (c) <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	5
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	5
		(e) Describe any sensitivity analyses	N/A

Continued on next page

<b>Results</b>			<b>Reported on page #</b>
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	---
		(c) Consider use of a flow diagram	---
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	---
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	---
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	---
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	---
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6-8
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-8
		(b) Report category boundaries when continuous variables were categorized	---
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	---
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	---
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8-9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-9
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Cannabis use among a nationally representative cross-sectional sample of smokers and non-smokers in The Netherlands: Results from the 2015 ITC Netherlands Gold Magic Survey

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Date Submitted by the Author:	23-Jan-2019
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<b>Primary Subject Heading</b>:	Smoking and tobacco
Secondary Subject Heading:	Public health
Keywords:	PUBLIC HEALTH, Tobacco, Cannabis

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Manuscripts

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3 **Cannabis use among a nationally representative cross-sectional sample of smokers and non-**  
4 **smokers in The Netherlands: Results from the 2015 ITC Netherlands Gold Magic Survey**  
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## Abstract

Objectives: Existing evidence shows that co-occurring use of tobacco and cannabis is widespread. Patterns of co-use of tobacco and cannabis may change as more jurisdictions legalize medicinal and/or recreational cannabis sales. This analysis examined predictors of current cannabis use and characterized methods of consumption among smokers and non-smokers in a context where cannabis use is legal.

Setting: 2015 International Tobacco Control (ITC) Netherlands – Gold Magic Survey, conducted between July and August 2015.

Participants: Participants (N=1,599; 1,003 current smokers, 283 former smokers, and 390 non-smokers) were asked to report their current (past 30-day) use of cigarettes and cannabis. Cigarette smokers reported whether they primarily used factory made (FM) or roll-your-own (RYO) cigarettes. Those who reported any cannabis use in the last 30 days were asked about forms of cannabis used. Chi-square and logistic regression analyses were used to assess relationships among combustible tobacco and cannabis use.

Results: Past 30-day cannabis use was somewhat higher among current tobacco (or cigarette) smokers ( $n=57/987=5.8\%$ ) than among former or never smokers ( $n=10/288=3.5\%$  and  $n=6/316=1.9\%$ , respectively). Joints were the most commonly used form of cannabis use for both current cigarette smokers (96.9%) and nonsmokers (76.5%). Among those who smoked cannabis joints, 95% current smokers and 67% of nonsmokers reported that they 'always' roll cannabis with tobacco.

Conclusions: In this Netherlands-based sample, most cannabis was reported to be consumed via smoking joints, most often mixed with tobacco. This behavior may present unique health concerns for non-cigarette smoking cannabis users, since tobacco use could lead to nicotine dependence. Moreover, many non-cigarette smoking cannabis users appear to be misclassified as to their actual tobacco/nicotine exposure.

### Strengths and limitations of this study

- The study collected data from 1,599 participants, including current cigarette smokers, former cigarette smokers, and never cigarette smokers.
- The inclusion of non-cigarette smokers allowed for a measure of potential misclassification in terms of actual exposure to nicotine and tobacco smoke.
- The data collected did not include an extensive characterization of cannabis use patterns.

For peer review only

## Introduction

Cannabis is a commonly used drug across the globe. In 2017, the World Health Organization estimated that there were 147 million consumers of cannabis, equivalent to 2.5% of the world's population.<sup>1</sup> The legal environment for use of cannabis, for either medicinal or recreational purposes, is rapidly evolving and in a number of jurisdictions, becoming less restrictive.

The long-term health impacts of chronic cannabis use are unclear.<sup>2</sup> A recent report by the National Academies of Science, Engineering, and Medicine (NASEM) suggests that there is substantial evidence that chronic cannabis smoking is linked to poorer respiratory health, lower birth weight of offspring born to mothers who smoke cannabis during pregnancy; in addition, there is a greater likelihood of the development of psychotic disorders among heavy users.<sup>3</sup> Risk factors for developing problematic cannabis use include earlier age of cannabis use, being male, and smoking tobacco cigarettes.<sup>3</sup>

