

IDENTIFYING PATTERNS OF TOBACCO USE IN MIDDLE AND HIGH SCHOOL STUDENTS IN THE DOMINICAN REPUBLIC: A LATENT CLASS ANALYSIS

Identificando patrones de consumo de tabaco en estudiantes de secundaria y preparatoria en la República Dominicana: un análisis de clase latente

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Abstract

The Dominican Republic (DR) has minimal national tobacco control strategies for youth tobacco use. This study seeks to understand how different patterns of tobacco use might occur in groups of Dominican youth. Methods: Using Latent Class Analyses, we analyzed the DR's 2016 Global Youth Tobacco Survey dataset (N= 1,532), a nationally representative school-based survey. We examined two indicators (ever use, past 30-day use) of cigarettes, shishas, smokeless tobacco, and e-cigarettes. Multinomial logistic regression was used to analyze predictors of class membership. Results: Five subclasses of tobacco users were identified: non-users (58.44%), shisha experimenters (18.55%), poly-tobacco experimenters (10.66%), poly-tobacco users (8.57%), and smokeless tobacco with experimentation (3.79%). Compared to non-users, Shisha experimenters had higher odds of being male, having more spending money, and having observed someone smoking tobacco in their house. Poly-tobacco experimenters and Poly-tobacco users class had higher odds of having observed someone smoking tobacco in their house. Smokeless tobacco, with experimentation of other forms of tobacco, had

Resumen

La República Dominicana cuenta con pocas estrategias nacionales para la prevención de consumo de tabaco en adolescentes. Este estudio busca comprender los diferentes patrones de consumo de tabaco en grupos de jóvenes dominicanos. Métodos: mediante el uso de análisis de clase latente, analizamos la base de dato de la Encuesta Mundial sobre Tabaquismo en Jóvenes de 2016 de República Dominicana (N= 1532), una encuesta representativa a nivel nacional. Examinamos dos indicadores (uso alguna vez y uso durante los últimos 30 días) de cigarrillos, hookah, tabaco sin humo y cigarrillos electrónicos. Se utilizó la regresión logística multinomial para analizar los predictores de pertenencia a una clase. Resultados: Se identificaron cinco subclases de consumidores de tabaco: *no consumidores* (58,44%), *experimentación con hookah* (18,55%), *experimentación de politabaco* (10,66%), *policonsumidores de tabaco* (8,57%) y *tabaco sin humo con experimentación con otras formas de tabaco* (3,79%). En comparación con los *no consumidores*, los jóvenes en la clase *experimentación con hookah* tenían mayores probabilidades de ser hombres, tener más dinero para gastar y haber observado a alguien fumando tabaco en su casa. Los jóvenes en *experimentación de politabaco* y *policonsumidores de tabaco* tenían mayores

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higher odds of having observed someone smoking tobacco in their house and outside. Discussion: Our findings indicate that most tobacco users belong to the shisha experimenters or were multiple product experimenters/user classes. This suggests that tobacco control strategies should focus on multiple products and aim prevention efforts toward younger male students.

Keywords: Tobacco use, smoking, vaping, cigarette, adolescent.

probabilidades de haber observado a alguien fumando tabaco en sus casas. Los jóvenes que pertenecían al grupo de *tabaco sin humo con experimentación con otras formas de tabaco* tenían mayores probabilidades de haber observado a alguien fumando tabaco en su casa y afuera. Discusión: Nuestros hallazgos indican que la mayoría de los consumidores de tabaco pertenecen a *experimentación con hookah* o eran experimentadores de múltiples productos. Esto sugiere que las estrategias de control del tabaco deben centrarse en múltiples productos y dirigir los esfuerzos de prevención hacia los estudiantes varones más jóvenes.

Palabras clave: Consumo de tabaco, tabaquismo, vapeo, cigarrillo, adolescente.

