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DEMOGRAPHICS, KNOWLEDGE AND SMOKING: AN INSTRUMENTAL VARIABLE APPROACH

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ABSTRACT

Smoking is one of the main factors that causes various diseases. The objective of the present study is to investigate factors determining smoking behaviour among adults. The present study used instrumental variable (IV) regressions to estimate the effects of demographic and knowledge factors on participation decision and amount decision of smoking. Nationally representative data of a developing country (Malaysia) was used. Contrary to popular belief, knowledge was found to be positively associated with the propensity to smoke, as well as the amount of smoking. Age, gender, wealth index, educational

level, ethnicity, marital status and house locality were significantly associated with smoking. Males were more likely to smoke and smoked more than females. Educational level reduced the likelihood and amount of smoking. Malays and married individuals were less likely to smoke than non-Malays and unmarried individuals. Urban dwellers smoked more cigarette relative to rural dwellers. In terms of policy implication, it is suggested that intervention measures directed toward reducing the prevalence of smoking should not pay too much attention to improving the knowledge of health effects of smoking among Malaysian adults. Anti-smoking policies must be designed carefully by taking into account of the demographic factors which are correlated with the likelihood and amount of smoking. The present study is the first of its kind that includes knowledge as a separate variable for analyses and uses IV regressions to analyse participation decision and amount decision of smoking.

Keywords: Cigarette, demographics, education, knowledge, smoking.

INTRODUCTION

Smoking is a serious public health issue worldwide, accounting for approximately 5 million mortalities annually (World Health Organization, 2015). It is clearly evident that smoking can lead to heart diseases, lung cancers, low birth weight among pregnant women and premature death (Oberg et al., 2011). Each year, at least half million of premature death in the world are related to smoking (World Health Organization, 2015). The majority of smoking-induced mortalities occur in developing countries, causing these countries to face a large smoking related disease burden (World Health Organization, 2015). This burden includes the deprivation of smokers' income, rapid rise in health care cost and deterioration in economic performance.

In Malaysia, one in every four adults smokes (Institute for Public Health, 2012). Approximately 20% of total mortalities are caused by smoking, which amounts to 10000 cases (Tan et al., 2009). In terms of economic costs, at least Ringgit Malaysia (RM) 4 billion is spent on treating smoking related diseases annually (Tan et al., 2009). In response to the increase in the prevalence of smoking, a nationwide anti-smoking campaign, named *Tak Nak* (Say No) was introduced in 2004. However, the outcome of this campaign was not very impactful.

Perhaps, this is because policy makers have poor information on how knowledge and demographic factors affect smoking behaviour (Tan et al., 2009).

To date, a large literature on the determining factors of smoking has emerged (Manrique and Jensen, 2004; Raptou et al., 2005; Yen, 2005; Bauer et al., 2007; Lin, 2010; Cheng and Kenkel, 2010; Kenkel et al., 2014). However, the actual role of knowledge in smoking behaviour remains unidentified. Previous studies, using educational level as a proxy for knowledge, concluded that knowledge could affect individuals' lifestyle (Kenkel, 1991; Cawley and Ruhm, 2012). In particular, the studies found that individuals who had better health knowledge were more likely to avoid smoking and participate in physical activity than their peers with poorer health knowledge. While using education to measure knowledge may seem appropriate, it has several limitations. Firstly, well-educated individuals do not necessarily have good health knowledge. Some individuals have high educational attainment but may be poorly-informed about health issue. Secondly, there can be a 'third variable' that explain the relationship between education and health behaviour, that is, time preference. Therefore, to gain a deeper understanding of the relationship between knowledge and health behaviour, knowledge should be included in regressions as a separate variable.

The objective of the present study is to investigate factors affecting smoking in Malaysia, a fast-growing developing country, in a more in-depth manner. The analysis is based on nationally representative data which consists of a large sample size. Hence, the findings can accurately mirror smoking behaviour among the population. Although numerous nationwide studies related to smoking have been conducted (Tan et al., 2009; Cheah and Naidu, 2012; Lim et al., 2013), none has paid attention to the effects of knowledge on smoking. The present study differs from previous studies in several ways. First, in addition to demographic variables, the present study includes knowledge of health effects of smoking variable in the regressions of smoking variables. Second, the present study uses instrumental variable (IV) regressions to analyse participation decision and amount decision of smoking in an effort to generate important findings.

The contributions of the present study are numerous. First, a sufficiency of studies on smoking can lead to improvement in the

nationwide anti-smoking policy. Second, findings of the present study can facilitate better understanding of which groups of the population are more or less likely to indulge in smoking. Third, the theory that explains the relationship between knowledge and smoking is tested in the present study. Hence, we are able to understand whether the theory supports or did not support the case of Malaysia.

