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Prevalence and correlates of smoking and nicotine dependence among Singapore residents

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Title: Prevalence and correlates of smoking and nicotine dependence among Singapore residents

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Abstract

Background: Since the Singapore Mental Health Study in 2010 which reported a 16% prevalence rate for current smokers and 4.5% for nicotine-dependence, new anti-smoking strategies have been implemented. The aim of this study was to compare smoking trends from the 2010 study with the second Singapore Mental Health Study in 2016 (SMHS 2016).

Methods: A household survey with 6126 residents was conducted using the same methodology as the 2010 study. The measures used in this analysis were sociodemographic questions, the Composite International Diagnostic Interview which assessed for psychiatric disorders, The Fagerstrom Test for Nicotine Dependence, and a list of chronic physical conditions which are prevalent in Singapore. Logistic regression analyses were used to test for associations between smoking/nicotine-dependence and other measures.

Results: In the SMHS 2016, 16% were current smokers and 3.3% were nicotine-dependent. As compared to non-smokers, current smokers were more likely to be of ethnic minority, male, divorced/separated (compared to married), and of lower/vocational education level. Male gender, lower/vocational education and psychiatric disorders (major depression, bipolar disorder and alcohol use disorders) predicted nicotine dependence. No associations were found between nicotine dependence and any of the chronic conditions.

Conclusion: The prevalence of current smokers in the population has plateaued while that of nicotine dependence has decreased from 2010. Inequalities in smoking and nicotine dependence continue to pervade the population particularly among those of ethnic minority, lower/vocational education and the mentally ill calling for strategies that move beyond raising cigarette prices and anti-smoking policies/campaigns that may further isolate stigmatised groups.

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Strengths and limitations of this study

- The study reports the prevalence and correlates of smoking and nicotine dependence based on a large representative sample of the Singapore population.

- The same methodology and instruments employed in the 2010 study was applied allowing direct comparisons with the earlier study.

- The study did not assess for alternative forms of smoking such as e-cigarettes that is gaining popularity.

- Reliance on self-report could lead to an underestimation of the true prevalence of nicotine dependence and associations with mental and medical conditions

Prevalence and correlates of smoking and nicotine dependence among Singapore residents

Cigarette smoking is a leading cause of preventable death worldwide [1]. Smoking-related diseases contribute significantly to the global rise in incidence of non-communicable diseases in both developed and developing countries [2]. Smoking ranks high among public health problems in the world, with an estimated 7.4-9.7 million tobacco-attributable deaths by 2030 [3].

In 2003, the World Health Assembly adopted the Framework Convention on Tobacco Control (FCTC) to take steps to reduce both the supply of and demand for tobacco products. This treaty is now ratified by 181 countries[2]. To help those countries fulfil their commitment to the FCTC, the WHO disseminated recommendations consisting of six strategies: monitor tobacco use; protect people from tobacco smoke; offer help to quit tobacco use; warn about the dangers of tobacco; enforce bans on tobacco advertising, promotion and sponsorship; and raise taxes on tobacco. Steady decline in smoking prevalence rates have been seen in countries such as New Zealand [4], Turkey, and Sweden [5] since the implementation of FCTC strategies.

However, these changes have not occurred uniformly across all population groups. Disparities in smoking prevalence are widening. In the United States, for example, less than 20% of those at or above the poverty level smoke compared with 30% of those below the poverty level. Other socioeconomic measures associated with inequalities in smoking include education, income, and neighbourhood deprivation [6]. The higher prevalence of smoking in individuals from lower SES groups is the single most important cause of socioeconomic differences in mortality (Stringhini et al., 2010).

Another subpopulation with exceptionally high rates of smoking internationally is individuals with mental illness. Individuals with mental illness smoke at rates approximately twice that of adults without mental disorders [9]. Smoking is believed to account for the majority of excess mortality among individuals with serious mental illness [10]. Life expectancy among people with severe mental illness is 25 years less than that among the general population [11]. Monitoring trends in the

population and between subgroups aids countries in taking necessary corrections or new actions for tobacco control.

Singapore is city-state located in the South-east Asia with a multi-ethnic population and was among the first 40 countries to ratify the FCTC. It exercises stringent smoking policies and extensive regulations on the demand and supply of tobacco [12]. In the nation-wide Singapore Mental Health Study conducted in 2010, (SMHS 2010), Picco et al. (2012) reported local smoking prevalence rates of 16%. Smokers were more likely to be of younger age, males, Malay ethnicity and have lower education. Prevalence of nicotine dependence was higher in those with alcohol abuse and those experiencing chronic pain. Singapore aims to lower smoking prevalence rates to 12 per cent by 2020 through a multipronged strategy composed of preventing initiation among the youth, public education and specific programs for target groups, and providing more support and access to smoking cessation programs [14].

The purpose of this study was to compare and contrast smoking trends from the 2010 study with the second Singapore Mental Health Study which began in 2016 (SMHS 2016). As stricter anti-smoking laws (e.g. raising minimum smoking age to 21years, expanding smoke-free zones) and new campaigns were launched after 2010, we hypothesize that there will be a decline in the prevalence of smoking and nicotine dependence in the SMHS 2016. This study also examined sociodemographic risk factors of smoking and nicotine dependence as well as the association of nicotine dependence with lifetime psychiatric and physical disorders.

Methods

Participants and Procedure

The SMHS 2016 was conducted following the same procedures as the SMHS 2010. This population-based, cross-sectional study included Singapore citizens and permanent residents aged 18 years and above living in Singapore. The sampling frame was based on a national population registry of all citizens and permanent residents in Singapore, and is updated regularly.

An invitation letter was sent to each respondent followed by a personal home visit by a

trained interviewer to obtain his/her agreement to participate in the survey. Trained interviewers from

a survey research company conducted face-to-face interviews with those who agreed to participate in

the study. The questionnaires were available in English, Chinese and Malay. Residents who were

incapable of doing an interview due to severe physical/mental conditions, language barriers; were

living outside the country, institutionalized/hospitalized, and those who were not contactable due to

incomplete/ incorrect address, were excluded from the survey. Consent was obtained from all

participants prior to commencement of any study procedure. Parental consent was also obtained for

minors aged 18-20 years.

Measures

Sociodemographic information: Data on gender, age groups (18–34, 35–49, 50–64, and ≥65 years),

ethnicity (Chinese, Malay, Indian, and Others), marital status (single, married, divorced/ separated or

widowed), educational level (primary and below, secondary, vocational institute, pre-university/

junior college, diploma and university), employment status (employed, unemployed and economically

inactive) and household income was collected.

Psychiatric Disorders: The World Health Organisation World Mental Health Composite

International Diagnostic Interview (WHO WMH-CIDI) is a structured instrument used to generate

diagnoses of DSM-IV disorders using established algorithms with organic exclusion criteria and

hierarchical rules. Modules on Depression, Mania, Generalised Anxiety Disorder, Obsessive

Compulsive Disorder, and Alcohol Use were included in the survey.

Smoking and Nicotine Dependence: Information on smoking was collected through a question that

asked participants whether they were current smokers, ex-smokers, or non-smokers who never

smoked before. The 6-item Fagerstrom Test for Nicotine Dependence was used to assess physical

dependence on tobacco smoking. Scores of 4 or less are classified as low dependence whilst scores of

8 to 10, as very high dependence. We categorised those with scores 5 and above as dependence as

defined by previous studies [15], including our previous study [13] to ensure consistency for

comparison.

Chronic Medical Conditions: Respondents were asked to report whether "a doctor ever told you that you have any of the following…". This was followed by a list of 18 chronic medical conditions which are prevalent in Singapore in the form of a checklist. These disorders were reclassified into the following 9 types of physical disorders: hypertension, hyperlipidemia, diabetes, asthma, chronic pain, cardiovascular diseases, ulcers, thyroid problems, and cancer.

Statistical analysis

All estimates were weighted to adjust for over-sampling and post-stratified for age and ethnicity distributions between the survey sample and the Singapore resident population. Mean and standard deviations were calculated for continuous variables, and frequencies and percentages for categorical variables. The socio-demographic characteristics were compared among the groups and tested for significant differences using Chi-square tests. This was followed by multiple logistic regression and multinomial logistic regression analyses to explore the sociodemographic correlates of nicotine dependence, and current or ex-smoking status. Statistical significance was evaluated at the <0.05 level using two-sided tests. All statistical analyses were carried out using the Statistical Analysis Software (SAS) System version 9 (SAS Institute Inc, 2011).

