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Exposure to second-hand tobacco smoke among non-smoking adults: an evaluation of effectiveness of smoke-free legislation

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Abstract

Objectives Second-hand smoke (SHS) has been associated with increased morbidity and mortality. Therefore, the aims of the paper are to assess SHS exposure among non-smoking adults attending various gazetted and non-gazetted public areas according to the Control of Tobacco Product Regulations (CTPR) as well as its relation with various sociodemographic variables.

Design: Data were extracted from a cross-sectional study, the Global Adults Tobacco Survey (GATS) 2011 which involved 3269 non smokers. Data was obtained through face-to-face interviews using a validated pre- tested questionnaire. Factors associated with exposure to SHS was identified via multivariable analysis.

Results: The study revealed that almost two-third of respondents were exposed to SHS in at least one public area in the past one month, with significantly higher exposure among males (70.6%), those with higher educational attainment (81.4%) and higher income (Quintile 1 – 73.9%). Besides, the exposure to SHS was almost four times higher in non-gazetted areas compared to gazetted areas under the CTPR (81.9 % vs 22.9). Multivariable analysis revealed that males and younger adults at non-gazetted areas were more likely to be exposed to SHS whilst no significant associated factors of SHS exposure was observed in gazetted areas.

Conclusions: The study revealed the prevalence of SHS exposure was high among Malaysian adults. Although smoke-free laws offer protection to non-smokers from exposure to SHS, enforcement activities in gazetted area should be enhanced to ensure strict public abidance. In addition, legislation of gazetted areas should also be extended to greatly reduce the SHS exposure among non-smokers in Malaysia.

Strength and limitation of the study:

The representativeness and adequacy of sample size as well as the high response rate enable generalization of findings to the Malaysian population

Face to face interview approach employed in the study will increased the quality of the data.

Under reporting or over-reporting might occur as the period of the study was for the one month prior.

Only Seven public areas were included in the study , exposure in other gazetted and non-gazetted areas was not extensively investigated.

Objective measurement of exposure to SHS among non-smokers (e.g., carbon monoxide in expired breath air, cotinine (a nicotine metabolite) was not carried out.

Introduction

Second-hand smoke (SHS) is composed of side stream smoke (the smoke released from the burning end of a cigarette) and exhaled main stream smoke (the smoke exhaled by the smoker)[1].It consists of a variety of chemicals and of which 40 have been identified as carcinogenic chemicals (eg., benzene, 1,3-butadiene, formaldehyde, mercury and hydrogen cyanide)[2]. Exposure to SHS could affect the health of an individual. Epidemiological studies revealed that SHS exposure causes an increased risk of cancer by 20–30%, heart disease by 25–30%, stroke of up to 82% and an increased risk of other non-fatal respiratory illnesses. In additions also has been shown to have adverse effects on reproduction and associated with sudden infant death syndrome (SIDS)[3] . Furthermore, SHS has also been associated with recurrent wheezing, respiratory illnesses, decreased lung function, and asthma [4], as well as chronic respiratory symptoms among adults. Annually 600,000 deaths were reported globally due to exposure to SHS[5,6.]

Prohibition of smoking in public areas was among the public health policies to reduce exposure to SHS in public areas apart from de-normalizing smoking behaviour. Studies revealed that the implementation of this policy have reduced the exposure of adults and children in Scotland to SHS by 39%. In addition, the implementation of smoke free policy have also significant reduce of salivary and urinary cotinine (a metabolite of nicotine) among non smoker in many countries, namely United States of America, Canada, Scotland Uruguay, and Ireland [7-12]. Furthermore, the measurement of air quality in public areas revealed a significant reduction of several chemical components available in SHS[13,14].. Furthermore, smoke free laws also reduced the quantity of cigarettes smoked, increased the intention to quit smoking among smokers and increase the proportion of smoking cessation [15]. More importantly, smoke free regulation has been shown significantly reduce the number of hospital admission for heart attacks and asthma-related diseases, and of premature births [16-18]. The policy had been identified as a non-monetary policy which will reduce the mortality and morbidity due to smoking related diseases [19].

The Malaysian government through the Ministry of Health, also implemented similar measures to protect non-smokers from exposure to SHS in public areas with the introduction of smoking prohibition in public areas via the Control of Tobacco Product Regulations (CTPR) 1993. Eight areas were gazetted (entertainment centre or theatre, hospital or health clinic, public lift, air-conditioned eating place, public vehicles, building of Island

&Peninsular Kuala Lumpur, and in any area of petrol station and Esso tower building, Kuala Lumpur). This is later expanded to other public areas through the amendment of the provision to the CTPR in 1997, 2004, 2008, 2009, 2010, 2011 and 2014 [20-22]. The expansion of smoke free public areas was in line with the provision of Article 8 of the Framework Convention on Tobacco Control (FCTC) [23] which was rectified by the Malaysian government in 2005. Until 2016, 38 public areas had been gazetted as smoking prohibition areas . This regulation was supported by enforcement by authorised officers with frequent visits to ensure that the public abides to this provision.