THEORETICAL BASIS

Cigarette is an addictive good. According to Becker and Murphy (1988), a good is considered to be an addictive good if it has these two main characteristics – reinforcement and tolerance. The former one means that stock of past consumption increases the current marginal utility of consumption, while the latter indicates that the current utility is determined by the stock of past consumption. Owing to the scarcity of resources, individuals need to consider the costs of cigarettes and consume only when the benefits outweigh the costs. The benefits are the instantaneous pleasures, while the costs consist of market price and the negative health consequences (Gruber and Koszegi, 2001). Since the stock of consumption of cigarettes that individuals accumulate increases their future consumption, an expected increase in the costs of cigarettes due to tax or realisation of negative health consequences may reduce the current consumption of cigarettes.

In actual fact, individuals are uncertain about the actual costs of cigarette. They can only predict the costs based on their knowledge. The present study argues that individuals who have better knowledge of smoking tend to anticipate higher costs of cigarettes than those who have poorer knowledge. This means that individuals who are more aware of the negative health consequences of cigarette smoking are less likely to smoke compared with individuals who are less aware. Cigarette smoking also causes negative externalities because it can affect the health of non-smokers. Thereby, individuals who take into consideration of these negative externalities may predict higher costs of smoking than those who do not. Knowledge of health effects of smoking is, therefore, expected to have negative impacts on smoking.

REVIEW OF LITERATURE

The economic and public health literature offer an interesting insight into the effects of demographic factors on smoking. These

demographic factors include age, gender, income, education, ethnicity, marital status and house locality. Previous studies consistently found a significant relationship between age and smoking. Using a Gaussian single-hurdle model, Yen (2005) found that in the United States (US), older individuals were less likely to smoke than younger individuals. Similar findings were made by Aristei and Pieroni (2008), who used the 2002 Italian Household Budget Survey data. In a more recent study, Lin (2010) using the 2004 Taiwan Panel Study of Family Dynamics found that age reduced an individual's propensity to smoke. Findings of another Taiwanese study suggested likewise (Chung et al., 2020). However, Cheng and Kenkel (2010) provided different results. They made use of time-series survey data and found that cigarette smoking increased with age.

The effects of gender on smoking appear to be mixed. Based on a nationwide survey conducted in Spain, Manrique and Jensen (2004) found that males were more likely to smoke than females. Alam et al. (2008) and Lin (2010) provided similar outcomes using Pakistani and Taiwanese data, respectively. Moreover, Lim et al. (2016) and Chung et al. (2020) drawing from Malaysian and Taiwanese data, respectively, found that men had higher odds of smoking than women. In contrast, Aristei and Pieroni (2008) found that males have a lower likelihood of smoking than females. More interestingly, Raptou et al. (2005) applying a two-part model found that males were less likely to smoke but smoked more than females. Bauer et al. (2007) further argued that different socioeconomic backgrounds of males and females generates different smoking behaviours.

The relationship between income and smoking remains ambiguous. Hersch (2000) drawing on the Current Population Survey of the US found that higher income earners were less likely to indulge in smoking and also smoked less compared with their lower income counterparts. This finding was shared by Bauer et al. (2007), who used data from the German Socio-Economic Panel and Fernando et al. (2019), who based their study on Sri Lanka, and Howell et al. (2015) using the US data. On the contrary, Manrique and Jensen (2004) and Raptou et al. (2005) found that higher income individuals were more likely to smoke than lower income individuals. Similarly, Kenkel et al. (2014) used an instrumental variable to examine income elasticity of smoking and concluded that smoking was a normal good.

There was a decrease in the likelihood of smoking for well-educated individuals. Yen (2005), Lin (2010), Lim et al. (2016) and Lim et

al. (2018) found that well-educated individuals were less likely to smoke relative to less-educated individuals. Drawing on the Social Statistic Survey of Korea, Cho et al. (2008) also found that education was negatively associated with smoking. These findings were further confirmed by Bilgic et al. (2010), who used the Turkish Household Expenditure Survey, and Cheng and Kenkel (2010), who examined the Gallup Poll data. Also, findings of Fernando et al. (2019) suggested likewise.

The influence of ethnicity on smoking was examined by Cawley et al. (2016) and Kenkel et al. (2014). They found that ethnic majorities were more likely to smoke than ethnic minorities. Few studies in Malaysia found ethnicity to be significantly associated with smoking. Tan et al. (2009) using the Malaysian Household Expenditure Survey found that Malays were more likely to smoke cigarettes relative to non-Malays. Likewise, Cheah (2012) using a primary survey in Penang (Malaysia) found that Malays had a higher likelihood of smoking than non-Malays. Cheah and Naidu (2012), Lim et al. (2013), Lim et al. (2016) and Lim et al. (2018) also shared similar findings.