Patient and Public involvement

This research was done without patient involvement. Patients were not invited to comment on the study design and were not consulted to develop patient relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy.

Results

Prevalence of smoking and nicotine dependence

Table 1 shows the socio-demographic characteristics of the sample. Table 2 summarises the prevalence rates in 2010 and 2016. Among the population, 16.1% were current smokers, 10.5% were ex-smokers, while 3.3% had nicotine dependence. The prevalence of smokers among males was 27.1% and among females it was 5.3%.

Sociodemographic correlates of nicotine dependence

Table 3 shows the sociodemographic correlates of current smokers and ex-smokers. As compared to non-smokers, those who were current smokers were more likely to be of Malay, Indian or Other ethnicity (versus Chinese), male, divorced/separated (compared to married), have lower education level (i.e. primary or secondary education) or vocational qualifications (i.e. Polytechnic, or Technical Education) (compared to university degree). Those in the older age groups (≥50 years compared to 18-34years), economically inactive (compared to employed) and with a monthly household income of more than SGD10, 000 (compared to a monthly household income of SGD 2000) were less likely to be a current smoker. Compared to non-smokers, ex-smokers, similarly, were of Malay or other ethnicity, males, divorced/separated and had lower/vocational education level.

Multiple logistic regression showed (Table 4) that males had 7 times higher risk of nicotine dependence than females. Furthermore, nicotine dependence was significantly higher in those with lower or vocational educational qualifications (compared to university education). Older age (≥50 years, compared to 18-34years), being economically inactive (compared to employed) and monthly household income of SGD 4000-5999 (compared to less than SGD2000) was associated with lower risk of nicotine dependence.

Relationship between Nicotine Dependence and Psychiatric and Physical Disorders

Those with nicotine dependence were significantly more likely to have major depressive disorder (14.8% vs 6.0%, p<.0001), bipolar disorder (5.2% vs 1.4% p=0.003), alcohol abuse (25.8% vs 3%, p<.0001) and alcohol dependence (3.0% vs .05%, p<.0001) (Table 5).

No associations were found between nicotine dependence and any of the chronic conditions.

Discussion

The prevalence of smoking in the general population remained at 16% from our 2010 national survey [13]. Prevalence rates in males and females likewise, remained at about 27% in males and about 5% in females indicating a plateau in smoking prevalence. The sharpest decline occurred between the 1980s and the 2000s [16] with local rates hovering around 15% in the past 10 years [13]. However, a desirable shift in nicotine dependence from 4.5% in 2010 to 3.3% in 2016 was observed.

With one of the lowest smoking prevalence rates in the world, Singapore's challenge is to go beyond these rates to achieve the target set at 12% by 2020 [12]. Novel endgame solutions such as prohibiting the sales of tobacco to citizens born after year 2000 and using plain packaging have been proposed [17].

It was noteworthy that as many as 1 in 4 adult males are current smokers accounting for the vast majority of smokers in the country, with males being 7 times more likely than females to be nicotine-dependent. More recently, Subramaniam et al. (2015) through focus group discussions with Singaporean youths identified multiple personal (e.g. coping), social (e.g. for networking) and familial influences (e.g. early exposure) on young adults' smoking behaviours which provide actionable information for further anti-smoking initiatives. Factors such as traditional values, normative gender expectations, and economic independence have been purported for the wide margin of difference between the sexes [19].

Not surprisingly, smoking and nicotine dependence groups were overrepresented in those with lower or vocational qualifications and less likely to be associated with higher income. Marques-Vidal et al. (2011) suggested that those with higher levels of education are more responsive to social initiatives to cut down smoking and anti-smoking messages or have more contact with exemplary role models. Despite the rising cigarette prices/taxes with the average cost of a pack of 20 cigarettes priced at US$9.66 (SGD$13.31; [21], higher levels of smoking and nicotine dependence were observed among those with the lowest income levels suggesting alternative strategies are needed to reduce morbidity and mortality due to smoking for this group.

Two other sociodemographic factors that were associated with current smoking prevalence were ethnic minority (Malay and other ethnicity) and divorced marital status. Almost all Malays in Singapore are Muslims. While drinking alcohol is clearly forbidden in Islam, smoking is deemed by many Muslims as acceptable. Ethnic differences may also represent residual confounding by socio-economic influences that have not been adequately controlled using our proxy measures. Being married is associated with increased probability of smoking cessation in several studies due to spousal pressure and support to reduce smoking [22] Other studies found that incompatible health behaviour

predict divorce [23]. The health mismatch hypothesis asserts that spousal similarity in health and lifestyle factors may be related to everyday interaction, support, and the amount of time spouses spend together. Thus, concordant couples are likely to meet these health challenges with better adaptive processes than discordant couples. Additionally, the strains of marital discord have also been associated with negative health behaviours [24].

It was also noteworthy that the trend of smokers being in the youngest age group was not seen in this 2016 dataset which contrasts with our SMHS 2010 study that found smoking to be highest among those in the 18-34 age group compared to older age groups. This could be due to combined efforts of raising the minimum age for smoking, increasing cigarette prices and smoking prevention and cessation programmes in institutes of higher learning in the recent years. Shahwan et al. (2016) through focus group discussions with youths, identified various elements that were deemed to be efficacious in anti-smoking campaigns (e.g. positive tone, low-fear visual images, low 'controlling' language) which may be translated into continued efforts towards further reducing smoking rates in youths.

The relationship between being economically inactive and smoking is less clear. While unemployment is defined as being out of work and actively seeking work, economic inactivity exists when a person is without any form of employment and is not actively seeking work. The majority of individuals in the economic inactivity group consist of housewives, retirees and students. As such, we speculate that there were several protective factors against smoking for this group such as, higher education, spousal support, increasing health concerns with advancing age and the desire to improve longevity and quality of life.

Nicotine dependence was significantly associated with alcohol abuse as well as alcohol dependence. Nicotine-dependent individuals were 26 times more likely to abuse alcohol and about 3 times more likely to be dependent on alcohol than those who were non-nicotine dependent. Psychosocial factors such risk-prone personality traits, greater opportunities and inclinations to drink, have been widely accepted as reasons for the well-documented link between smoking and alcoholism [26]. However, these psychosocial factors may not completely account for the association between

smoking and alcohol problems. Some authors have speculated that the progression from the use of alcohol and tobacco to abuse may be facilitated by effects of early-stage use on central reward circuitry [27].

An association between nicotine dependence and major depressive disorder (MDD) and bipolar disorder, which was not apparent in 2010, emerged in the current study. The proportion of individuals with nicotine dependence who had MDD and bipolar disorder increased from 7% to 14% and 1% to 5% respectively. The prevalence of nicotine dependence in patients with mood disorders has been reported to range from 50-70% compared to 25% in the general population in other studies [28]. The comorbidity between nicotine dependence and mood disorders may be explained in at least two ways. First, various studies have demonstrated shared genetic and environmental influences. Second, it could also be argued that (i) depression increases the risks of smoking (i.e. through self-medication) or (ii) smoking increases the risk of depression [29]. Given that the proportion of MDD and bipolar disorder among individuals with nicotine dependence increased from 2010 to 2016, further exploration of this relationship is warranted.

Current population-level tobacco control interventions may be less effective for those with mental illness. Health promotion campaigns and smoking policies that use stigma (e.g. the peril that smokers bring to the rest of the population) as the main motivating factor for giving up smoking may contribute to social isolation among those with psychiatric disorders [30]. Thus, these efforts are more likely to perpetuate smoking inequalities than remove them. Cook et al. (2014) found that individuals receiving mental health treatment are not only less likely to smoke but are more likely to quit, suggesting that the mental health facility is a promising setting to promote smoking cessation in this group.

Despite cigarette smoking being recognised as a major risk factor of non-communicable diseases such as cardiovascular disease, cancer, and chronic lung disease, no significant associations with the chronic medical illnesses assessed in this study were found. We suspected that that individuals who had developed physical illness would have quit smoking to manage their illness and improve their prognosis. We conducted a post-hoc logistic regression analysis to examine this and

found that ex-smokers were more likely to be diagnosed with diabetes (p=.038) and cardiovascular

disease (p<.001) after controlling for age and gender. Individuals receiving medical care for these

conditions are likely to be advised by their physicians on the harms of smoking and receive smoking

cessation interventions, which contributes to successful quitting. Another possible reason for the lack

of association between current smoking and physical illness could be due to under-diagnosis.