Introduction

The reduction of tobacco use is a health priority worldwide¹. In 2013, the United Nations set a target to reduce the relative prevalence of tobacco by 30% by 2025². Most high-income countries are expected to reach that target; However, low and middle-income countries remain in the early stages of tobacco control^{1, 2}.

Currently, the Dominican Republic is a middle-income tobacco-producing country located in the Caribbean and with limited tobacco control efforts^{3, 4}. In 2018, the overall tobacco smoking prevalence in the Dominican Republic was 9.4%, with 11.2% for men and 7.4% for women reporting current smoking⁵. The Dominican Republic is not on track to meet the goal of reducing tobacco prevalence by 30% by 2025².

One study in the Dominican Republic found that most smokers started before age 16, and the initiation age can be as early as six years old⁶. Adolescents with a younger smoking initiation have elevated risks of negative health outcomes such as nicotine dependence⁷. Prevention interventions that delay the start of tobacco use are an essential tool to fighting needed to fight the tobacco epidemic; yet,

little is known about the initiation and use behaviors of Dominican youth⁷.

The introduction of many new tobacco products to the market may mean that youth are more likely to be dual- and poly-tobacco users⁸. In the Dominican Republic, surveillance data suggest that Dominican youth may also be exposed to and use multiple products. In 2011, 19.5% of Dominican students reported using tobacco products other than cigarettes⁹. Understanding the different tobacco use patterns may help to identify various risk groups to target prevention and cessation interventions for youth. In addition, understanding what social and environmental exposures might be associated with these patterns of tobacco use may further identify high-risk groups of youth.

Our study aims to understand the patterns of tobacco use in the Dominican Republic and identify what factors are related to those patterns to inform future prevention efforts.

Methods

Dataset

We analyzed the Dominican Republic's 2016 Global Youth Tobacco Survey dataset (GYTS) for this

study. The GTYS is a school-based cross-sectional survey that employs a two-stage clustered design to obtain a national representative sample (10). The Dominican Republic's GTYS data was collected by the Ministry of Health in the Dominican Republic. A total of 1532 seventh to twelfth grade students from 15 different schools participated as the sample. The overall response rate was 79.5%.

Measures

Tobacco Products

Cigarette use. Cigarette ever use was assessed by asking participants, "Have you ever tried or experimented with cigarette smoking, even one or two puffs?" and answer choices were 1= "yes" or 0= "no." Cigarette current use was assessed by asking participants, "During the past 30 days, on how many days did you smoke cigarettes?" Answers were recoded and dichotomized into 1= "1 day to all 30 days" and 0= "0 days."

Shisha use. Shisha ever use was assessed by asking participants, "Have you ever tried or experimented with shisha smoking, even one or two puffs?" and answer choices were 1= "yes" or 0= "no." Shisha current use was assessed by asking participants, "During the past 30 days, on how many days did you smoke shisha?" Response choices were "0 days," "1 or 2 days," "3 to 5 days," "6 to 9 days," "10 to 19 days," "10 to 19 days," "20 to 29 days," and "all 30 days." Answers were recoded and dichotomized into 1= "1 day to all 30 days" and 0= "0 days."

Smokeless tobacco use. Smokeless tobacco ever use was assessed by asking participants, "Have you ever tried or experimented with any form of smokeless tobacco products (such as dip, chewing tobacco or snuff)?" and answer choices were 1= "yes" or 0= "no." Smokeless tobacco current use was assessed by asking participants, "During the past 30 days,

did you use any form of smokeless tobacco products (such as dip, chewing tobacco or snuff)?" and answer choices were 1= "yes" or 0= "no."