It is well-documented that marital status can affect individuals' propensity to smoke. Hersch (2000) and Cho et al. (2008) found that married individuals were less likely to smoke compared to unmarried individuals. This finding suggested that social support provided by spouses may help to reduce the tendency to indulge in smoking. The results obtained by Bilgic et al. (2010), Cheah and Naidu (2012) and Kenkel et al. (2014) were in agreement with this finding.

A thorough review of previous literature indicates that the relationship between house locality and smoking is inconclusive. On one hand, Bauer et al. (2007) found that urban dwellers were more likely to engage in smoking than rural dwellers. Alam et al. (2008) and Tan et al. (2009), on the other hand, found that urbanites had a lower likelihood of smoking compared to their rural peers.

METHODS

Data

The data used in the present study was extracted from the Global Adult Tobacco Survey (GATS) of Malaysia (Institute for Public

Health, 2012). The survey was jointly conducted by the Ministry of Health Malaysia and the World Health Organization. The survey was conducted in 2011. Following the protocol of the GATS, all the individuals in Malaysia aged 15 years or above were eligible for the survey, except tourists and institutionalised individuals who stayed in hospital, hotel, prison and military base. Pretested questionnaires were used by trained staff to interview the respondents. Written consents were obtained from the respondents prior to the interview.

In order to ensure representativeness, the survey covered all the states in Malaysia, including the Federal Territories. A multistage stratified sampling approach was adopted. The first stage was based on enumeration block (EBs). A total of 426 EBs were chosen (222 urban areas and 204 rural areas). The second stage was based on living quarters (LQs). In particular, 12 LQs were selected from each EB. Eligible households were randomly selected in the third stage. Members in each selected household were surveyed. The response rate was 88.10%, which is equivalent to a sample size of 4153 respondents. In Malaysia, respondents aged below 18 were unlikely to report smoking, even though they smoked because the legal age of smoking is 18. Unlike other countries, there is no regional variation in the legal smoking age among states or districts. Hence, in order to avoid biased results caused by reporting errors, respondents who were under 18 were removed from the sample. As a result, only 3971 respondents were used for analyses. All the protocols were approved by the Medical Research and Ethics Committee of Ministry of Health Malaysia.

Variables

The measurement of smoking consisted of the question: 'How much money do you spend for the purchase of cigarettes per month?' The respondents' age was collected and categorised into four categories: 18-24 years, 25-44 years, 45-64 years and ≥65 years. The survey also recorded the respondents' gender. Inclusion of gender in the model was important because risk preference may vary across gender (Croson and Gneezy, 2009). Because the information on income was unavailable, the present study used wealth index to measure the respondents' financial capability. Wealth index is an indicator of wealth of a household. It measured the value of all kinds of assets owned by a household, which included productive assets,

non-productive assets and household's amenities (Rutstein and Johnson, 2004). Analysis of wealth index was based on quintiles. There were a total of five quintiles: lowest, second, middle, fourth and highest.

Information on the respondents' educational attainment was obtained by asking the respondents: 'What is your highest level of education?' The answers were grouped into three categories: primary, secondary and tertiary. A question on the respondents' ethnic background was also asked. In order to facilitate comparison, ethnic variable was categorised into two categories: Malay (i.e., the ethnic majority) and non-Malay. There could be a relationship between marital status and smoking (Hersch, 2000; Cho et al., 2008). Hence, the respondents' marital status was taken into account and grouped into two categories: married and unmarried. House locality was divided into urban and rural areas. It was reasonable to believe that people who resided in urban areas had different health behaviours than people who resided in rural areas.

Knowledge of smoking (*knowledge*) contained information on the adverse effects of smoking on smokers' and non-smokers' health condition. The respondents were asked to answer 'yes' or 'no' to few questions about the health consequences of smoking. In the first section, the questions asked was: 'Based on your knowledge, does smoking cause the following illnesses?' The illnesses included stroke, heart attack, lung cancer, oral cancer, premature birth, throat cancer, miscarriage, gangrene, bladder cancer, stomach cancer and osteoporosis. In the second section, the questions asked was: 'Based on what you know, does breathing other people's smoke cause serious illnesses, heart diseases, lung illnesses and lung cancer?' Each 'yes' was assigned a value of 1, while each 'no' was assigned a value of 0. Since there were total 15 questions, the maximum value was 15 (complete knowledge) whereas the minimum value was 0 (empty knowledge). These questions and methodology have been used in several past studies to measure knowledge of smoking (Hsieh et al., 1996; Cheng et al., 2015; Park et al., 2018). Hsieh et al. (1996) claimed that these questions and methodology were appropriate for the investigation of the impact of knowledge on smoking behaviour. Their findings showed that people who have a higher score of smoking knowledge were less likely to indulge in smoking than those with a lower score. Cheng et al. (2015) used somewhat similar questions

to measure smoking knowledge and found that people who correctly answered three questions about smoking related diseases were unlikely to indulge in smoking. Similarly, Park et al. (2018) designed a few questions about the risks of smoking with the aim of studying the effects of knowledge of smoking on smoking cessations. Each correct answer was given a score. They found a positive relationship between the score and preference for smoking cessations.