With the rise in the number of jurisdictions, both subnational and national, in legalization of cannabis, it is important to measure and understand the interactions between cannabis and tobacco use (especially cigarettes). Existing evidence shows that co-occurring use of tobacco and cannabis ("co-use") is widespread, with as many as 90% of cannabis users reporting a history of tobacco smoking.<sup>4</sup> Co-use of these substances can take several forms, including concurrent use of tobacco and cannabis (i.e., "dual users" of both substances). Co-administration through use of "blunts" (cigar wrappers partially or fully emptied and replaces with cannabis), "spliffs"/"mulled cigarettes" (joints filled with tobacco and cannabis), or waterpipes is commonplace, with use of mulled cigarettes being significantly more common in areas outside of the U.S.<sup>5</sup> More recent reports suggest low-level prevalence of co-use occurs by the delivery of cannabis plant material and/or concentrates via personal vaporizers and electronic nicotine delivery systems (ENDS) such as e-cigarettes.<sup>6,7</sup> Chronic co-use is associated with greater dependence on both substances,<sup>5,8</sup> greater difficulty in quitting cannabis,<sup>5,8</sup> and potentially increased health risks.<sup>3,7</sup> As more jurisdictions permit medicinal and/or recreational cannabis sales, examining tobacco-cannabis associations and co-use becomes particularly relevant due to the prospect of increasing cannabis use<sup>9</sup> and potentially, tobacco product use and dependence.

In 1976, the Netherlands was among the first countries to relax restrictions on cannabis use through revisions to its Opium Act, in conjunction with government decisions to discontinue prosecuting cannabis-related offenses under specific circumstances.<sup>10</sup> During this time, the Netherlands introduced its coffeeshop model, which permitted such establishments to sell cannabis in small quantities for personal consumption. Coffeeshops are subject to numerous restrictions, including bans on the sale of alcohol, hard drugs (such as heroin, cocaine, amphetamine, ecstasy and GHB), advertising, youth sales, and restrictions on the quantity of

cannabis sold per day as well as intolerance of public nuisances.<sup>11</sup> Use of tobacco is not permitted in coffeeshops, although most have a designated section where smoking is allowed, in accordance with the current Dutch tobacco law, which permits smoking in separately ventilated smoking sections in hospitality industry venues.<sup>11</sup>

This study examined co-use of cannabis and tobacco in a country where cannabis use is legal. The objectives were to examine predictors of current cannabis use and characterize methods of consumption among smokers and non-smokers.

## Methods

*Sample.* Respondents to the baseline wave (W1) of the ITC Netherlands Gold Magic Survey were recruited by a commercial online survey research firm (TNS NIPO) in April 2014. The sampling frame was constructed to provide a nationally representative sample of smokers and non-smokers age 16 years and older in the Netherlands. The W1 survey was initiated around the expected launch of a very low nicotine content cigarette (VLNC) in the Netherlands (Gold Magic). The survey was re-fielded after approximately 1 year (W2), at which point questions on cannabis use were added to assess potential co-use of cannabis with VLNC. However, Gold Magic was never introduced into the marketplace, so we were not able to examine use of cannabis and VLNC. However, the inclusion of the cannabis questions in the W2 survey allowed us to examine cannabis use and its association with regular cigarette use, which in the Netherlands often includes use of roll-your-own tobacco. Participants were compensated via the survey firm's internal points redemption system. Additional information about the survey questions, methods, and sample can be found in other papers published from the Gold Magic Survey and the survey's technical report.<sup>12, 13</sup> All procedures were approved by the Institutional Review Board at the University of Waterloo.

*Outcome measures.* Participants were asked to report their current (past 30 day) use of cigarettes and cannabis. Cigarette smokers reported whether they primarily used factory made (FM) or roll-your-own (RYO) cigarettes. Those who reported any cannabis use in the last 30 days were asked in what form cannabis was used (smoked in a joint, smoked with waterpipe, vaped with e-cigarette). Those who smoked cannabis were asked how frequently the joint was rolled with tobacco (mulling).

*Data analysis.* Weighted data were analyzed among 1,599 participants in the ITC Netherlands–Gold Magic W2 survey (1,003 current smokers, 283 former smokers, and 390 non-smokers), conducted in July–August 2015. Chi-square and logistic regression were used to assess relationships among combustible tobacco and cannabis use. Model covariates are listed in Table 1.