Electronic cigarettes tobacco use. Electronic cigarette ever use was assessed by asking participants, "In total, how many days have you used an electronic cigarette or e-cigarette in your entire life?" Response choices were "0 days," "1 day," "2 to 10 days," "11 to 20 days," "21 to 50 days," "51 to 100 days," and "More than 100 days." Answers were recoded and dichotomized into 1= "yes" and 0= "No." and answer choices were 1= "yes" or 0= "no." Electronic cigarette current use was assessed by asking participants, "During the past 30 days, on how many days did you use electronic cigarettes?" Response choices were "0 days," "1 or 2 days," "3 to 5 days," "6 to 9 days," "10 to 19 days," "10 to 19 days," "20 to 29 days," and "all 30 days." Answers were recoded and dichotomized into 1= "1 day to all 30 days" and 0= "0 days."

Sociodemographic variables

Gender. Gender was assessed by asking participants, "What is your sex?" Response choices were 1 = "Male" or 0 = "Female."

Age. Age was measured by asking participants, "How old are you?" Response choices were "11 or younger," "12 years old," "13 years old," "14 years old," "15 years old," "16 years old," and "17 years old or older". Answers were recoded and dichotomized into 1= "15 to 17 years or older" and 0= "11 or younger to 14 years old". We recoded it this way because the Dominican Republic's secondary education is divided into two cycles. The first one is from seventh to ninth grade, and the second is from tenth to twelfth grade, which roughly corresponds to the ages we have grouped together¹¹.

Weekly spending money. Weekly spending money was measured by asking participants, "During an

average week, how much money do you have that you can spend on yourself, however you want?” Response choices were “I usually don’t have any spending money”, “Less than Dominican Pesos (DOP)100.00,” “DOP 100.00 to DOP 199.00,” “DOP 200.00 to DOP 299.00,” “DOP 300.00 to DOP 399.00,” “DOP 500.00 to DOP 999.00,” and “DOP 1000.00 or more.” Answers were recoded and dichotomized into 1= “DOP 200 to DOP 9999” and 0= “No spending money to DOP 199.” The price of the most sold 20 cigarette pack was DOP 150 (equivalent to \$7.28) (12). We decided to set the cutoff at DOP 200 since it reflected that all students above DOP 200 had enough money to buy at least one pack each week.

Social modeling variables

Exposure to tobacco inside their house. Exposure to tobacco inside their house was measured by asking participants, “During the past 7 days, on how many days has anyone smoked inside your home, in your presence?” Response choices were “0 days,” “1 to 2 days,” “3 to 4 days,” “5 to 6 days,” and “7 days.” Answers were recoded and dichotomized into 1= “1 to 7 days” and 0= “0 days.”

Exposure to tobacco inside enclosed spaces. Exposure to tobacco inside enclosed spaces was measured by asking participants, “During the past 7 days, on how many days has anyone smoked in your presence, inside any enclosed public place, other than your home (such as school, stores, shops, restaurants, shopping malls, hair salon, barber shop, liquor store)?” Response choices were “0 days,” “1 to 2 days,” “3 to 4 days,” “5 to 6 days,” and “7 days.” Answers were recoded and dichotomized into 1= “1 to 7 days” and 0= “0 days.”

Exposure to tobacco outside. Exposure to tobacco outside was measured by asking participants, “During the past 7 days, on how many days has

anyone smoked in your presence, at any outdoor public place (such as playgrounds, sidewalks, entrances to buildings, parks, beaches, colmados or mini markets)?” Response choices were “0 days,” “1 to 2 days,” “3 to 4 days,” “5 to 6 days,” and “7 days.” Answers were recoded and dichotomized into 1= “1 to 7 days” and 0= “0 days.”

Statistical Analyses

Descriptive statistics were calculated in R to summarize participant characteristics and *Survey* package was used to estimate the weighted proportions and confidence intervals^{13, 14}. Latent class analyses (LCA) were used to identify distinct patterns of tobacco use among a DR youth. Multinomial regression analyses were then used to estimate odds ratios for each covariate to compare the probability of belonging for each class versus a reference class.

Absolute and relative model fit statistics (the G2 likelihood ratio Chi-Square Test, the Bayesian Information Criteria (BIC), Akaike Information Criteria (AIC)), were used to compare model selection. Final model selection depended on fit statistics and interpretability.