Miravitlles et al. (2009) found a large discrepancy when comparing self-report chronic obstructive

pulmonary disease (COPD) and spirometry defined COPD (only 27% of cases identified reported

previous diagnosis). They observed that even though undiagnosed patients had a milder airflow

obstruction, they had significant impairment in health-related quality of life (HRQL) and reduced

levels of activities of daily living (ADL). Both HRQL and ADL are not only markers of ''well-being''

but also important predictors of survival in patients with COPD [33] . Local community health

screenings can include spirometry tests and offer simple smoking cessation behavioural support to all

smokers.

The study had several limitations. We did not assess other forms of smoking such as use of e-

cigarettes which is gaining popularity despite its ban in Singapore. Secondly, we relied on self-report

which could lead to an underestimation of true prevalence of nicotine dependence and associations

with mental and medical conditions. Third, as this was a cross-sectional study, we are unable to

determine causality. Fourth, although we achieved a fair response rate of 69.5%, there were

sociodemographic differences between respondent and non-respondent groups. Respondents were

more likely to be in the younger age group (i.e. 18-35 years compared to 35-49 years; OR=0.65,

p<.0001; 50-64 years; OR=0.68, p<.0001; 65+years; OR= 0.82, p=0.005) and of Malay or Indian

ethnicity (compared to Chinese; OR=1.87, p<.0001 and OR=1.91, p<.0001 respectively). In order to

minimise the impact of this bias, non-response weighting was used to statistically adjust for these

differences. The strengths of this study include the large sample size, the use of structured, well-

validated instruments, and a methodology similar to the 2010 study that allows for a direct

comparison between these two time-points.

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Tables

Table 1. Socio-demographic distribution of the sample (N = 6,126)

Sociodemographic characteristics		N	Unweighted %	Weighted %
Age Group (years)	18-34	1707	27.9	30.4
(Mean = 45.2)	35-49	1496	24.4	29.6
	50-64	1626	26.5	26.9
	65+	1297	21.2	13.1
Gender	Female	3058	49.9	50.4
	Male	3068	50.1	49.6
Ethnicity	Chinese	1782	29.1	75.7
	Malay	1990	32.5	12.5
	Indian	1844	30.1	8.7
	Others	510	8.3	3.1
Marital Status	Never Married	1544	25.2	31.0
	Married	3843	62.7	59.8
	Divorced / Separated	343	5.6	5.2
	Widowed	396	6.5	4.1
Education	Primary and below	1187	19.4	16.3
	Secondary	1648	26.9	23.0

	Pre-U/Junior College	304	5.0	6.0
	Vocational/ITE	508	8.3	6.3
	Diploma	1024	16.7	19.0
	University	1455	23.8	29.4
Employment	Employed	4055	66.2	72.0
	Economically inactive*	1716	28.0	22.7
	Unemployed	354	5.8	5.3
Household Income (SGD/ month)	Below 2000	1147	21.0	16.5
	2,000 – 3,999	1331	24.4	20.0
	4,000 – 5,999	1113	20.4	21.4
	6,000 – 9,999	1003	18.4	21.8
	10,000 & above	861	15.8	20.3

* Includes homemakers, students and retirees / pensioners; SGD- Singapore Dollars

Table 2. Prevalence of smoking and nicotine dependence

	2010	2016	p value
Current smokers	16.0	16.1	n.s.
Ex-smokers	10.8	10.5	n.s.
Nicotine dependence	4.5	3.3	0.007
Gender			
Male	27.0	27.1	n.s.
Females	5.6	5.3	n.s.

Table 3. Sociodemographic correlates of current smoking and ex-smokers

		Current smoker vs Non-smoker			Ex-smoker versus Non-smoker		
		OR	95% CI	p value	OR	95% CI	p value
Age group	18-34	Ref			Ref		
	35-49	0.9	(.6, 1.3)	0.48	1.1	(.7, 1.6)	0.84
	50-64	**0.4**	**(.2, .6)**	**<.0001**	0.7	(.5, 1.2)	0.18
	65 and above	**0.2**	**(.1, .4)**	**<.0001**	0.8	(.5,1.4)	0.43
Ethnicity	Chinese	Ref			Ref		
	Malay	**2.4**	**(1.9, 3.0)**	**<.0001**	**1.9**	**(1.5, 2.5)**	**<.0001**
	Indian	**1.4**	**(1.1, 1.8)**	**0.004**	1.1	(.9, 1.5)	0.32
	Others	**1.7**	**(1.2, 2.6)**	**0.008**	**2.0**	**(1.3, 2.8)**	**0.001**
Sex	Male	**8.8**	**(6.5, 11.8)**	**<.0001**	**5.5**	**(4.0, 7.5)**	**<.0001**
	Female	Ref			Ref		
Marital	Single	Ref			Ref		
	Married	0.9	(.6, 1.2)	0.42	1.3	(.8, 2.0)	0.27
	Divorced/Separated	**1.9**	**(1.1, 3.5)**	**0.04**	**2.5**	**(1.3, 4.8)**	**0.008**
	Widowed	0.8	(.3, 1.8)	0.57	0.7	(.3, 1.8)	0.52
Education	Primary	**13.8**	**(7.9, 24.1)**	**<.0001**	**3.8**	**(2.3, 6.3)**	**<.0001**
	Secondary	**7.3**	**(4.5, 12.0)**	**<.0001**	**2.6**	**(1.7, 4.1)**	**<.0001**
	Pre-U/JC/Diploma	1.7	(.8, 3.8)	0.185	1.5	(.7, 3.0)	0.26
	Vocational/ITE	**7.8**	**(4.7, 13.0)**	**<.0001**	**3.1**	**(1.8, 5.3)**	**<.0001**
	Diploma	**3.1**	**(2.0, 4.8)**	**<.0001**	1.8	**(1.2, 2.8)**	**0.008**
	University	Ref			Ref		
Employment	Employed	Ref			Ref		
	Economically inactive	**0.3**	**(.2, .5)**	**<.0001**	0.9	(.6, 1.3)	0.46
	Unemployed	0.9	(.5, 1.5)	0.65	0.9	(.5, 1.6)	0.8
Household	<SGD 2000	Ref			Ref		
Income	SGD 2000-3999	0.8	(.6, 1.2)	0.23	0.7	(.5, 1.1)	0.1
	SGD 4000-5999	0.8	(.5, 1.1)	0.16	0.8	(.5, 1.3)	0.43

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SGD 6000-9999	0.9	(.6, 1.3)	0.45	0.9	(.5, 1.4)	0.54
≥SGD 10 000	**0.6**	**(.3, 1.0)**	**0.04**	1.0	(.6, 1.6)	0.88

Table 4. Sociodemographic correlates of Nicotine Dependence

		OR	95% CI	P value
Age group	18-34	Ref		
	35-49	0.6	(.3, 1.1)	0.34
	50-64	**0.3**	**(.2, .6)**	**0.001**
	65 and above	**0.3**	**(.1, .7)**	**0.007**
Ethnicity	Chinese	Ref		
	Malay	1.5	(.9, 2.3)	0.1
	Indian	1.3	(.8, 2.0)	0.31
	Others	1.4	(.6, 3.2)	0.41
Sex	Male	**6.9**	**(3.6, 13.2)**	**<.0001**
	Female	Ref		
Marital	Single	Ref		
	Married	0.8	(.5, 1.5)	0.5
	Divorced/Separated	0.8	(.3, 1.8)	0.57
	Widowed	1.7	(.4, 6.7)	0.43
Education	**Primary**	**37.0**	**(8.3, 165.1)**	**<.0001**
	Secondary	**23.3**	**(5.8, 92.6)**	**<.0001**
	Pre-U/JC/	2.1	(.4, 9.8)	0.359
	Vocational/ITE	**16.0**	**(4.0, 63.8)**	**<.0001**
	Diploma	**10.0**	**(2.7, 37.0)**	**<.0001**
	University	Ref		
Employment	Employed	Ref		
	Economically inactive	**0.1**	**(.1, .3)**	**<.0001**