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3 *Patient and public involvement.* No patients were involved in the development, design, and  
4 recruitment of this study.  
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## 8 **Results**

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10 *Past 30 Day Cannabis Use and Cigarette Smoking Status.* Cigarette use was split between  
11 primary FM (51.2%) and primary RYO (44.8%). Past 30-day use of cannabis use was  
12 substantially higher among current cigarette smokers (n=57/987=5.8%) than among former or  
13 never smokers (n=10/288=3.5% and n=6/316=1.9%, respectively) [ $X^2(2) = 9.22, p=.010$ ]. There  
14 was evidence for marginally higher cannabis use among FM compared to RYO smokers (7.3% vs.  
15 4.3%, p=0.087). Table 1 illustrates the factors independently associated with current cannabis  
16 use. Current cigarette smoking was the strongest predictor of cannabis use (OR=4.13). Older  
17 respondents (aged 25+) were less likely to use cannabis (OR=0.36). We saw no differences in  
18 use by sex, income, or education (all p<.08).  
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**Table 1.** Predictors of Current Cannabis Use (n=1591 respondents who answered the cannabis use questions)

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			Lower Bound	Upper Bound	
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Moderate (N=674)	3.9	1.95	0.77	4.93	
High (N=608)	5.9	<b>2.52</b>	1.01	6.32	
<b>CIGARETTE SMOKING STATUS</b>					
Current Nonsmoker (N=604)	2.6	Ref.			0.004
Current Smoker (N=987)	5.8	<b>4.13</b>	1.97	8.69	

*Cannabis Consumption Methods and Cigarette Smoking Status.* Among cannabis users, joints were by far the most prevalent use method for both current tobacco (or cigarette) smokers (96.9%) and nonsmokers (comprised of former and never smokers) (76.5%). Among cannabis users, waterpipe was the use method for 8.8% of current smokers and 12.5% of nonsmokers. Using a vaping product was the use method for 5.3% of smokers and 0% of nonsmokers. Among those who used joints, nearly all current smokers (94.6%) and 2/3 of nonsmokers (66.7%) reported “always” rolling cannabis with tobacco when they used cannabis (see Figure 1). There was no difference between mostly factory made cigarette users and mostly roll your own users in whether they “always” roll tobacco with cannabis (93.8% vs. 95.2%, respectively; p=0.903).

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3 **Figure 1.** % Reporting Rolling Tobacco with Cannabis Among Past 30-Day Cannabis Users (n=68)  
4 Chi-Square = 8.70; p=0.013  
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11 **[INSERT FIGURE ONE HERE]**  
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## 18 **Discussion**

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20 This study collected data from 1,599 participants, including current cigarette smokers, former  
21 cigarette smokers, and never cigarette smokers, which allowed for a measure of potential  
22 misclassification in terms of accrual exposure to nicotine and tobacco smoke. In this  
23 Netherlands-based sample, most cannabis was reported to be consumed via smoking joints,  
24 most often mixed with tobacco. The practice of mixing cannabis with tobacco is consistent with  
25 data from other European countries.<sup>14-16</sup> This behavior may present unique health concerns for  
26 non-cigarette smoking cannabis users, since they are being exposed to tobacco, and that  
27 exposure could lead to nicotine dependence. Moreover, many non-cigarette smoking cannabis  
28 users appear to be misclassified as to their actual tobacco/nicotine exposure.  
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34 Although the sample size in this study was small, a high proportion of self-reported non-  
35 cigarette smokers reported always (66.7%) or sometimes (16.7%) rolling cannabis with  
36 combustible tobacco for consumption. This means that many non-cigarette smoking cannabis  
37 users are likely misclassified as to their actual tobacco/nicotine exposure in surveys. This has  
38 importance in terms of future research when considering the precision with which we measure  
39 tobacco use and cannabis use separately and together. Future studies should take into account  
40 the potential that cannabis users are being exposed to tobacco through joints but might not  
41 identify as tobacco users in a survey.  
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46 With respect to public health considerations, mixing tobacco with cannabis increases tobacco  
47 smoking among current cigarette smokers and might work to promote tobacco related toxicant  
48 exposure and nicotine dependence among non-cigarette smokers. Qualitative work<sup>15</sup> has  
49 suggested as much as 50% of a mulled cigarette consists of tobacco, which represents a  
50 significant opportunity for nicotine exposure among those who otherwise may not consider  
51 using tobacco or other nicotine-containing products to a substance with known addictive  
52 properties. Considering the relative differences in perceived harms<sup>17-19</sup> for smoking cannabis in  
53 contrast to smoking cigarettes, further studies should work to disentangle how such  
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3 perceptions may influence co-use and design studies that would allow for a more precise  
4 measurement of exposure and dependence among cigarette smokers and non-cigarette  
5 smokers who engage in this type of consumption in various policy contexts.  
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8 A limitation of this study is the low sample size of overall past 30 day cannabis users and non-  
9 cigarette smoking cannabis users limits the generalizability of the results, as well as the ability  
10 to conduct more sophisticated data analysis in terms of consumption methods and use  
11 patterns.  
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14 Further research is needed to examine the impact of mixing tobacco and cannabis on important  
15 outcomes such as the development of nicotine dependence and prospective sustained tobacco  
16 consumption.  
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## Competing Interests Statement