Missing Data.

Missing data on age, gender, and average weekly spending money was imputed using the using *k*-nearest neighbor (KNN) method¹⁵. To perform KNN imputation, we used the *fancyimputer* module in Python 3.6 with *k*=5 selected¹⁶. Imputations that had a value equal to or higher than .5 were rounded up to 1, while imputations lower than .5 were rounded up to 0.

We computed multinomial logistic regression using posterior probabilities to assign members to latent classes¹⁷. Sociodemographic characteristics and social modeling variables were added as covariates to investigate whether the classes differed

by these variables. We used Maximum Likelihood Estimation to estimate all of the LCA models, and multinomial logistic regression LCA was conducted in Mplus 7.7^{18, 19}.

Results

The sociodemographic characteristics of the study sample (N= 1,532) are presented in Table 1. The overall analytic sample consisted of nearly 50% male youth, 77% were age 15 or older, and 49%

had spending money between DOP 200 – DOP 9999. The most common space where students were exposed to people smoking tobacco was in outside areas (30%), followed by enclosed spaces (25%), and lastly, inside their houses (16%). The most common tobacco product used was shishas (39% lifetime use; 17% last month use), followed by electronic cigarettes (23% lifetime use; 11% last month use), cigarettes (16% lifetime use; 4% last month use) and smokeless tobacco (7% lifetime use; 3% last month use).

Table 1. Summary statistics of variables used in the study

Variable	Count	Unweighted proportion	Weighted proportion (95% CI)
Demographic			
Gender			
Male	706	0.461	0.502 (0.476-0.530)
Female	826	0.539	0.498 (0.471-0.520)
Age			
15 - +17	923	0.602	0.768 (0.650 -0.860)
<11-14	609	0.398	0.232 (0.145 -0.350)
Spending money			
DOP 200 - DOP 9999	757	0.494	0.558 (0.514 - 0.600)
No Money - DOP 199	775	0.506	0.442 (0.398 -0.490)
Tobacco Variables			
Has experimented with cigarettes	234	0.159	0.205 (0.169 - 0.250)
Used cigarettes in the last month	54	0.037	0.045 (0.032 - 0.060)
Has experimented with shishas	505	0.335	0.389 (0.344 - 0.440)
Used shishas in the last month	237	0.158	0.167 (0.137 - 0.200)
Has experimented with smokeless tobacco	103	0.069	0.079 (0.062 - 0.100)
Used smokeless tobacco in the last month	49	0.033	0.035 (0.020 - 0.060)
Has experimented with electronic cigarettes	265	0.176	0.225 (0.183 - 0.270)
Used electronic cigarettes in the last month	136	0.09	0.106 (0.086 - 0.130)
Social modeling variables			
Observed someone smoke tobacco in their house	244	0.164	0.167 (0.144 - 0.190)
Observed someone smoke tobacco in an enclosed space	381	0.253	0.283 (0.238 - 0.330)
Observed someone smoke tobacco outside	452	0.3	0.335 (0.281- 0.390)

Note: DOP = Dominican pesos

Identifying Patterns of Tobacco Use in Middle and High School Students in the Dominican Republic: A Latent Class Analysis

Latent Class Models

Table 2 shows model fit statistics for each model with an increasing number of classes. Latent class models ranging from one class to seven classes were created. A 5-class model was selected due to model statistics, interpretability, and parsimony (Loglikelihood = -3418.977, AIC = 6949.953, BIC = 7248.676).

Latent classes and the item-response probability are presented in Table 3. The *Nonusers* class captured majority of the sample (58.44%), followed by *Shisha experimenters* (18.55%), *Poly-tobacco experimenters* (10.66%), *Poly-tobacco users* (8.57%), and last was the *Smokeless users and cigarette and shisha experimenters* (3.79%).