	Unemployed	0.6	(.3, 1.4)	0.26
Household				
Income	Below SGD 2000	Ref		
	SGD 2000-3900	0.8	(.5, 1.5)	0.56
	SGD **4000-5999**	**0.4**	**(.2, .8)**	**0.009**
	SGD 6000-9999	0.6	(.3, 1.4)	0.24
	10 000 and above	0.6	(.2, 1.4)	0.21

Table 5. Prevalence and odds ratio of other lifetime psychiatric disorders in people with

nicotine dependence

Lifetime psychiatric disorders	%	SE	OR	95CI	p value
Major Depressive Disorder	**14.8**	**0.4**	**3.0**	**(1.7, 5.5)**	**<.0001**
Dysthymia	0.1	0.0	0.4	(.1, 3.5)	0.42
Bipolar Disorder	**5.2**	**0.0**	**3.7**	**(1.6, 8.8)**	**0.003**
Generalised Anxiety Disorder	1.6	0.0	1.0	(.4, 2.2)	0.96
Obsessive Compulsive Disorder	5.1	0.0	1.5	(.6,3.7)	0.34
Alcohol Abuse	**25.8**	**0.0**	**6.7**	**(4.0, 11.3)**	**<0001**
Alcohol dependence	**3.0**	**0.0**	**4.0**	**(1.4,11.5)**	**0.009**

After adjusting for age and gender

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Prevalence and correlates of smoking and nicotine dependence: Results of a nationwide cross-sectional survey among Singapore residents

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Title: Prevalence and correlates of smoking and nicotine dependence: Results of a nationwide cross-sectional survey among Singapore residents

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Abstract

Background: Since the Singapore Mental Health Study in 2010 which reported a 16% prevalence rate for current smokers and 4.5% for nicotine-dependence, new anti-smoking strategies have been implemented. The aim of this study was to compare smoking trends from the 2010 study with the second Singapore Mental Health Study in 2016 (SMHS 2016).

Methods: A survey of 6126 individuals aged 18 years and above randomly selected among Singapore residents was conducted using the same methodology as the 2010 study. The measures used in this analysis were sociodemographic questions, the Composite International Diagnostic Interview which assessed for psychiatric disorders, The Fagerstrom Test for Nicotine Dependence, and a list of chronic physical conditions which are prevalent in Singapore. Logistic regression analyses were used to test for associations between smoking/nicotine-dependence and other measures.

Results: In the SMHS 2016, 16% were current smokers and 3.3% were nicotine-dependent. As compared to non-smokers, current smokers were more likely to be younger, male, of ethnic minority , and had lower/vocational education level. Younger age, male gender, lower/vocational education and psychiatric disorders (major depression, bipolar disorder and alcohol use disorders) predicted nicotine dependence. No associations were found between nicotine dependence and any of the chronic conditions.

Conclusion: The prevalence of current smokers in the population has plateaued while that of nicotine dependence has decreased from 2010. However, the study did not investigate the use of e-cigarettes. Inequalities in smoking and nicotine dependence continue to pervade the population particularly among those of ethnic minority, lower/vocational education and the mentally ill.

Strengths and limitations of this study

- The study reports the prevalence and correlates of smoking and nicotine dependence based on a large representative sample of the Singapore population.

- The same methodology and instruments employed in the 2010 study was applied allowing direct comparisons with the earlier study.

- The study did not include individuals below 18 years of age and did not assess for alternative forms of smoking such as e-cigarettes that are gaining popularity.

- Reliance on self-report could lead to an underestimation of the true prevalence of nicotine dependence and associations with mental and medical conditions

Prevalence and correlates of smoking and nicotine dependence among Singapore residents

Cigarette smoking is a leading cause of preventable death worldwide [1]. Smoking-related diseases contribute significantly to the global rise in incidence of non-communicable diseases in both developed and developing countries [2]. Smoking ranks high among public health problems in the world, with an estimated 7.4-9.7 million tobacco-attributable deaths by 2030 [3].

In 2003, the World Health Assembly adopted the Framework Convention on Tobacco Control (FCTC) to take steps to reduce both the supply of and demand for tobacco products. This treaty is now ratified by 181 countries[2]. To help those countries fulfil their commitment to the FCTC, the WHO disseminated recommendations consisting of six strategies: monitor tobacco use; protect people from tobacco smoke; offer help to quit tobacco use; warn about the dangers of tobacco; enforce bans on tobacco advertising, promotion and sponsorship; and raise taxes on tobacco. Steady decline in smoking prevalence rates have been seen in countries such as New Zealand [4], Turkey, and Sweden [5] since the implementation of FCTC strategies.

However, these changes have not occurred uniformly across all population groups. An upward trend in smoking debut in early adolescence was found in a European study [6]. Disparities in smoking prevalence in underprivileged populations are also widening. In the United States, for example, less than 20% of those at or above the poverty level smoke compared with 30% of those below the poverty level. Other socioeconomic measures associated with inequalities in smoking include education, income, and neighbourhood deprivation [7]. The higher prevalence of smoking in individuals from lower SES groups is the single most important cause of socioeconomic differences in mortality [8].

Another subpopulation with exceptionally high rates of smoking internationally is individuals with mental illness. Individuals with mental illness smoke at rates approximately twice that of adults without mental disorders [9]. Smoking is believed to account for the majority of excess mortality among individuals with serious mental illness [10]. Life expectancy among people with severe mental illness is 25 years less than that among the general population [11]. Monitoring trends in the

population and between subgroups aids countries in taking necessary corrections or new actions for tobacco control.

Singapore is city-state located in the South-east Asia with a multi-ethnic population and was among the first 40 countries to ratify the FCTC. It exercises stringent smoking policies and extensive regulations on the demand and supply of tobacco [12]. In the nation-wide Singapore Mental Health Study conducted in 2010, (SMHS 2010), Picco and colleagues [13] reported local smoking prevalence rates of 16%. Smokers were more likely to be of younger age, males, Malay ethnicity and have lower education. Prevalence of nicotine dependence was higher in those with alcohol abuse and those experiencing chronic pain. Singapore aims to lower smoking prevalence rates to 12 per cent by 2020 through a multipronged strategy composed of preventing initiation among the youth, public education and specific programs for target groups, and providing more support and access to smoking cessation programs [14].

The purpose of this study was to compare and contrast smoking trends from the 2010 study with the second Singapore Mental Health Study which began in 2016 (SMHS 2016) [15]. As stricter anti-smoking laws (e.g. raising minimum smoking age to 21years, expanding smoke-free zones) and new campaigns were launched after 2010, we hypothesize that there will be a decline in the prevalence of smoking and nicotine dependence in the SMHS 2016. This study also examined sociodemographic risk factors of smoking and nicotine dependence as well as the association of nicotine dependence with lifetime psychiatric and physical disorders.

Methods

Participants and Procedure

The SMHS 2016 was conducted between 2016 and 2018 following the same procedures as the SMHS 2010 [16]. This population-based, cross-sectional study included Singapore citizens and permanent residents aged 18 years and above living in Singapore. The sampling frame was based on a national population registry of all citizens and permanent residents in Singapore, and is updated regularly. Individuals were randomly selected using a disproportionate stratified sampling design with

16 strata defined according to ethnicity (Chinese, Malay, Indian, Others) and age groups (18-34, 35-49, 50-64, 65 and above). Residents aged 65 and above, Malays and Indians were over sampled to ensure that an adequate sample size would be achieved to improve the reliability of estimates for the subgroup analysis. We requested 15,907 records of Singapore residents. 11,100 records were eventually released in eight different batches. About 20% of these were ineligible cases (e.g. ineligible language, incorrect address) which were excluded from the response rate calculation. In all, 6126 respondents were interviewed, giving a response rate of 69.5%. Data on household structure was not collated and not accounted for in the analysis.

An invitation letter was sent to each respondent followed by a personal home visit by a trained interviewer to obtain his/her agreement to participate in the survey. Trained interviewers from a survey research company conducted face-to-face interviews with those who agreed to participate in the study. The questionnaires were available in English, Chinese and Malay. Residents who were incapable of doing an interview due to severe physical/mental conditions, language barriers; were living outside the country, institutionalized/hospitalized, and those who were not contactable due to incomplete/ incorrect address, were excluded from the survey. Consent was obtained from all participants prior to commencement of any study procedure. Parental consent was also obtained for minors aged 18-20 years.