Although smoking prohibition policy had been implemented since the last two decades and studies elsewhere show its efficacy to reduce the exposure of non-smokers to SHS [12 14], its efficacy in Malaysia has not be studied. Knowledge on effect of exposure to SHS will assist policy makers in planning and formulating suitable policies, as well as measuring and strengthening existing policies and regulations. In addition, it will ensure the allocation of human and material resources to reduce SHS among the Malaysian public. This paper intends to narrow the knowledge gap with the illustration of SHS exposure in various public areas (gazetted and non-gazetted) and social demographic variation of exposure among Malaysians to SHS.

Methods

Data for this write-up was derived from the Malaysian Global Adult Tobacco Survey(GATS) which was carried out from October 2011 to January 2012.The study utilised a cross sectional design and three stage sampling proportionate to size to obtain a representative sample of Malaysians aged 15 years and above. First strata consist of 15 states in Malaysia whilst second stage was the division of urban and rural areas by each state. Enumeration blocks (EBs) which is an artificial geographical area created by the Department of Statistics consisted of 80-120 living quarters based on 2010 population census was the primary sampling unit (PSU) and living quarters (LQs) were the secondary sampling unit. One household member aged 15 years and above from the selected LQs will be selected by simple random sampling method based on random number generated by handheld devices.

Face to face interview approach by trained research assistants was used to obtain data from selected respondents. Detailed information regarding the purpose of the survey was explained to the respondents. Their participation was based on a voluntary basis and they have the right not to answer any question as well as withdrawing from the study at any juncture. All information given was treated as confidential and utilised for research purposes only. The interview session only started after written consent was obtained from the selected respondents. For respondents aged below 18 years old, written consent was obtained from their parent or guardian in addition to permission by the respondent. Detail of the methodology is published by Azahadi et al., 2015[24]. Ethical approval was granted by Malaysia Research Ethical Committee, Ministry of Health, Malaysia.

Study instrument was a questionnaire adopted from GATS, translated and pre-tested before use. It consists of 8 components, namely social demographics, smoking status, type of tobacco product used, exposure to SHS at home, work and selected public areas, expenditure on cigarettes, knowledge of smoking hazards and SHS, intention to quit , exposure to tobacco product advertisement and information regarding the hazards of tobacco products.

Smoking status of respondents were evaluated by several items “Are you currently smoking, “Do you use any smokeless tobacco/sisha/bidi/electronic cigarettes”?, with the choice of “daily, “less than daily”, and “not at all”. Respondents who answered “not at all” were classified as “non-smokers” whilst those who answered “daily, less than daily” as “current smokers”. Only non-smokers were included in the analysis for exposure to SHS. Exposure to SHS was determined by items “Do you visit these public areas:(1) Government

offices(2) Health facilities (including hospital or clinic) (3) Public transport terminal (4)Air-conditioned shopping complex(5) bar or night club(6) cafes/ coffee shop/bistro and (7) non air-conditioned restaurant "during the last one month" with the choice of "Yes", "No", "Don't know" and "Refused to answer". Respondents who answered "Yes" to any area/s mentioned were asked if during the visit they have seen anyone smoke in any of those seven areas. Respondents who answered "Yes" to any item was classified as exposed to SHS in those areas. Those who were exposed to SHS at government offices/health facilities/ public transport terminal / air conditioning shopping complexes were further categorised as exposed to SHS in gazetted non-smoking areas. In the same note, those who answered "Yes" to (1) bar or night club (2) cafes / coffee shop/bistro and (3) restaurant without air-conditioning were classified as exposure to SHS at non-gazetted areas.

Independent variables were social demographics, namely, gender, ethnicity, education attainment (which was divided into four categories;"No formal education", primary education, secondary school and tertiary"), age group (15-24 years old, 25-44 years old , 45-64 years old and 65+), locality (urban/ rural), while income level was measured using Wealth index, a proxy measure for respondents' socioeconomic status was constructed using principal component analysis with information on household ownership of assets (Global Tobacco Surveillance System, 2009). Assets included were electricity, flush toilet, fixed telephone, cell telephone, television, radio, refrigerator, car, moped/scooter/motorcycle, washing machine, etc. The sample was divided into quintiles from quintile one (highest) to quintile five (lowest). Marital status of respondents were classified as single, married and widow/widower/separated.