Econometric Specification

There appears to be an endogeneity issue if *knowledge* is used as an independent variable in the regression of smoking. *knowledge* is an endogenous variable caused by reverse causality between smoking and knowledge of adverse effects of smoking on health. The fact of the matter is that people who smoke are aware of health warning on cigarette packets and may have better knowledge of smoking than people who do not smoke. Therefore, using non-IV regression to analyse the effect of *knowledge* on smoking may generate biased and inconsistent results. In an effort to solve this endogeneity problem, IV regression was used in the present study.

The present study used awareness of health warning on cigarette packets as an IV for *knowledge*. This information came from the question: "Have you observed any information about health warning on cigarette packets?". Awareness of health warning on cigarette packets variable satisfies two main criteria of IV. First, it is not an independent variable in the regression of smoking but is highly correlated with *knowledge*. Second, it affects smoking through *knowledge*.

We estimated the IV regressions using two stage least square (2SLS). In the first stage, we regressed *knowledge* on all the exogenous variables, including the IV. The fitted values of *knowledge* were then used in the second stage for estimation. In the second stage, we regressed smoking on all the independent variables as well as the fitted values of *knowledge* obtained in the first stage. Two IV regressions were estimated separately. One was to analyse whether or not individuals smoke (participation equation), that is, the probability of smoking. Individuals who have non-zero expenditure on cigarette were considered to be smokers. Another one was to analyse how much money was spent on cigarette per month (in RM) (amount equation). The independent variables included in both participation and amount

equations were identical, which consisted of age, gender, wealth index, educational level, ethnicity, marital status, house locality and *knowledge*. Robust standard errors were calculated and presented. In addition, we performed Wu-Hausman test for endogeneity in order to further confirm that *knowledge* is an endogenous variable.

Another statistical issue is that educational level could be seen as a confounding factor that affect smoking and *knowledge*. In particular, educational level reduces smoking and increases knowledge of adverse effects of smoking on health. We used two methods to overcome this confounding issue. First, we included educational level variable in the IV regressions with the aim of controlling the effect of confounding variable. Second, we stratified the IV regressions by educational level. In this case, the respondents in the subsample have the same values of confounding factor.

RESULTS AND DISCUSSION

The descriptive statistics of the independent variables are presented in Table 1. Majority of the respondents are aged between 25-44 years. Slightly less than half of the respondents were males. The distributions of wealth index were quite equal. A large proportion of the respondents had primary-level education. The majority of the respondents were Malay, married and rural dwellers. The average value of *knowledge* was 11.92.

Table 1

Descriptive Statistics of the Independent Variables

Variables	Mean	Std. dev.	Max.	Min.
Age				
18-24	0.1388	0.3457	1	0
25-44	0.4362	0.4960	1	0
45-64	0.3246	0.4683	1	0
≥65	0.1005	0.3007	1	0
Gender				
Male	0.4835	0.4998	1	0
Female	0.5165	0.4998	1	0
Wealth index				

(continued)

Variables	Mean	Std. dev.	Max.	Min.
Lowest	0.2007	0.4006	1	0
Second	0.1984	0.3989	1	0
Middle	0.1962	0.3972	1	0
Fourth	0.1997	0.3998	1	0
Highest	0.2050	0.4037	1	0
Education				
Primary	0.4626	0.4987	1	0
Secondary	0.4362	0.4960	1	0
Tertiary	0.1012	0.3017	1	0
Ethnicity				
Malay	0.5915	0.4916	1	0
Non-Malay	0.4085	0.4916	1	0
Marital status				
Married	0.6631	0.4727	1	0
Unmarried	0.3369	0.4727	1	0
House locality				
Urban	0.4883	0.4999	1	0
Rural	0.5117	0.4999	1	0
Knowledge	11.9207	4.1029	0	16
Observations	3971			

Source: The Global Adult Tobacco Survey (GATS)

Prior to estimating the IV regressions, the proportion of smokers and that of non-smokers were compared. The results are presented in Table 2. Out of 3971 respondents, 746 were smokers and 3225 were non-smokers. Comparing the proportion of smokers among all age groups, approximately 23.27% of individuals aged 25-44 years were smokers, followed by those aged 18-24 (18.15%), 45-64 (16.76%) and ≥65 years (6.77%). In terms of gender, 37.60% of males were smokers, compared with 1.17% of females. Among all the wealth index quintiles, the highest proportion of smokers were in the middle wealth index quintile (23.75%), whereas the proportion of smokers among individuals who were in the lowest, second, fourth and highest wealth index quintiles were 16.44%, 17.13%, 18.54% and 18.18%, respectively. With regards to the education variable, about 17.09%, 21.54% and 14.68% of individuals with primary-, secondary- andtertiary- level education were smokers, respectively. The significant proportion differences found provide support for the use of regressions. The independent relationships between dependent and independent variables can, thus, be better understood.