Measures

Sociodemographic information: Data on gender, age groups (18–34, 35–49, 50–64, and ≥65 years), ethnicity (Chinese, Malay, Indian, and Others), marital status (single, married, divorced/ separated or widowed), educational level (primary and below, secondary, vocational institute, pre-university/ junior college, diploma and university), employment status (employed, unemployed and economically inactive) and household income was collected.

Psychiatric Disorders: The World Health Organisation World Mental Health Composite International Diagnostic Interview (WHO WMH-CIDI) is a structured instrument used to generate diagnoses of DSM-IV disorders using established algorithms with organic exclusion criteria and

hierarchical rules. Modules on Depression, Mania, Generalised Anxiety Disorder, Obsessive

Compulsive Disorder, and Alcohol Use were included in the survey.

Smoking and Nicotine Dependence: Information on smoking was collected through a question that

asked participants whether they were current smokers, ex-smokers, or non-smokers who never

smoked before. The 6-item Fagerstrom Test for Nicotine Dependence was used to assess physical

dependence on tobacco smoking. Scores of 4 or less are classified as low dependence whilst scores of

8 to 10, as very high dependence. We categorised those with scores 5 and above as dependence as

defined by previous studies [17], including our previous study [13] to ensure consistency for

comparison.

Chronic Medical Conditions: Respondents were asked to report whether "a doctor ever told you that

you have any of the following…". This was followed by a list of 18 chronic medical conditions which

are prevalent in Singapore in the form of a checklist. These disorders were reclassified into the

following 9 types of physical disorders: hypertension, hyperlipidemia, diabetes, asthma, chronic pain,

cardiovascular diseases, ulcers, thyroid problems, and cancer.

Statistical analysis

All estimates were weighted to adjust for over-sampling and post-stratified for age and ethnicity

distributions between the survey sample and the Singapore resident population. Mean and standard

deviations were calculated for continuous variables, and frequencies and percentages for categorical

variables. The socio-demographic characteristics were compared among the groups and tested for

significant differences using Chi-square tests. This was followed by multiple logistic regression and

multinomial logistic regression analyses to explore the sociodemographic correlates of nicotine

dependence, and current or ex-smoking status. Gender-specific analyses were also conducted to

compare the prevalence rates between 2010 and 2016 as well to explore sociodemographic correlates

of nicotine dependence, current and ex-smoking status. Statistical significance was evaluated at the

<0.05 level using two-sided tests. All statistical analyses were carried out using the Statistical Analysis

Software (SAS) System version 9.

Patient and Public involvement

This research was done without patient involvement. Patients were not invited to comment on the study design and were not consulted to develop patient relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy.

Results

Prevalence of smoking and nicotine dependence

Table 1 shows the socio-demographic characteristics of the sample classified by smoker, ex-smoker and non-smoker status. Table 2 summarises the prevalence rates in 2010 and 2016. Among the population, 16.1% were current smokers, 10.5% were ex-smokers, while 3.3% had nicotine dependence. The prevalence of smokers among males was 27.1% and among females it was 5.3%. Supplementary Table 1 provides further information of the prevalence of current smokers, ex-smokers and nicotine dependence by age group and gender.

Sociodemographic correlates of nicotine dependence

Table 3 shows the sociodemographic correlates of current smokers and ex-smokers. As compared to non-smokers, those who were current smokers were more likely to be of Malay, Indian or Other ethnicity (versus Chinese), male, divorced/separated (compared to married), have lower education level (i.e. primary or secondary education) or vocational qualifications (i.e. Polytechnic, or Technical Education) (compared to university degree). Those in the older age groups (≥50 years compared to 18-34years), economically inactive (compared to employed) and with a monthly household income of more than SGD10, 000 (compared to a monthly household income of SGD 2000) were less likely to be a current smoker. Compared to non-smokers, ex-smokers, similarly, were of Malay or other ethnicity, males, divorced/separated and had lower/vocational education level. Supplementary Tables 2a and 2b present the sociodemographic correlates of male current and ex-smokers and that of females respectively. The results are consistent for both sexes with exception to income, where the highest income group (>SGD 10, 000) was associated with lower odds of smoking in males whereas the lower income group (SGD 2000-3999) was associated with lower odds of

smoking in females. The relationship between marital status and smoking however was inconsistent with no association found for males and a lower odds of current smoking associated with being widowed in females (although being divorced/separated was associated with higher odds of being a current or ex-smoker for the overall sample).

Multiple logistic regression showed (Table 4) that males had 7 times higher risk of nicotine dependence than females. Furthermore, nicotine dependence was significantly higher in those with lower or vocational educational qualifications (compared to university education). Older age (≥50 years, compared to 18-34years), being economically inactive (compared to employed) and monthly household income of SGD 4000-5999 (compared to less than SGD2000) was associated with lower risk of nicotine dependence. Supplementary Tables 3a and 3b present the sociodemographic correlates of nicotine dependence in males and females respectively. The results are for both sexes are consistent with that of the overall sample.

Relationship between Nicotine Dependence and Psychiatric and Physical Disorders

Those with nicotine dependence were significantly more likely to have major depressive disorder, bipolar disorder, alcohol abuse and alcohol dependence. Gender difference was observed for OCD where females with nicotine dependence were 6 times more likely to have OCD than those without nicotine dependence but this association was not observed in males. These results are summarised in Table 5.

No associations were found between nicotine dependence and any of the chronic conditions.

Discussion

The prevalence of smoking in the general population remained at 16% from our 2010 national survey [13]. Prevalence rates in males and females likewise, remained at about 27% in males and about 5% in females indicating a plateau in smoking prevalence. The sharpest decline occurred between the 1980s and the 2000s [18] with local rates hovering around 15% in the past 10 years [13]. However, a desirable shift in nicotine dependence from 4.5% in 2010 to 3.3% in 2016 was observed. With one of the lowest smoking prevalence rates in the world, Singapore's challenge is to go beyond

these rates to achieve the target set at 12% by 2020 [12]. Novel endgame solutions such as prohibiting the sales of tobacco to citizens born after year 2000 and using plain packaging have been proposed [19].

It was noteworthy that as many as 1 in 4 adult males are current smokers accounting for the vast majority of smokers in the country, with males being 7 times more likely than females to be nicotine-dependent. More recently, Subramaniam and colleagues [20] through focus group discussions with Singaporean youths identified multiple personal (e.g. coping), social (e.g. for networking) and familial influences (e.g. early exposure) on young adults' smoking behaviours which provide actionable information for further anti-smoking initiatives. Factors such as traditional values, normative gender expectations, and economic independence have been purported for the wide margin of difference between the sexes [21].

Not surprisingly, smoking and nicotine dependence groups were overrepresented in those with lower or vocational qualifications and less likely to be associated with higher income. Marques-Vidal and colleagues [22]suggested that those with higher levels of education are more responsive to social initiatives to cut down smoking and anti-smoking messages or have more contact with exemplary role models. Despite the rising cigarette prices/taxes with the average cost of a pack of 20 cigarettes priced at US$9.66 (SGD$13.31; [23], higher levels of smoking and nicotine dependence were observed among those with the lowest income levels suggesting alternative strategies are needed to reduce morbidity and mortality due to smoking for this group.

Two other sociodemographic factors that were associated with current smoking prevalence were age and ethnic minority status (Malay and other ethnicity). An age effect was observed with the prevalence of smoking being higher in the younger age groups despite the combined efforts of raising the minimum age for smoking, increasing cigarette prices and smoking prevention and cessation programmes in institutes of higher learning in the recent years. Shahwan and colleagues [24]through focus group discussions with youths, identified various elements that were deemed to be efficacious in anti-smoking campaigns (e.g. positive tone, low-fear visual images, low 'controlling' language) which may be translated into continued efforts towards further reducing smoking rates in youths. With

regard to ethnicity, almost all Malays in Singapore are Muslims. While drinking alcohol is clearly

forbidden in Islam, smoking is deemed by many Muslims as acceptable. Ethnic differences may also

represent residual confounding by socio-economic influences that have not been adequately controlled

using our proxy measures.

The correlates of smoking and nicotine dependence identified in the current study (i.e. the

association between smoking and younger age, males, ethnic minority, lower/vocational education)

are similar to the findings of the 2010 study, representing the stability and persistence of these factors.