Table 2. Fit indices of the LCA models

Number of classes	Loglikelihood	χ^2	<i>df</i>	<i>p</i>	AIC	BIC	Entropy
1	-7714.007	1289.18	208	> .01	15456.015	15530.695	-
2	-3712.45	953.707	220	> .01	7464.9	7571.586	0.875
3	-3570.857	699.531	218	> .01	7205.713	7376.412	0.894
4	-3470.997	483.229	211	> .01	7029.995	7264.705	0.925
5*	-3418.977	367.765	202	> .01	6949.953	7248.676	0.905
6	-3265.408	208.302	191	0.186	6876.043	7238.777	0.931
7	-3330.973	204.871	184	0.139	6821.946	7248.692	0.956

Note: LCA = Latent Class Analysis, χ^2 = Chi-square value, AIC = Akaike information criterion, BIC = Bayesian information criterion, * indicates the selected model

Table 3. Class prevalence and item-response probability

	Class 1 Non-Users (58.44%)	Class 2 Shisha Ex- perimenters (18.55%)	Class 3 Poly-Tobacco Experiment- ers (10.66%)	Class 5 Poly- Tobacco Users (8.57%)	Class 5 Smokeless Tobacco With experimenta- tion (3.79%)
Ever use Cigarette	0.027	0.366	.520*	.586*	.562*
Cigarette Use in the last 30 days	0	0.101	0	0.181	.384
Ever use Shisha	0.045	0.929*	.749*	1	.778 *
Shisha Use in the last 30 days	0	0.376	0	.959*	0.377
Ever use Smokeless tobacco	0.013	0.035	0.134	0.187	1*
Smokeless Use in the last 30 days	0	0	0	0	1*
Ever use Electronic Cigarette	0.008	0	1*	1*	0.394
e-Cigarette Use in the last 30 days	0	0	0	.753*	0.28

Note: * Indicates the indicator was significant for that class

Predictors of class membership

Table 4 presents the multinomial regression analysis results using covariates to identify differences in latent class membership. Relative to the *Nonuser* class, members of the *Shisha Experimenter* class had higher odds of being male (OR = 2.670; 95% CI = 1.936 – 3.813), having between DOP\$200 - DOP\$9999 for spending money (OR = 2.273; 95% CI = 1.355 -2.596), and having observed someone smoking tobacco in their house (OR = 1.725; 95% CI = 1.034-2.876). Relative to *Nonusers*, members of the *Poly-tobacco experimenters*

class had higher odds of having observed someone smoking tobacco in their house (OR = 2.948; 95% CI = 1.650 - 2.876). Relative to *Nonuser*, members of the *Poly-tobacco users* class had higher odds of having observed someone smoking tobacco in their house (OR = 4.773; 95% CI = 1.904 – 11.968) and outside (OR = 2.702; 95% CI = 1.248 – 5.849). Relative to *Nonuser*, members of the *Smokeless users and cigarette and shisha experimenters* class had higher odds of having observed someone smoking tobacco in their house (OR = 3.770; 95% CI = 1.454 – 9.772) and outside (OR = 6.633; 95% CI = 1.261- 34.886).

Table 4. Odds Ratios of Covariates on the Tobacco Use Latent Classes

	Non-Users. (OR (95% CI))	Shisha Exper- imenters (OR (95% CI))	Poly-Tobacco Experimenters (OR (95% CI))	Poly-Tobacco Users (OR (95% CI))	Smokeless Tobacco With experimentation (OR (95% CI))
Male	REF	2.670 (1.936-3.682)*	3.277 (0.931-11.534)	1.992 (0.924-4.294)	0.665 (0.176-2.516)
Age 15-17+	REF	0.977 (0.457- 2.091)	1.456 (0.905-2.345)	1.040 (0.466-2.318)	1.557 (0.760-3.191)
Spending money 200- 9999	REF	2.273 (1.355-3.813)*	0.929 (0.554-1.558)	1.328 (0.632-2.792)	1.422 (0.951-2.125)
Observed someone smoke tobacco in house	REF	1.725 (1.034-2.876)*	2.948 (1.650-5.265)*	4.773 (1.904-11.968)*	3.770 (1.454-9.772)*
Observed someone smoke tobacco inside	REF	1.619 (0.528-4.968)	2.147 (0.959-4.804)	1.196 (0.519-2.756)	1.062 (0.316-3.565)
Observed someone smoke tobacco outside	REF	0.849 (0.425-1.695)	0.915 (0.552-1.517)	2.702 (1.248-5.849)*	6.633 (1.261-34.886)*