Table 2

Proportion of Smokers and Proportion of Non-smokers

Variables	Smoker	Non-smoker	p-value
Age			
18-24	18.15	81.85	<0.001
25-44	23.27	76.73	
45-64	16.76	83.24	
≥65	6.77	93.23	
Gender			
Male	37.60	62.40	<0.001
Female	1.17	98.83	
Wealth index			
Lowest	16.44	83.56	0.002
Second	17.13	82.87	
Middle	23.75	76.25	
Fourth	18.54	81.46	
Highest	18.18	81.82	
Education			
Primary	17.09	82.91	<0.001
Secondary	21.54	78.46	
Tertiary	14.68	85.32	
Ethnicity			
Malay	19.16	80.84	0.471
Non-Malay	18.25	81.75	
Marital status			
Married	18.19	81.81	0.179
Unmarried	19.96	80.04	
House locality			
Urban	19.13	80.87	0.584
Rural	18.45	81.55	
Observations	746	3225	

Note: The entries refer to percentage. The *p*-value is based on the Pearson χ^2 test of differences between the proportion of smokers and that of non-smokers.
Source: The Global Adult Tobacco Survey (GATS)

Table 3 shows the results of IV regressions for overall sample. In terms of endogeneity test, the value of Wu-Hausman test was highly significant, implying that there was an endogeneity issue in the regression and *knowledge* was an endogenous variable. Hence,

in order to generate unbiased and consistent results, IV regressions were used. In the first stage of 2SLS, awareness of health warning on cigarette packets variable was highly significant in explaining *knowledge*, indicating that it was an appropriate IV for *knowledge*. In the second stage of 2SLS, as the estimates of *knowledge* implied, knowledge about the adverse effects of smoking on health increased the propensity to smoke and money spent on cigarette. In particular, if the values of other variables were fixed, one point increase in *knowledge* increased the probability of smoking and money spent on cigarette by 9% and RM 19.10, respectively. It was apparent that knowledge of health effects of smoking plays an important role in influencing participation and amount decisions of smoking.

Table 3

Correlates of Demographic and Knowledge Factors to Smoking from Instrumental Variable Regressions

Variables	Participation	Amount
Constant	-1.190 (0.168)***	-274.378 (53.603)***
Age		
18-24	–	–
25-44	0.065 (0.025)***	4.484 (17.573)
45-64	0.011 (0.028)	3.251 (21.434)
≥65	0.030 (0.043)	-1.317 (21.312)
Gender		
Male	0.392 (0.018)***	74.169 (9.232)***
Female	–	–
Wealth index		
Lowest	–	–
Second	0.028 (0.025)	13.452 (6.574)**
Middle	0.105 (0.028)***	45.994 (17.718)***
Fourth	0.094 (0.028)***	30.723 (9.500)***
Highest	0.151 (0.036)***	37.731 (13.719)***
Education		
Primary	0.148 (0.032)***	32.273 (14.133)**
Secondary	0.053 (0.027)**	10.501 (7.052)
Tertiary	–	–

(continued)

Variables	Participation	Amount
Ethnicity		
Malay	-0.061 (0.021)***	-7.567 (8.684)
Non-Malay	–	–
Marital status		
Married	-0.057 (0.020)***	-10.317 (8.063)
Unmarried	–	–
House locality		
Urban	-0.025 (0.018)	16.154 (7.925)**
Rural	–	–
Warning		
Yes	–	–
No	–	–
Knowledge#	0.090 (0.013)***	19.099 (4.134)***
Wu-Hausman	109.247***	9.753***
Observations	3971	3971

Note: Instrumental variable regression is estimated using 2SLS. Awareness of health warning on cigarette packets is used as an instrumental variable for knowledge, and it is significant at the 1% level in the first-stage regression. Robust standard errors in parentheses. # fitted values. * indicates significant at the 1% level, ** at the 5% level and *** at the 10% level.

Source: The Global Adult Tobacco Survey (GATS)

Individuals aged 25-44 years were more likely to smoke than those aged 18-24 years. Males are more likely to smoke and smoked more than females. Compared to individuals who were in the lowest quintile of wealth index, individuals who were in the middle, fourth and highest quintiles are more likely to smoke and smoked more. The likelihood of smoking was higher among individuals who had primary- and secondary-level education than those with tertiary-level education. Malays and married individuals are less likely to smoke than non-Malays and unmarried individuals. Urban dwellers consumed more cigarettes than rural dwellers.