The relationship between being economically inactive and smoking is less clear. While

unemployment is defined as being out of work and actively seeking work, economic inactivity exists

when a person is without any form of employment and is not actively seeking work. The majority of

individuals in the economic inactivity group consist of housewives, retirees and students. As such, we

speculate that there were several protective factors against smoking for this group such as, higher

education, spousal support, increasing health concerns with advancing age and the desire to improve

longevity and quality of life.

Nicotine dependence was significantly associated with alcohol abuse as well as alcohol

dependence. Nicotine-dependent individuals were 26 times more likely to abuse alcohol and about 3

times more likely to be dependent on alcohol than those who were non-nicotine dependent.

Psychosocial factors such risk-prone personality traits, greater opportunities and inclinations to drink,

have been widely accepted as reasons for the well-documented link between smoking and alcoholism

[25]. However, these psychosocial factors may not completely account for the association between

smoking and alcohol problems. Some authors have speculated that the progression from the use of

alcohol and tobacco to abuse may be facilitated by effects of early-stage use on central reward

circuitry [26].

An association between nicotine dependence and major depressive disorder (MDD) and

bipolar disorder, which was not apparent in 2010, emerged in the current study. The proportion of

individuals with nicotine dependence who had MDD and bipolar disorder increased from 7% to 14%

and 1% to 5% respectively. The prevalence of nicotine dependence in patients with mood disorders

has been reported to range from 50-70% compared to 25% in the general population in other studies

[27]. The comorbidity between nicotine dependence and mood disorders may be explained in at least

two ways. First, various studies have demonstrated shared genetic and environmental influences.

Second, it could also be argued that (i) depression increases the risks of smoking (i.e. through self-

medication) or (ii) smoking increases the risk of depression [28]. Given that the proportion of MDD

and bipolar disorder among individuals with nicotine dependence increased from 2010 to 2016,

further exploration of this relationship is warranted.

A gender difference was found in the association between nicotine dependence and OCD

where 26% of females with nicotine dependence had OCD compared to 2.5% for males. We identified

three other studies that have similarly found an association between smoking and OCD only in

females [29][30][31]. However, our finding differs from the vast majority of clinical studies that have

shown that patients with OCD are less likely to smoke compared to the general population (e.g.

[32][33]). As suggested by Wu and colleagues, this may have to do with differences between clinical

and community samples and further research is needed to shed light on the association between

nicotine dependence and OCD in males and females.

Current population-level tobacco control interventions may be less effective for those with

mental illness. Health promotion campaigns and smoking policies that use stigma (e.g. the peril that

smokers bring to the rest of the population) as the main motivating factor for giving up smoking may

contribute to social isolation among those with psychiatric disorders [34]. Thus, these efforts are more

likely to perpetuate smoking inequalities than remove them. Cook and colleagues [35] found that

individuals receiving mental health treatment are not only less likely to smoke but are more likely to

quit, suggesting that the mental health facility is a promising setting to promote smoking cessation in

this group.

The study had several limitations. We did not include individuals below 18 years of age and

did not assess other forms of smoking such as use of e-cigarettes which is gaining popularity despite

its ban in Singapore. Secondly, we relied on self-report which could lead to an underestimation of true

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prevalence of nicotine dependence and associations with mental and medical conditions. Third, as this was a cross-sectional study, we are unable to determine causality. Fourth, although we achieved a fair response rate of 69.5%, there were sociodemographic differences between respondent and non-respondent groups. Respondents were more likely to be in the younger age group (i.e. 18-35 years compared to 35-49 years; OR=0.65, p<.0001; 50-64 years; OR=0.68, p<.0001; 65+years; OR= 0.82, p=0.005) and of Malay or Indian ethnicity (compared to Chinese; OR=1.87, p<.0001 and OR=1.91, p<.0001 respectively). This could lead to obscuring true prevalence as mental health determinants differ between responders and non-responders [36]. In order to minimise the impact of this bias, non-response weighting was used to statistically adjust for these differences. The strengths of this study include the large sample size, the use of structured, well-validated instruments, and a methodology similar to the 2010 study that allows for a direct comparison between these two time-points.

Data sharing statement. No data are available.

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Tables

Table 1. Socio-demographic profile of the sample by smoking status

Sociodemographic characteristics		N	Smoking status			
			Smoker	Ex-smoker	Non-smoker	Total
			(N=1176)	(N=750)	(N=4181)	(N=6107)
			Weighted percentage			
Age Group (years) (Mean = 45.2)	18-34	1707	35.1	23.7	30.5	30.4
	35-49	1496	30.8	29.9	29.2	29.6
	50-64	1626	27.1	28.4	26.6	26.9
	65+	1297	7.0	18.0	13.7	13.1
Gender	Female	3058	16.5	24.3	61.7	50.4
	Male	3068	83.5	75.7	38.3	49.6
Ethnicity	Chinese	1782	63.7	71.1	79.0	75.7
	Malay	1990	23.9	16.3	9.4	12.5
	Indian	1844	9.8	8.3	8.5	8.7
	Others	510	2.6	4.3	3.1	3.1
Marital Status	Never Married	1544	35.5	22.6	31.3	31
	Married	3843	54.7	66.8	59.8	59.8
	Divorced / Separated	343	7.9	7.8	4.2	5.2
	Widowed	396	2.0	2.8	4.7	4.1
Education	Primary and below	1187	21.8	20.8	14.4	16.3
	Secondary	1648	29.6	25.3	21.2	23
	Pre-U/Junior College	304	3.2	4.6	6.8	6
	Vocational/ITE	508	15.9	8.8	3.8	6.3
	Diploma	1024	18.8	18.2	19.2	19
	University	1455	10.7	22.3	34.6	29.4
Employment	Employed	4055	83.4	73.5	69.3	72
	Economically inactive*	1716	9.3	22.0	25.8	22.7
	Unemployed	354	7.3	4.5	4.8	5.3
Household Income (SGD/ month)	Below 2000	1147	21.0	20.8	14.8	16.5
	2,000 – 3,999	1331	27.2	18.1	18.7	20
	4,000 – 5,999	1113	23.0	21.2	21.0	21.4
	6,000 – 9,999	1003	19.4	20.0	22.7	21.8
	10,000 & above	861	9.5	19.9	22.8	20.3

* Includes homemakers, students and retirees / pensioners; SGD- Singapore Dollars;

Table 2. Comparison of the prevalence of Current smokers, Ex-smokers and Nicotine
Dependence in SMHS 2010 and SMHS 2016

	2010	2016	p value
Current smokers	16.0	16.1	n.s.
Male	27.0	27.1	n.s.
Females	5.6	5.3	n.s.
Ex-smokers	10.8	10.5	n.s.
Nicotine dependence	4.5	3.3	0.007

Chi square analysis; n.s. : not statistically significant

Table 3. Sociodemographic correlates of current smoking and ex-smokers

		Current smoker vs Non-smoker			Ex-smoker versus Non-smoker		
		OR	95% CI	p value	OR	95% CI	p value
Age group	18-34	Ref			Ref		
	35-49	0.9	(.6, 1.3)	0.48	1.1	(.7, 1.6)	0.84
	50-64	**0.4**	**(.2, .6)**	**<.0001**	0.7	(.5, 1.2)	0.18
	65 and above	**0.2**	**(.1, .4)**	**<.0001**	0.8	(.5,1.4)	0.43
Gender	Male	**8.8**	**(6.5, 11.8)**	**<.0001**	**5.5**	**(4.0, 7.5)**	**<.0001**
	Female	Ref			Ref		
Ethnicity	Chinese	Ref			Ref		
	Malay	**2.4**	**(1.9, 3.0)**	**<.0001**	**1.9**	**(1.5, 2.5)**	**<.0001**
	Indian	**1.4**	**(1.1, 1.8)**	**0.004**	1.1	(.9, 1.5)	0.32
	Others	**1.7**	**(1.2, 2.6)**	**0.008**	**2.0**	**(1.3, 2.8)**	**0.001**
Marital	Single	Ref			Ref		
	Married	0.9	(.6, 1.2)	0.42	1.3	(.8, 2.0)	0.27
	Divorced/Separated	**1.9**	**(1.1, 3.5)**	**0.04**	**2.5**	**(1.3, 4.8)**	**0.008**
	Widowed	0.8	(.3, 1.8)	0.57	0.7	(.3, 1.8)	0.52
Education	Primary	**13.8**	**(7.9, 24.1)**	**<.0001**	3.8	**(2.3, 6.3)**	**<.0001**
	Secondary	**7.3**	**(4.5, 12.0)**	**<.0001**	2.6	**(1.7, 4.1)**	**<.0001**
	Pre-U/JC/Diploma	1.7	(.8, 3.8)	0.185	1.5	(.7, 3.0)	0.26
	Vocational/ITE	**7.8**	**(4.7, 13.0)**	**<.0001**	**3.1**	**(1.8, 5.3)**	**<.0001**
	Diploma	**3.1**	**(2.0, 4.8)**	**<.0001**	1.8	**(1.2, 2.8)**	**0.008**
	University	Ref			Ref		
Employment	Employed	Ref			Ref		
	Economically inactive	**0.3**	**(.2, .5)**	**<.0001**	0.9	(.6, 1.3)	0.46
	Unemployed	0.9	(.5, 1.5)	0.65	0.9	(.5, 1.6)	0.8
Household	<SGD 2000	Ref			Ref		
Income	SGD 2000-3999	0.8	(.6, 1.2)	0.23	0.7	(.5, 1.1)	0.1
	SGD 4000-5999	0.8	(.5, 1.1)	0.16	0.8	(.5, 1.3)	0.43
	SGD 6000-9999	0.9	(.6, 1.3)	0.45	0.9	(.5, 1.4)	0.54
	≥SGD 10 000	**0.6**	**(.3, 1.0)**	**0.04**	1.0	(.6, 1.6)	0.88