Data was cleaned prior to analyses. It was weighted taking into account study design, non-response and social characteristics (gender, residence, age group, education attainment, ethnicity) based on Malaysia population census 2010). Descriptive statistics was utilised to describe the social demographic characteristics of the respondents. Cross tabulation was used to describe proportion of respondents to SHS exposure at various public places. Multivariable Logistic Regression was run to determine the association between various social demographic background with SHS exposure in gazetted and non- gazetted public areas. We reported 95% confidence intervals without p values as the large sample size could generate significant results even if statistical differences or associations were small. All analyses were carried out by SPSS statistical software version 20.

Results

A total of 3269 of an overall sample of 4250 respondents interviewed were non- smokers (76.9%, 95% confidence interval, CI 74.8-78.8), The proportion of females was significantly higher compared to males (98.7%, 95% CI 98.0-99.1 vs 56.1%, 95% CI 52.7 – 58.9) . Those from the youngest (15-24 years; 83.3%, 95% CI 79.7-86.4)) and oldest age group (65+; 85.0%, 95% CI 80.1-88.8) also reported a significantly higher proportion of non-smokers compared to the 25-44 years old group (71.0%, 95% CI 67.8-73.9). Similarly, proportion of non-smoking participants was higher in those with tertiary education attainment (84.7%, 95% CI 80.1-88.4) and higher income group(Quintile 1: 82.9%, 95% CI 79.3-86.0and Quintile 2: 80.8%, 95% CI 76.9-84.2) were (Table 1).

Table 2 shows that almost two thirds of non-smokers (63.6%, 95% CI 60.6-66.2)were exposed to SHS at one or more public areas during the last one month. The exposure among males was significantly higher compared to that among females (70.9%, 95% CI 66.5-74.9 vs 59.1%, 95% CI 55.7-62.4).In addition, respondents from urban areas, with higher education attainment and income also reported higher proportion of exposure to SHS. However, older respondents reported lower exposure compared to their younger counterparts (15-24 years, 72.1% , 95% CI 67.4-76.3, 25-44 years, 67.9%, 95% CI 63.8%, 95% CI 63.8-71.5, 45-64 years, 54.4%, 95 CI% 49.9-58.8; and 65 +,37.3%, 95% CI 29.1-46.1%).

Exposure of non-smokers to SHS was significantly higher in non-gazetted public areas compared to gazetted areas, in which the proportion of exposure was approximately four times higher than that reported in gazetted areas (81.9%, 95% CI 79.5-84.1 vs. 22.9 %, 95 CI% 20.4-25.5). Further analysis on exposure to SHS in gazetted areas revealed that the level of exposure was significantly lower in health care facilities (8.7%, 95% CI 6.9-10.8) compared to indoor shopping complexes (13.6%, 95% CI 11.7-15.7), government offices (20.0%, 95% CI 16.4-24.2) and public transport (27.9%, 95% CI 22.5-34.0). No significant difference was observed among all social demographic characteristics to SHS in non-gazetted areas except for the younger age group of 15-24 years (30.2%, 95% CI 25.6-35.3). The study also revealed that the level of SHS exposure at the three non-gazetted smoking areas were almost similar for all respondents from different social demographic backgrounds (Table 3)

Multivariable Logistic regression analysis revealed that the likelihood of exposure to SHS in gazetted public areas were almost similar across all social demographic variables, whilst for non-gazetted area, smokers from the younger age group (15-24, AOR 5.07, 95% CI 2.18-11.7, 25-44. AOR 3.12, 95% CI 1.51-6.45, 45-64, AOR 2.08, 95% CI 1.10-3.93, 65+ as reference) and males (AOR 1.46, 95% CI 1.03-2.05) were more likely to be exposed to SHS in the last one month. However, other ethnic group (AOR 0.49, 95% CI 0.28-0.85) reported less likelihood to being exposed to SHS in non-gazetted areas compared to participants from Chinese descents. (Table 4)

Discussions

This is to our knowledge the first report on exposure to SHS in various public areas among a representative sample of Malaysian adults population after two decades of anti smoking law implementation.. The study reveals that almost two out of three (66.7%) Malaysian adults aged 15 years were exposed to SHS in at least one public area investigated during the one month prior to the study. This is similar (66%) to that reported in Spain [25], but lower as compared to that reported by Xiao et al., (2010) [26] among non-smokers aged 15 years and above in China; 72.4% (95% CI, 70.4-74). Interestingly, it is higher than that reported among non-smokers in Cambodia [27], which was 37.4%. The proportion of SHS exposure by gender was almost two times higher compared to that reported globally (70% vs. 33% for males; 59% vs. 31% for females) [28]. The different proportion of exposure might be due to different social norms in related countries, in which existing anti-smoking norm might reduce the likelihood of smoking in public area. In addition, different anti-smoking laws /policies might be another contributing factor for this difference proportion of exposure to SHS. Hence, further studies are required to elucidate the real factors for the differences in exposure to SHS reported.