Note: OR = Odds Ratio, * Indicates that the odds ratios are significant at $p < 0,05$

Discussion

Understanding groups of people who display similar risk patterns of tobacco use may lead to more effective tobacco prevention and cessation interventions and messaging. The current study identified five distinct groups of tobacco users among Dominican

Republic youth. Most students have never experimented with tobacco; however, most students who have ever experimented with tobacco have experimented with multiple substances. This is similar to other studies that have used LCA to classify tobacco users^{20, 22}. Our study, however, found different patterns of tobacco experimentation compared to

those in the US, suggesting that subpopulations of tobacco use might vary between countries. Studies using similar datasets and methodologies in the US found four distinct tobacco use groups in high and middle school. In their studies, the most prevalent group, after nonusers, is the group of ever use of cigarettes and cigars. However, in the Dominican Republic, shisha experimenters are the most prevalent group, after non-users.

Shisha is the most prevalent form of nicotine consumption in the youth of the Dominican Republic. Previous research in the country found that shishas are the second most prevalent product after cigarettes in adults⁴. Given the high prevalence of shisha use and the identified patterns of tobacco smoking, shisha use appears to be the main exposure point for tobacco use. Previous research in the US has also identified shishas as an entry point for other tobacco products^{23, 24}. Shishas are generally perceived to be less harmful and more socially acceptable²⁵. Since shisha are used along with other tobacco products, to reduce tobacco use we need public health interventions that focus on multiple concurrent use of tobacco products. The Dominican Republic has made some progress in control of shishas. In 2019 they banned the use of Shishas in enclosed spaces to reduce secondhand smoking²⁶. The Dominican Republic is also one of the eleven countries in the Americas to raise their taxes on tobacco products to lower accessibility by 10%²⁷. This criterion was set by the WHO in 2015²⁸. However, there has been no evaluation to see if these policies have been successful in reducing shisha use among teenagers.

The social modeling variables that we used as covariates predicted group membership. Students who observed people smoking tobacco in their houses were more likely to belong to the shisha experimenter, poly-tobacco experimenter, poly-tobacco users, and smokeless tobacco with experimentation classes than the non-users class. Likewise, stu-

dents who had observed people smoking outside were more likely to belong to the poly-tobacco and smokeless tobacco users classes than the non-users class. Interventions that focus on changing social norms have successfully reduced tobacco use, morbidity, and mortality^{29, 30}. By changing the social norms, adolescents will be less exposed to tobacco products inside and outside their homes.

This study is subject to some limitations. The study uses a cross-sectional study design. Therefore, it is only a snapshot in time and not able to capture transitions between classes. However, even with cross-sectional data, we could show that most adolescents who use tobacco in the Dominican Republic use different forms of tobacco. This indicates a need to focus on the prevention of multiple tobacco products to reduce tobacco use.

Further research using longitudinal data is necessary to investigate whether these classes represent different stages of tobacco use or if they represent stable subgroups of users. Future studies should include other variables that have been related to tobacco use, such as attitudes, self-efficacy to resist tobacco, and the price of tobacco products.

Our study advances the limited literature on tobacco use in the Dominican Republic. By using nationally representative data, we have identified groups in tobacco patterns in middle and high school students in the Dominican Republic. By analyzing the prevalence of these groups, we can conclude that most tobacco users in middle and high school use multiple tobacco products. This highlights the need to have prevention efforts focused on multiple tobacco products.

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