Multinomial logistic regression analysis controlled for potential confounders including age, ethnicity, marital status,

education, employment and household income. OR: Odds Ratio; CI: Confidence Intervals

Table 4. Sociodemographic correlates of Nicotine Dependence

		OR	95% CI	P value
Age group	18-34	Ref		
	35-49	0.6	(.3, 1.1)	0.34
	50-64	**0.3**	**(.2, .6)**	**0.001**
	65 and above	**0.3**	**(.1, .7)**	**0.007**
Gender	Male	**6.9**	**(3.6, 13.2)**	**<.0001**
	Female	Ref		
Ethnicity	Chinese	Ref		
	Malay	1.5	(.9, 2.3)	0.1
	Indian	1.3	(.8, 2.0)	0.31
	Others	1.4	(.6, 3.2)	0.41
Marital	Single	Ref		
	Married	0.8	(.5, 1.5)	0.5
	Divorced/Separated	0.8	(.3, 1.8)	0.57
	Widowed	1.7	(.4, 6.7)	0.43
Education	**Primary**	**37.0**	**(8.3, 165.1)**	**<.0001**
	Secondary	**23.3**	**(5.8, 92.6)**	**<.0001**
	Pre-U/JC/	2.1	(.4, 9.8)	0.359
	Vocational/ITE	**16.0**	**(4.0, 63.8)**	**<.0001**
	Diploma	**10.0**	**(2.7, 37.0)**	**<.0001**
	University	Ref		
Employment	Employed	Ref		
	Economically inactive	**0.1**	**(.1, .3)**	**<.0001**
	Unemployed	0.6	(.3, 1.4)	0.26
Household	<SGD 2000	Ref		
Income	SGD 2000-3900	0.8	(.5, 1.5)	0.56
	SGD **4000-5999**	**0.4**	**(.2, .8)**	**0.009**
	SGD 6000-9999	0.6	(.3, 1.4)	0.24
	10 000 and above	0.6	(.2, 1.4)	0.21

Table 5. Prevalence and odds ratio of other lifetime psychiatric disorders in people with nicotine dependence

Lifetime psychiatric disorders	Sample	%	SE	OR	95% CI	p value
Major Depressive Disorder	**Total**	**14.8**	**0.4**	**3.0**	**(1.7, 5.5)**	**<.0001**
	Males	14.9	**3.9**	**3.3**	**(1.7, 6.5)**	**<.0001**
	Females	13.6	5.7	1.6	(.6,4.4)	0.359
Dysthymia		0.1	0.0	0.4	(.1, 3.5)	0.420
	Males	0.1	0.1	0.5	(.06, 4.9)	0.590
	Females	0.0	0.0	.	.	.
Bipolar Disorder		**5.2**	**0.0**	**3.7**	**(1.6, 8.8)**	**0.003**
	Males	**5.1**	**2.2**	**4.0**	**(1.5,10.8)**	**0.006**
	Females	5.8	3.5	2.9	(.7,11.2)	0.131
Generalised Anxiety Disorder		1.6	0.0	1.0	(.4, 2.2)	0.960
	Males	1.3	0.6	0.7	(.3,1.9)	0.540
	Females	4.9	3.1	2.5	(.6,10.2)	0.210
Obsessive Compulsive Disorder		5.1	0.0	1.5	(.6,3.7)	0.340
	Males	2.5	0.8	0.7	(.4,1.6)	0.429
	Females	**26.4**	**13.9**	**6.2**	**(1.5, 24.6)**	**0.010**
Alcohol Abuse		**25.8**	**0.0**	**6.7**	**(4.0, 11.3)**	**<.0001**
	Males	**27.2**	**4.7**	**6.7**	**(3.9,11.4)**	**<.0001**
	Females	14.2	11.2	5.9	(.9,37.2)	0.060
Alcohol dependence		**3.0**	**0.0**	**4.0**	**(1.4,11.5)**	**0.009**
	Males	**2.7**	**1.2**	**3.2**	**(1.0, 10.0)**	**0.040**
	Females	5.3	3.3	25.7	(5.8,113.8)	<.0001

Multiple logistic regression analyses in total sample and by gender-specification, adjusted for age. SE:

standard error

Supplementary Tables

Supplementary Table 1. Prevalence of current smokers, ex-smokers, nicotine dependence by age group and gender

	Males			Females		
	2010	2016	p value	2010	2016	p value
Current smokers						
18-34	31.1	28.1	0.27	9.3	8.1	0.44
35-49	25.9	28.9	0.31	5.6	6.2	0.71
50-64	24.8	28.5	0.24	2.3	3.3	0.46
65+	23.1	17.0	0.08	1.6	1.0	0.64
Ex-smokers						
18-34	8.3	9.3	0.59	5.4	7.0	0.24
35-49	16.9	16.9	0.99	3.8	5.2	0.27
50-64	20.5	18.0	0.39	2.9	3.8	0.48
65+	**39.2**	**26.9**	**0.02**	6.9	3.0	0.10
Nicotine dependence						
18-34	8.1	6.4	0.25	2.1	1.7	0.60
35-49	7.1	6.1	0.54	**2.1**	**0.4**	**<0.001**
50-64	7.6	6.1	0.39	1.4	0.5	0.19
65+	6.9	3.6	0.17	.	.	.

Chi square analysis; (.) denotes missing or less than 5 cases

Supplementary Table 2a. Sociodemographic correlates of current and former smoking status among males

		Current smoker vs Non-smoker				Ex-smoker versus Non-smoker			
		OR	95% CI		p value	OR	95% CI		p value
Age group	18-34	Ref				Ref			
	35-49	1.3	0.8	2.0	0.321	**2.0**	**1.2**	**3.5**	**0.013**
	50-64	**0.6**	**0.3**	**0.9**	**0.028**	1.4	0.8	2.4	0.270
	65 and above	**0.3**	**0.2**	**0.6**	**0.001**	1.4	0.8	2.7	0.272
Ethnicity	Chinese	Ref				Ref			
	Malay	**2.7**	**2.0**	**3.5**	**<0.001**	**2.1**	**1.6**	**2.9**	**0.000**
	Indian	**1.4**	**1.1**	**1.9**	**0.010**	1.2	0.9	1.6	0.298
	Others	1.4	0.9	2.3	0.123	**1.6**	**1.0**	**2.6**	**0.041**
Marital	Single	Ref				Ref			
	Married	0.9	0.6	1.4	0.657	1.1	0.7	1.9	0.602
	Divorced/Separated	1.6	0.7	3.8	0.296	2.1	0.9	5.3	0.104
	Widowed	2.0	0.5	7.1	0.301	0.6	0.1	2.2	0.399
Education	**Primary**	**13.3**	**7.0**	**25.3**	**<0.001**	**5.0**	**2.7**	**9.3**	**0.000**
	Secondary	**6.3**	**3.7**	**10.8**	**<0.001**	**3.3**	**2.0**	**5.5**	**0.000**
	Pre-U/JC/Diploma	1.9	0.8	4.5	0.125	1.3	0.6	3.0	0.544
	Vocational/ITE	**7.4**	**4.2**	**12.8**	**<0.001**	**3.3**	**1.7**	**6.4**	**0.000**
	Diploma	**2.8**	**1.7**	**4.5**	**<0.001**	**2.4**	**1.5**	**4.1**	**0.001**
	University	Ref				Ref			
Employment	Employed	Ref				Ref			
	Economically inactive	**0.4**	**0.3**	**0.7**	**0.001**	1.2	0.8	2.0	0.401
	Unemployed	1.0	0.6	1.9	0.924	1.2	0.6	2.5	0.557
Household Income	<SGD 2000	Ref							
	SGD 2000-3999	1.0	0.6	1.5	0.920	0.7	0.4	1.3	0.257
	SGD 4000-5999	0.9	0.5	1.4	0.548	0.8	0.5	1.4	0.385
	SGD 6000-9999	0.9	0.6	1.6	0.810	0.9	0.5	1.6	0.708
	≥SGD 10 000	**0.5**	**0.3**	**1.0**	**0.048**	1.1	0.6	2.1	0.667