Study reveals that respondents residing in urban areas reported a higher proportion of SHS compared to their counterparts in rural areas. The public areas assessed in the current study were mainly located in urban areas, namely coffee house/bistro, bar, government facilities and public transportation which are the places visited by the public to manage their activities and daily chores which might increase the likelihood of exposure to SHS. Similarly, the same factor might explain why respondents from Chinese descent were more likely to be exposed to SHS in view of majority of them residing in the urban area.

Respondents from the younger age group reported higher exposure to SHS. This finding is in line with that by Li et al. (2015) among women in China[29], in which the level of exposure decreased from 66.8% in those aged 18-24 to 38.9% among those aged 65 and above. The finding might due to the respondents from younger age group mostly consist of those who are productive and economically active, therefore they are more mobile and visit public areas more often compared to their counterparts from lower education, lower income and older age group. Furthermore, the public areas under investigation (e.g., coffee house and bistro) were premises which were tailored to attract the younger age group.

Male respondents were more likely to be exposed to SHS in non -gazetted areas in univariate and multivariate analysis compared to females. The finding is in-line with Rudatsikira et al., (2008), Desalu et al.,(2011)and Li et al., (2015)[28-30] who reported higher proportion of SHS exposure among non smoking males in Cambodia ,adults residing two cities in Nigeria and adults in North East China, respectively. This might due to males being more mobile compared to females in view of their nature of occupation which require them to travel more. In Malaysia, males tend to socialize more as compared to females as it is the patriarchal society. In addition, non-smoking males might befriend those who are smokers in view of high prevalence of smokers among males (45%) in Malaysia and therefore increases the likelihood of exposure to second hand smoke [31].

Exposure to SHS was significantly lower in gazetted areas as compared to non-gazetted areas. This is consistent with several previous studies, including Mulcahy et al., (2005) [10], Pellegrini et al., (2010) [32], Carpenter et al., (2011)[33], Jensen et al., (2012)[7], Azagba et al (2015) [34],and Park et al 2016[13]. All studies revealed that laws significantly reduced exposure to SHS in a variety of public places, especially bars, restaurants, and outdoor patios of these premises.. These reductions in public-place exposure are observed for both smokers and non-smokers. Multivariable analysis which showed no difference in the likelihood among various socioeconomic background to SHS exposure support the notion that smoke free areas offer protection to non-smokers from SHS exposure (Table 5).

Among the gazetted areas, non-smokers reported the lowest exposure to SHS in health facilities, followed by air-conditioned shopping centres, government offices and public transports. Similar finding was also reported from the Global Adult Tobacco Survey (GATS) in the Philippines in 2010 (GATs 2010)[35]. This could be due to the majority of health personals being aware of the dangers of smoking and SHS which translate to their attitude and behaviour toward smoking, therefore creating a non-smoking social norm among their fraternity. This reduces the likelihood of smoking behaviour and increases advising of those who smoke in the hospitals/health facilities to smoke elsewhere. The respondents who visited the hospitals /health facilities usually consist of those who seek treatment, hence their health condition might not permit them to continue their smoking behaviour. Teh et al.,(2014)[36] also reported that a majority of the public perceived that hospitals/health facilities were premises which provided treatment and therefore inappropriate for anyone to practice

unhealthy lifestyle. In addition, respondents who visit the hospitals were mostly from the older age group with less likelihood to be smokers in view of lower prevalence of smoking among older Malaysians (16.4%)[37]

The low prevalence of SHS exposure among non-smokers in the shopping centres (approximately one in ten or 10%) might be due to central air-conditioning system utilised in most Malaysian shopping centres whereby any cigarette smoking within the premises created a nuisance to the public who visited the shopping centres, and their reactions serve as deterrent for smokers to smoke. In addition, the management personnel of these shopping centres usually try to take all necessary measures to retain their customers through a conducive and cosy environment for shopping, one of approaches was to ensure the conducive environment for visitors via a smoke free environment. In addition, owners' of premises fear of being fined for having people smoking in their premise could be another possible reason for the finding in this study.

More than one-fifth and almost one-third of non -smokers were exposed to SHS in the last one month during their visit to government office and use of public transportation, respectively. The high exposure was rather surprising in view of the area and facility having been designated as smoke free since the last 20 years. This is a clear indication of noncompliance to the legislation. Further investigation from multiple angles, such as the people who smoke (either government officers in government premises or drivers of the public transport), level of awareness among the public and enforcement activities which had been carried out, are urgently needed to elucidate the factors contributed to the current finding..