Table 4 presents the results of IV regressions, which are stratified by educational level. *knowledge* remained significant in affecting participation decision and amount decision of smoking in all the sub-samples. Specifically, an additional unit of *knowledge* increased the probability of smoking and money spent on cigarette by 5.8-13.9% and RM 15.66-26.10, respectively. This indicated that even the values of educational level, i.e., the confounding factor, were held fixed, *knowledge* was still significant and had a positive effect on smoking.

Table 4

Correlates of Demographic and Knowledge Factors to Smoking, by Educational Level from Instrumental Variable Regression

Variables	Primary		Secondary		Tertiary	
	Part.	Amt.	Part.	Amt.	Part.	Amt.
Constant	-0.642***	-135.013*	-1.813***	-389.992***	-1.792**	-292.773**
	(0.184)	(81.662)	(0.385)	(91.732)	(0.793)	(131.340)
Age						
18-24	–	–	–	–	–	–
25-44	0.078*	-60.459	0.016	7.522	0.050	10.631
	(0.046)	(82.335)	(0.043)	(8.897)	(0.084)	(14.110)
45-64	0.003	-47.413	-0.012	-2.012	-0.077	-4.814
	(0.045)	(81.176)	(0.049)	(13.109)	(0.114)	(19.025)
≥65	-0.001	-57.570	-0.277**	-60.222***	-0.022	15.956
	(0.055)	(78.035)	(0.115)	(22.575)	(0.236)	(44.370)
Gender						
Male	0.341***	65.428***	0.469***	89.724***	0.462***	72.659***
	(0.022)	(14.845)	(0.033)	(12.694)	(0.111)	(19.216)
Female	–	–	–	–	–	–
Wealth index						
Lowest	–	–	–	–	–	–
Second	0.068	24.014*	0.036	14.553	-0.028	-0.385
	(0.046)	(12.572)	(0.041)	(10.489)	(0.069)	(12.788)
Middle	0.097**	52.681	0.133***	50.649**	0.139	24.955
	(0.044)	(35.560)	(0.046)	(22.222)	(0.120)	(22.835)
Fourth	0.117**	48.127*	0.075	21.264**	-0.112	-11.040
	(0.045)	(20.212)	(0.046)	(10.029)	(0.143)	(24.466)
Highest	0.117**	41.061*	0.233***	45.324***	0.315	31.786
	(0.049)	(22.541)	(0.072)	(16.273)	(0.201)	(21.133)
Ethnicity						
Malay	-0.080***	-20.480	-0.070*	-0.270	-0.036	-5.213
	(0.027)	(13.995)	(0.041)	(9.659)	(0.073)	(12.876)
Non-Malay	–	–	–	–	–	–
Marital status						
Married	-0.072***	-30.079*	-0.003	15.672	-0.005	2.771
	(0.025)	(17.366)	(0.037)	(10.272)	(0.075)	(14.081)
Unmarried	–	–	–	–	–	–
House locality						
Urban	-0.029	14.337	-0.020	17.897*	-0.052	-3.062
	(0.025)	(11.545)	(0.031)	(10.508)	(0.072)	(12.389)
Rural	–	–	–	–	–	–
Knowledge#	0.058***	15.660***	0.139***	26.098***	0.135**	21.336**
	(0.014)	(5.895)	(0.030)	(6.422)	(0.061)	(10.092)
Wu-Hausman	31.007***	2.870***	70.379***	6.531**	16.507***	8.220***
Observations	1837		1732		402	

Note: Part. refers to participation. Amt. refers to amount. Instrumental variable regressions are estimated using 2SLS. Awareness of health warning on cigarette packets is used as an instrumental variable for knowledge, and it is significant at the

1% level in the first-stage regression. Robust standard errors in parentheses. # fitted values. *** indicate significant at the 1% level, ** at the 5% level and * at the 10% level. **Source**: The Global Adult Tobacco Survey (GATS)

The present study highlights the influences of demographic and knowledge factors on smoking using nationwide data from the GATS 2011. IV regressions were estimated based on 2SLS. Evidence of the present study suggested that being males, wealth, primary-level education, being urban dwellers and knowledge of smoking increased the amount of expenditure on cigarette. In terms of participation decision, the probability of smoking was greater among individuals aged 25-44, males, higher wealth index quintiles, individuals with secondary or primary-level education, non-Malays, unmarried individuals, as well as individuals with good knowledge of smoking.

The effect of age on smoking appeared to be significant. Compared to individuals aged 18-24 years, individuals aged 25-44 years are more likely to smoke. This finding suggests that the probability of smoking increases with age when individuals are young. However, it does not lend support to the findings of previous studies that age reduced individuals' propensity to smoke (Yen 2005; Aristei and Pieroni, 2008; Lin, 2010; Chung et al., 2020). The explanations for our findings are quite straightforward. Because individuals aged 25-44 years are usually more financially independent than their counterparts aged 18-24 years, they are more capable of indulging in cigarette smoking. However, when individuals reach the age of 45 or above, they tend to be more concerned about their health condition. As a result, there are no differences in smoking participation and amount between this age group and the young age group.