Multinomial logistic regression analysis controlled for potential confounders including age, ethnicity, marital status, education, employment and household income.

Supplementary Table 2b. Sociodemographic correlates of current and former smoking status among females

		Current smoker vs Non-smoker				Ex-smoker versus Non-smoker			
		OR	95% CI		p value	OR	95% CI		p value
Age group	18-34	Ref				Ref			
	35-49	0.4	0.2	0.9	0.019	**0.4**	**0.2**	**0.8**	**0.016**
	50-64	**0.1**	**0.0**	**0.3**	**<0.001**	**0.2**	**0.1**	**0.5**	**0.001**
	65 and above	**0.1**	**0.0**	**0.3**	**<0.001**	**0.1**	**0.0**	**0.4**	**0.001**
Ethnicity	Chinese	Ref				Ref			
	Malay	**1.9**	**1.2**	**3.0**	**0.005**	1.7	1.0	2.7	0.032
	Indian	1.3	0.8	2.2	0.300	1.0	0.6	1.6	0.904
	Others	**2.3**	**1.1**	**5.1**	**0.033**	**2.5**	**1.3**	**4.8**	**0.005**
Marital	Single	Ref				Ref			
	Married	0.6	0.3	1.2	0.138	1.4	0.7	2.8	0.381
	Divorced/Separated	2.3	1.0	5.4	0.064	**3.5**	**1.3**	**9.5**	**0.013**
	Widowed	**0.2**	**0.0**	**0.7**	**0.010**	2.3	0.7	8.1	0.187
Education	**Primary**	**22.3**	**6.4**	**78.1**	**<0.001**	**3.2**	**1.2**	**8.5**	**0.021**
	Secondary	**13.6**	**4.6**	**39.8**	**<0.001**	1.7	0.7	4.0	0.242
	Pre-U/JC/Diploma	0.3	0.0	2.2	0.216	1.9	0.6	5.6	0.260
	Vocational/ITE	**8.1**	**2.9**	**22.3**	**<0.001**	**3.3**	**1.3**	**8.5**	**0.011**
	Diploma	**4.6**	**1.7**	**11.9**	**0.002**	0.8	0.4	1.8	0.574
	University	Ref				Ref			
Employment	Employed	Ref				Ref			
	Economically inactive	**0.2**	**0.1**	**0.4**	**<0.001**	0.7	0.4	1.2	0.176
	Unemployed	0.8	0.3	2.2	0.645	0.5	0.2	1.5	0.207
Household Income	<SGD 2000								
	SGD 2000-3999	**0.5**	**0.2**	**0.9**	**0.035**	0.9	0.5	1.7	0.714
	SGD 4000-5999	0.5	0.3	1.1	0.073	1.3	0.6	2.5	0.497
	SGD 6000-9999	0.7	0.3	1.6	0.418	1.1	0.5	2.4	0.888
	≥SGD 10 000	0.9	0.3	2.2	0.760	0.8	0.3	2.1	0.645

Multinomial logistic regression analysis controlled for potential confounders including age, ethnicity, marital status, education, employment and household income.

Supplementary Table 3a. Sociodemographic correlates of Nicotine Dependence among Males

		OR	95% CI		P value
Age group	18-34	Ref			
	35-49	0.9	0.5	1.6	0.666
	50-64	**0.4**	**0.2**	**0.9**	**0.018**
	65 and above	0.3	0.1	0.9	0.038
Ethnicity	Chinese	Ref			
	Malay	1.4	0.9	2.2	0.163
	Indian	1.3	0.8	2.1	0.343
	Others	1.2	0.5	3.3	0.701
Marital	Single	Ref			
	Married	0.8	0.4	1.4	0.432
	Divorced/Separated	1.0	0.2	1.8	0.415
	Widowed	3.3	0.7	15.7	0.134
Education	**Primary**	**33.0**	**6.3**	**171.8**	**<0.001**
	Secondary	**21.1**	**4.6**	**97.4**	**<0.001**
	Pre-U/JC/	1.5	0.3	8.5	0.622
	Vocational/ITE	**16.1**	**3.5**	**72.9**	**<0.001**
	Diploma	8.0	1.9	34.2	0.005
	University	Ref			
Employment	Employed	Ref			
	Economically inactive	**0.2**	**0.1**	**0.4**	**<0.001**
	Unemployed	0.6	0.3	1.7	0.362
Household Income	Below SGD 2000	Ref			
	SGD 2000-3900	0.8	0.4	1.5	0.558
	SGD 4000-5999	**0.4**	**0.2**	**0.9**	**0.031**
	SGD 6000-9999	0.6	0.2	1.4	0.199
	10 000 and above	0.6	0.2	1.8	0.318

Multiple logistic regression analysis controlled for potential confounders including age, ethnicity, marital status, education, employment and household income.

Supplementary Table 3b. Sociodemographic correlates of Nicotine Dependence among Females

		OR	95% CI		P value
Age group	18-34	Ref			
	35-49	**0.1**	**0.0**	**0.3**	**<0.001**
	50-64	**0.1**	**0.0**	**0.5**	**0.004**
	65 and above	.			.
Ethnicity	Chinese	Ref			
	Malay	1.9	0.7	5.6	0.224
	Indian	1.5	0.4	5.4	0.522
	Others	2.3	0.4	14.4	0.389
Marital	Single	Ref			
	Married	0.8	0.2	3.5	0.812
	Divorced/Separated	1.7	0.4	7.3	0.479
	Widowed	.	.	.	.
Education	**Primary**	**103.0**	**8.3**	**1272.6**	**<0.001**
	Secondary	**61.8**	**7.4**	**514.9**	**<0.001**
	Pre-U/JC/	13.3	0.8	218.8	0.070
	Vocational/ITE	4.3	0.3	69.3	0.304
	Diploma	**36.8**	**4.3**	**314.1**	**0.001**
	University	Ref			
Employment	Employed	Ref			
	Economically inactive	.	.	.	.
	Unemployed	0.6	0.2	2.4	0.489
Household Income	Below SGD 2000	Ref			
	SGD 2000-3900	1.0	0.3	3.8	0.987
	SGD 4000-5999	**0.0**	**0.0**	**0.5**	**0.010**
	SGD 6000-9999	1.1	0.3	4.1	0.914
	10 000 and above	0.4	0.1	2.1	0.300

Multiple logistic regression analysis controlled for potential confounders including

age, ethnicity, marital status, education, employment and household income.

(.) denotes missing or less than 5 cases

STROBE Statement

Checklist of items that should be included in reports of observational studies

Section/Topic	Item No	Recommendation	Reported on Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
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	5
Methods			
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*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—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 *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5-6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	-
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
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	6-7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	-
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	-

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Section/Topic	Item No	Recommendation	Reported on Page No
Results			
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	6
		(b) Give reasons for non-participation at each stage	6
		(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	20
		(b) Indicate number of participants with missing data for each variable of interest	-
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	-
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	21
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	-
		Cross-sectional study—Report numbers of outcome events or summary measures	8,21
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	21-24
		(*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	7-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-12
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	12-13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other Information			
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	14

*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.