There were several limitations in this study. Firstly, under reporting or over-reporting might occur as the period of the study was for the one month prior. Secondly, with seven areas included, exposure in other gazetted and non-gazetted areas was not extensively investigated. Future studies should include more public areas (both gazetted or non-gazetted) and employ objective measurement of exposure to SHS among non-smokers (e.g., carbon monoxide in expired breath air, cotinine (a nicotine metabolite) or measurement of air quality for chemicals related to SHS. However, previous study had found satisfactory validity of self-reported of SHS exposure [38, 39]. In addition, the representativeness and adequacy of sample size as well as the high response rate enable generalization of findings to the

Malaysian population, Furthermore; face to face interview approach employed in the study will increased the quality of the data.

The findings from the study add to the body of evidence that prohibition of smoking in public area will reduce the exposure to SHS [13,14,25].Therefore, more public areas should be gazetted as non-smoking areas to further reduce the exposure to SHS among public and to create the environment which is not conducive for smoking. However, the sizeable reported exposure to SHS by non-smokers demands for stricter and more frequent enforcement of the provision under the current anti-smoking law to ensure all gazetted areas to be 100% smoke free .

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Availability of data and materials

Please contact author for data requests.

Authors' contributions

LKH, TCH and MHNM, LHL wrote the manuscript, SMG and KCC carried out statistical analysis, SP , MFY, LMY design the study, NH, NZ, NDD and NI responsible for data collection, and coordination of the study. CKH manage and clean the data. LKH, TCH and LHL were involved in interpretation and implications of the analysis. All authors contributed to developing the manuscript, and read and approved the final version

Competing interests

The authors declared that they have no competing interest.

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Exposure to tobacco secondhand smoke and its associated factors among non-smoking adults in smoking-restricted and non-restricted areas: Findings from a nationwide study in Malaysia

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Exposure to tobacco secondhand smoke and its associated factors among non-smoking adults in smoking-restricted and non-restricted areas: Findings from a nationwide study in Malaysia

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Abstract

Objectives Second-hand smoke (SHS) has been associated with increased morbidity and mortality. Therefore, the aims of the paper are to assess SHS exposure among non-smoking adults in Malaysia attending various smoking restricted and non-restricted public areas according to the Control of Tobacco Product Regulations (CTPR) as well as its relation with various sociodemographic variables.

Design: Data were extracted from a cross-sectional study, the Global Adults Tobacco Survey (GATS) 2011 which involved 3269 non smokers in Malaysia. Data was obtained through face-to-face interviews using a validated pre- tested questionnaire. Factors associated with exposure to SHS was identified via multivariable analysis.

Results: The study revealed that almost two-third of respondents were exposed to SHS in at least one public area in the past one month, with significantly higher exposure among males (70.6%), those with higher educational attainment (81.4%) and higher income (Quintile 1 – 73.9%). Besides, the exposure to SHS was almost four times higher in non-restricted areas compared to restricted areas under the CTPR (81.9 % vs 22.9). Multivariable analysis revealed that males and younger adults at non-restricted areas were more likely to be exposed to SHS whilst no significant associated factors of SHS exposure was observed in restricted areas.

Conclusions: The study revealed the prevalence of SHS exposure were higher among Malaysian adults. Although smoke-free laws offer protection to non-smokers from exposure to SHS, enforcement activities in restricted area should be enhanced to ensure strict public abidance. In addition, legislation of restricted areas should also be extended to greatly reduce the SHS exposure among non-smokers in Malaysia.

Strength and limitation of the study:

The representativeness and adequacy of sample size as well as the high response rate enable generalization of findings to the Malaysian population

Face to face interview approach employed in the study will increase the quality of the data.

Under reporting or over-reporting might occur as the period of the study was for the one month prior.

Only Seven “types of public areas” were included in the study , exposure in other restricted and non-restricted areas was not extensively investigated.

Objective measurement of exposure to SHS among non-smokers (e.g., carbon monoxide in expired breath air, cotinine (a nicotine metabolite) was not carried out.

Introduction

Second-hand smoke (SHS) is composed of side stream smoke (the smoke released from the burning end of a cigarette) and exhaled mainstream smoke (the smoke exhaled by the smoker)[1]. There are more than 200 of these chemicals confirmed carcinogens and respiratory toxins (eg., benzene, 1,3-butadiene, formaldehyde, mercury and hydrogen cyanide)[2]. Exposure to SHS could affect the health of an individual. Epidemiological studies revealed that SHS exposure causes an increased risk of lung cancer by 20–30%[3], heart disease by 25–30%[4], stroke by up to 82%[5] and an increased risk of other non-fatal respiratory illnesses[4]. In additions also has been shown to have adverse effects on reproduction and associated with sudden infant death syndrome (SIDS)[3,4] . Furthermore, SHS has also been associated with recurrent wheezing, respiratory illnesses, decreased lung function, and asthma [6,7], as well as chronic respiratory symptoms among adults[8]. Annually 600,000 deaths were reported globally due to exposure to the SHS[9,10.]