The result on gender seemed to be in agreement with the evidence of previous studies that men were more likely to smoke and smoked more than women. (Manrique and Jensen, 2004; Alam et al., 2008; Lin, 2010; Lim et al., 2016; Chung et al., 2020). Several reasons may explain this outcome. First, men are less risk-averse than women (Croson and Gneezy, 2009). Since smoking is a risk behaviour, it is not surprising that men have a higher preference for it compared with women. Second, women tend to face lower social and cultural tolerance for smoking than men, especially given that Islam is the main religion in Malaysia (Waldron, 1991). Among Muslim women, smoking is deemed to be socially unacceptable and inappropriate

because smoking is banned in Islam (Dar-Odeh and Abu-Hammad, 2011). Muslim women who smoke are likely to ruin their own reputation and be ashamed of themselves. Additionally, in the Chinese culture, the traditional family-oriented role for women could be a factor that discourages women from smoking (Cheng et al., 2015). The stigma of smoking is always with women. Third, women possess better family caregiving characteristics than men (Miller and Cafasso, 1992). Given that smoking has harmful effects on family health, women are unlikely to adopt it.

Although wealth index is not a very good proxy for measuring budget constraint, it is sufficient for the current research. By including wealth index into the analysis, the present study avoided omitted variable bias and identify whether or not smoking is more prevalent among individuals who are wealthier. Previous studies using income as an explanatory variable found that higher income individuals are more likely to smoke than lower income individuals (Manrique and Jensen, 2004; Raptou et al., 2005; Kenkel et al., 2014). Results of the present study suggested likewise that wealth was positively associated with smoking. The increases in the probability and amount of smoking in the middle, fourth and highest wealth index quintiles. This indicates that wealthier individuals may find cigarette more affordable than their less-wealthy counterparts. In Malaysia, the quality and price of all brands of cigarettes are similar, except illegal cigarettes, which have a lower quality and cheaper price. However, given the prohibition of illegal cigarettes in the market, no respondent is likely to confess to using illegal cigarettes, particularly to a health authority interviewer. Therefore, we were unable to identify whether poor people smoke cheap and low-quality cigarettes while rich people smoke expensive and high-quality cigarettes. With data availability, future research could put efforts into investigating the effects of price and quality of cigarettes on smoking behaviour.

Consistent with the findings of Yen (2005), Cho et al. (2008), Bilgic et al. (2010), Lin (2010), Cheng and Kenkel (2010), Lim et al. (2016), Lim et al. (2018) and Fernando et al. (2019), there is a negative relationship between education and smoking. After controlling for knowledge factor, educational level was significant in explaining smoking participation and amount of smoking. This implies that there could be a 'third' variable which explains the relationship between education and smoking. It is often claimed that this 'third' variable

is time preference. As pointed out by Fuchs (1982), education could lower the rate of time preference. Van Der Pol (2011) exploring the effect of time preference on health concluded that individuals who have a higher rate of time preference (i.e., the less-educated) were less likely to make an effort to improve their health than individuals who have a lower rate of time preference (i.e., the well-educated) because they were more present oriented. Another explanation for this finding is that education improves efficiency of health production (Grossman, 1972). Since smoking is harmful to health, well-educated individuals are less likely to indulge in it relative to their less-educated counterparts (Kenkel, 1991).

The effect of ethnicity on smoking is worth discussing. Compared to non-Malays, Malays are considered less likely to smoke. This is mainly due to the fact smoking is forbidden in Islam. Surprisingly, however, findings of other Malaysian studies suggested otherwise and that Malays has a higher tendency to smoke than non-Malays (Tan et al., 2009; Cheah, 2012; Cheah and Naidu, 2012; Lim et al., 2013; Lim et al., 2016; Lim et al., 2018). A conclusion that can be drawn from our finding is that different ethnic backgrounds of individuals may adopt different lifestyle because of cultural and religious differences. A better understanding of the relationship between ethnicity and smoking could, therefore, be supplemented by a qualitative research.

Consistent with the findings of previous studies, married individuals are less likely to smoke relative to unmarried individuals (Hersch 2000; Cho et al., 2008; Bilgic et al., 2010; Cheah and Naidu, 2012; Kenkel et al., 2014). Since married individuals receive social and psychological supports from their spouses, they have a lower tendency to indulge in smoking compared with their unmarried counterparts (Cho et al., 2008). As pointed out by Hersch (2000), stress induced by divorce was likely to increase one's propensity to smoke. Furthermore, Bilgic et al. (2010) argued that marriage may promote a healthy lifestyle and discourage one from participating in smoking.