KMC has received consulting fees and grant support from Pfizer for his work in smoking cessation. He has also received fees as a paid expert witness in litigation filed against cigarette manufacturers.

## Contributorship Statement

KMC, RJO, MCW, GTF: conception and design of the work and acquisition of data.  
BVF, DMS, RJO, BWH, MCW, KMC, GTF: analysis and interpretation of the data.  
BVF, DMS, RJO, BWH, MCW, KMC, GTF: drafting the manuscript and revising it critically for content.  
All authors have granted final approval for the work published in this manuscript.

## Data Sharing Statement

All data relevant to the study are included in the article or uploaded as supplementary information.

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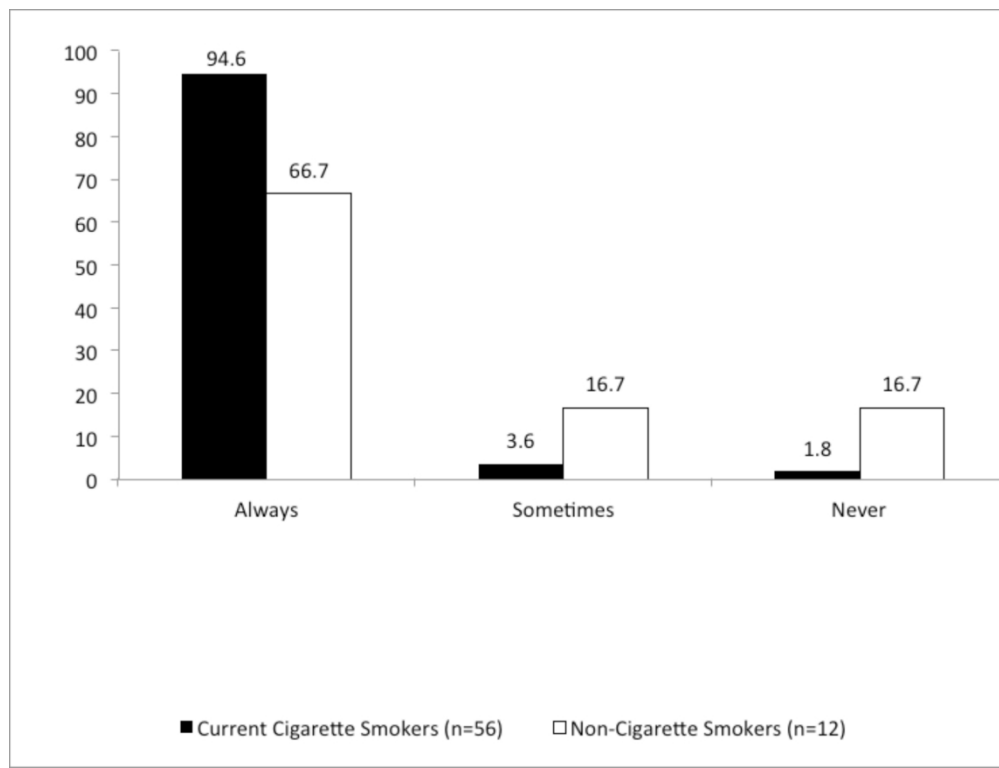


Figure 1. % Reporting Rolling Cannabis with Tobacco Among Past 30 Day Cannabis Users (n=68)

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## Cannabis use among smokers and non-smokers: Results from the ITC Netherlands Gold Magic Survey

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Reported on page #
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	4
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls (c) <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	5
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	5
		(e) Describe any sensitivity analyses	N/A

Continued on next page

<b>Results</b>			<b>Reported on page #</b>
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	---
		(c) Consider use of a flow diagram	---
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	---
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	---
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	---
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	---
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6-8
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-8
		(b) Report category boundaries when continuous variables were categorized	---
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	---
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	---
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8-9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-9
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).