Prohibition of smoking in public areas was among the public health policies to reduce exposure to SHS in public areas apart from de-normalizing smoking behaviour. Studies revealed that the implementation of this policy has reduced the exposure of adults and children in Scotland to SHS by 39%[11], reduce the active smoking rate among smokers[12] In addition, the implementation of smoke free policies has also significantly reduced the salivary and urinary cotinine (a metabolite of nicotine) among non smoker in United States of America, Canada, Scotland Uruguay, and Ireland [13-18]. Furthermore, the measurement of air quality in public areas revealed a significant reduction of several chemical components available in SHS [19,20] Furthermore, smoke free laws also reduced the quantity of cigarettes smoked[21], increased the intention to quit smoking among smokers[22] and increase the proportion of smoking cessation [23]. More importantly, smoke free regulation has been shown to significantly reduce the number of hospital admissions for heart attacks and asthma-related diseases, and premature births [24-26]. Systematic review of Frazer et al in 2010 and 2016 revealed that the smoke free policy significantly reduces the mortality related to smoking illness and improve the outcome of cardiovascular health outcome[12.27] The policy had been identified as a non-price measures which will reduce the mortality and morbidity due to smoking related diseases [28].

The Malaysian government through the Ministry of Health, also implemented similar measures to protect non-smokers from exposure to SHS in public areas with the introduction of smoking prohibition in public areas via the Control of Tobacco Product Regulations (CTPR) 1993. Eight areas were restricted (entertainment centre or theatre, hospital or health clinic, public lift, air-conditioned eating place, public vehicles, building of Island & Peninsular Kuala Lumpur, and in any area of petrol station and Esso tower building, Kuala Lumpur). This was later expanded to other public areas through the amendment of the provision to the CTPR in 1997 until 2017 [29-36]. The expansion of smoke free public areas was in line with the provision of Article 8 of the Framework Convention on Tobacco Control (FCTC) [37] which was rectified by the Malaysian government in 2005. As of the year 2017, 29 types of public areas and thirty five localities had been declared as smoking restricted areas (Appendix 1-supplementary file). This regulation was supported by enforcement by authorised officers with frequent visits to ensure that the public abides by this provision.

Although the smoking prohibition policy had been implemented since the last two decades and studies elsewhere show its efficacy to reduce the exposure of non-smokers to SHS [20 22], The effect of smoke free policies on SHS exposure in Malaysia has not been studied. Knowledge on the effect of exposure to SHS will assist policy makers in planning and formulating suitable policies, as well as measuring and strengthening existing policies and regulations. In addition, it will ensure the allocation of human and material resources to reduce SHS among the Malaysian public. This paper intends to narrow the knowledge gap with the illustration of SHS exposure in various public areas (restricted and non-restricted) and social demographic variation of exposure among Malaysians to SHS.

Methods

Data for this write-up was derived from the Malaysian Global Adult Tobacco Survey(GATS) which was carried out from October 2011 to January 2012.The study utilised a cross sectional design and three stage sampling proportionate to size to obtain a representative sample of Malaysians aged 15 years and above. First strata consist of 15 states in Malaysia whilst second stage was the division of urban and rural areas by each state. Enumeration blocks (EBs) which is an artificial geographical area created by the Department of Statistics consisted of 80-120 living quarters based on 2010 population census was the primary sampling unit (PSU) and living quarters (LQs) were the secondary sampling unit. One household member aged 15 years and above from the selected LQs will be selected by the simple random sampling method based on a random number generated by hand-held devices. The sample size was determined based on GATs protocol , of at least 4,000 respondents is required for the study , after adjusting for potential non-ineligibility and non-response, the respondents needed for the study are 5112.

Face to face interview approach by trained research assistants was used to obtain data from selected respondents. Detailed information regarding the purpose of the survey was explained to the respondents. Their participation was based on a voluntary basis and they have the right not to answer any question as well as withdrawing from the study at any juncture. All information given was treated as confidential and utilised for research purposes only. The interview session only started after written consent was obtained from the selected respondents. For respondents aged below 18 years old, written consent was obtained from their parent or guardian in addition to permission by the respondent. Detail of the methodology is published by Azahadi et al., 2015[38]. Ethical approval was granted by Malaysia Research Ethical Committee, Ministry of Health, Malaysia.