While urban locality did not affect the likelihood of smoking, it increased the amount of smoking. The positive relationship between residing in urban areas and smoking was also evidenced by Bauer et al. (2007). This outcome is not surprising because cigarette is more available in urban areas than in rural areas (Ho et al., 2010). Furthermore, urbanites are likely to have better job opportunities

and a stronger financial background relative to rural dwellers. Misconception about smoking may be another contributing factor of this outcome. People may often think that cigarette smoking can reduce stress. Since urban dwellers tend to live a more hectic and stressful lifestyle than their rural counterparts, they smoke more cigarette (Ho et al., 2010).

Although educational level reduced smoking, knowledge was positively correlated with smoking. This finding contradicts our hypothesis that knowledge discourages people from indulging in smoking. Knowing the fact that smoking has adverse impact on the health of smokers and non-smokers seems to increase an individual's intention to smoke and smoking amount. This is a unique finding and has a distinct contribution to literature and policy development. It is in contrast to the outcomes of previous studies (Hsieh et al., 1996; Cheng et al., 2015; Park et al., 2018). Based on a national survey of Taiwan, Hsieh et al. (1996) found that a 1% increase in smoking knowledge lowered the probability of smoking by 0.48%. Using nationwide data of China, Cheng et al. (2015) observed that the likelihood of smoking was lower among people with good knowledge of smoking than those with poor knowledge. Park et al. (2018), in examining the effects of knowledge on smoking behaviour among Koreans, found that people who have greater knowledge of smoking has a higher preference for smoking cessation relative to their peers with poorer knowledge. Our findings lead to a conclusion that Malaysian people who are more aware of the negative effects of smoking on health are more likely to indulge in smoking compared with those who are less aware. An important implication is that a public policy directed towards improving knowledge about health effects of smoking among Malaysian adults may not be very effective in lowering the prevalence of smoking. It is important to obtain a better understanding of the reasons that explain these unique findings, and this can be a direction of future qualitative research.

CONCLUSION AND POLICY IMPLICATION

In terms of theoretical implication, our finding on knowledge is not in line with the theory. According to the theory, knowledge should reduce one's propensity to smoke cigarettes because it improves the awareness of negative consequences of smoking. However, findings

of the present study suggest otherwise that knowledge promotes smoking. It can, thereby, be concluded that people who are more knowledgeable are more likely to smoke and smoke more than those who are less knowledgeable. Furthermore, our finding implies that being aware of the negative externalities of smoking does not lower the likelihood of smoking. In fact, it encourages people to smoke.

Findings of the present study appear to have several important implications for policy. Firstly, priority should not be given to the policy that focuses on reducing smoking prevalence among young adults. Policy makers must be aware that adults aged between 25 and 44 years are more likely to smoke than their younger peers aged between 18 and 24 years. Thereby, special attention could be paid to this particular age group of individuals. Secondly, considering the gender differences in smoking behaviour, an intervention strategy directed towards reducing smoking in male population may seems promising. The mindset that smoking is more acceptable in males than females should be changed. Thirdly, our findings suggest that government should make a concerted effort to discourage people who are in the high wealth index quintiles from smoking.

Fourthly, while encouraging people to pursue higher education could be an intervention strategy that helps to lower participation and amount decisions of smoking, providing people with more information about the adverse effects of smoking on health may not necessarily produce promising outcomes because having good smoking knowledge could raise the probability and amount of smoking among Malaysian adults. Our findings suggest that people with good knowledge of smoking should be given special attention by policy makers if the goal of reducing the prevalence of smoking is to be achieved. Fifthly, in light of the fact that non-Malays have a higher likelihood of smoking than Malays, anti-smoking campaigns or mass media should use languages other than Malay language to deliver messages. Additionally, using spokespersons from non-Malay ethnic groups to highlight the disadvantages of smoking may also yield desirable results. Finally, government should take various measures to discourage urbanites from smoking cigarettes. These include reducing the availability of cigarette products in urban areas and educating urban dwellers about the appropriate ways to cope with stress.

Although the present study has shed light on factors affecting smoking, it has several limitations. First, the substitution and income effects of

smoking cannot be tested as the information on price is not available. Second, all the information obtained from the survey is self-reported. Hence, some respondents may under-report their expenditure on cigarettes. Third, few important health variables, such as self-rated health and presence of diseases are not available. It seems reasonable to expect that individuals who have a poorer health background are less likely to smoke than individuals with a better health condition. One of the directions for future research is that studies could be extended to investigate how quitting smoking acts as an input to determine health. In addition, factors that affect knowledge of smoking could be explored. A good understanding of factors affecting knowledge would serve the interests of policy makers in the effort to reduce the prevalence of smoking. Another suggestion for future research is an analysis that explains the relationship between smoking and knowledge through mediational analysis. The mediators that may be considered are demographic and health factors. This analysis could further identify the predominant factors within these two categories that could explain the association between smoking and knowledge.

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