Study instrument was a questionnaire adopted from GATS, translated and pre-tested before use. It consists of 8 components, namely social demographics, smoking status, type of tobacco product used, exposure to SHS at home, work and selected public areas, expenditure on cigarettes, knowledge of smoking hazards and SHS, intention to quit , exposure to tobacco product advertisement and information regarding the hazards of tobacco products.

Smoking status of respondents was evaluated by several items (1)“Are you currently smoke (2) “Do you use any smokeless tobacco” (3) Do you used any sisha (5) Do you use any bidi (5) Do you used any electronic cigarettes”?, with the choice of “daily, “less than daily”, and “not at all”. Respondents who answered “not at all” to all the items were classified as “non-smokers” whilst those who answered “daily, less than daily” as “current smokers”. Only non-smokers were included in the analysis for exposure to SHS. Exposure to SHS was determined by items “Do you visit these public areas: (1) Government offices (2) Health facilities (including a hospital or clinic) (3) Public transport terminal (4) Air-conditioned shopping complex (5) bar or night club(6) cafes/ coffee shop/bistro and (7) non air-conditioned restaurant “during the last one month” with the choice of “Yes”, “No”, “Don’t know” and “Refused to answer”. The respondents who answered “No” , “Don’t know” and “refused to answer” was excluded from further analysis. Those who answered “Yes” to any area/s mentioned were asked if during the visit they have seen anyone smoke in

any of those seven areas. Whilst the respondents who answered "Yes" to any item was classified as exposed to SHS in those areas. Those who were exposed to SHS at government offices/health facilities/ public transport terminal / air conditioning shopping complexes were further categorised as exposed to SHS in restricted non-smoking areas. In the same note, those who answered "Yes" to (1) bar or night club (2) cafes / coffee shop/bistro and (3) restaurant without air-conditioning were classified as exposure to SHS at non-restricted areas.

The independent variables were social demographics, namely, gender, ethnicity, education attainment (which was divided into four categories;"No formal education", primary education, secondary school and tertiary"), age group (15-24 years old, 25-44 years old , 45-64 years old and 65+), locality (urban/ rural), while income level was measured using Wealth index, a proxy measure for respondents' socioeconomic status was constructed using principal component analysis with information on household ownership of assets[39]. Assets included were electricity, flush toilet, fixed telephone, cellular telephone, television, radio, refrigerator, car, moped/scooter/motorcycle, washing machine, etc. The sample was divided into Quintiles, from quintile one (highest) to quintile five (lowest). Marital status of respondents was classified as single, married and widow/widower/separated.

Data was cleaned prior to analyses. It was weighted,taking into account study design, non-response and social characteristics (gender, residence, age group, education attainment, ethnicity) based on Malaysia population census 2010). Descriptive statistics were utilised to describe the social demographic characteristics of the respondents. Cross tabulation was used to describe proportion of respondents to SHS exposure at various public places. Multivariable Logistic Regression was run to determine the association between various social demographic backgrounds with SHS exposure in restricted and non- restricted public areas. We reported 95% confidence intervals without p values as the large sample size could generate significant results even if statistical differences or associations were small. All analyses were carried out by using SPSS statistical software version 20.

Results

Of the 5112 respondents, 4250 completed the interview, given the response rate of 83.1%. 3269 of an overall sample of 4250 respondents who participated in the study were non-smokers (76.9%, 95% confidence interval, CI 74.8-78.8), The proportion of female non smokers was significantly higher compared to males (98.7%, 95% CI 98.0-99.1 vs 56.1%, 95% CI 52.7 – 58.9) . Those from the youngest (15-24 years; 83.3%, 95% CI 79.7-86.4)) and oldest age group (65+; 85.0%, 95% CI 80.1-88.8) also reported a significantly higher proportion of non-smokers compared to the 25-44 years old group (71.0%, 95% CI 67.8-73.9). Similarly, the proportion of non-smoking participants were higher in those with tertiary education attainment (84.7%, 95% CI 80.1-88.4) and higher income group(Quintile 1: 82.9%, 95% CI 79.3-86.and Quintile 2: 80.8%, 95% CI 76.9-84.2) (Table 1).

Table 2 shows that almost two thirds of non-smokers (63.6%, 95% CI 60.6-66.2)were exposed to SHS at one or more public area during the last one month. The exposure among males was significantly higher compared to that among females (70.9%, 95% CI 66.5-74.9 vs 59.1%, 95% CI 55.7-62.4).In addition, respondents from urban areas, with higher education attainment and income also reported a higher proportion of exposure to SHS. However, older respondents reported lower exposure compared to their younger counterparts (15-24 years, 72.1% , 95% CI 67.4-76.3, 25-44 years, 67.9%, 95% CI 63.8%, 95% CI 63.8-71.5, 45-64 years, 54.4%, 95 CI% 49.9-58.8; and 65 +,37.3%, 95% CI 29.1-46.1%).

Exposure of non-smokers to SHS was significantly higher in non-restricted public areas compared to restricted areas, in which the proportion of exposure was approximately four times higher than that reported in restricted areas (81.9%, 95% CI 79.5-84.1 vs. 22.9 %, 95 CI% 20.4-25.5). Further analysis of exposure to SHS in restricted areas revealed that the level of exposure was significantly lower in health care facilities (8.7%, 95% CI 6.9-10.8) compared to indoor shopping complexes (13.6%, 95% CI 11.7-15.7), government offices (20.0%, 95% CI 16.4-24.2) and public transport (27.9%, 95% CI 22.5-34.0). No significant difference was observed among all social demographic characteristics to SHS in non-restricted areas except for the younger age group of 15-24 years (30.2%, 95% CI 25.6-35.3). The study also revealed that the level of SHS exposure on the three non-restricted smoking areas were almost similar for all respondents from different social demographic backgrounds (Table 3)

Multivariable Logistic regression analysis revealed that the likelihood of exposure to SHS in restricted public areas were almost similar across all social demographic variables, whilst for non-restricted area, non-smokers from the younger age group (15-24, AOR 5.07, 95% CI 2.18-11.7, 25-44. AOR 3.12, 95% CI 1.51-6.45, 45-64, AOR 2.08, 95% CI 1.10-3.93, 65+ as reference) and males (AOR 1.46, 95% CI 1.03-2.05) were more likely to be exposed to SHS in the last one month (Table 4).

Discussions

This is to our knowledge the first report on exposure to SHS in various public areas among a representative sample of Malaysian adult population after two decades of anti smoking law implementation.. The study reveals that almost two out of three (66.7%) Malaysian adolescents (below the age of 19 years old) and adults were exposed to SHS in at least one public area investigated during the one month prior to the study. This is similar (66%) to that reported in Spain [40], but lower as compared to that reported by Xiao et al., (2010) [41] among non-smokers aged 15 years and above in China; 72.4% (95% CI, 70.4-74). Interestingly, it is higher than that reported among non-smokers in Cambodia [42] and European union (EU)[43], which were 37.4% and 29.0%, respectively. The proportion of SHS exposure by gender was almost two times higher compared to that reported globally (70% vs. 33% for males; 59% vs. 31% for females) [44]. The different proportion of exposure might be due to different social norms in related countries, an existing anti-smoking norm might reduce the likelihood of smoking in public areas. In addition, different anti-smoking laws /policies might be another contributing factor for this difference in proportion of exposure to SHS. Hence, further studies are required to elucidate the real factors for the differences in exposure to SHS reported.

There were no significant differences in SHS exposure in restricted areas among urban and rural dwellers, after controlling for potential confounders. In contrast, urban dwellers were significantly more likely to expose to SHS in non-restricted areas as compared to their rural counterparts. This could be possibily due to the fact that restaurants, bar/night clubs and cafes/coffee shops/bistros were less readily accessible in rural areas[45]. On the other hand, no significant differences in SHS exposure were observed across ethnics, in both restricted and no-restricted areas. One of the possible expanations is that, regardless of ethnicity, most of the restricted areas (healthcare facilities, indoor shopping complexes and public transportations) and non-restricted areas (restaurants and cafes/coffee shops/bistros) were commonly visited or patronised by Malaysians.

Respondents from the younger age group reported higher exposure to SHS in non-restricted areas. This finding is in line with that by Li et al. (2015) among women in China[46], in which the level of exposure decreased from 66.8% in those aged 18-24 to 38.9% among those aged 65 and above. The finding might due to the respondents of younger age group mostly consist of those who are productive and economically active, therefore they are more mobile and visit public areas more often compared to their counterparts from lower education, lower income and older age group. Furthermore, the public areas under investigation (e.g., coffee house and bistro) were premises which were tailored to attract the younger age group.

Male respondents were more likely to be exposed to SHS in non -restricted areas in univariate and multivariate analysis compared to females. The finding is in-line with Rudatsikira et al., (2008)[42], Li et al., (2015)[46] and Desalu et al.,(2011)[47] who reported a higher proportion of SHS exposure among non smoking males in Cambodia adults residing two cities in Nigeria and adults in North East China, respectively. This might due to males being more mobile compared to females in view of their nature of occupation which require

them to travel more. In Malaysia, males tend to socialize more as compared to females as it is the patriarchal society. In addition, non-smoking males might befriend those who are smokers in view of the high prevalence of smokers among males (45%) in Malaysia and therefore increases the likelihood of exposure to secondhand smoke [48].

Exposure to SHS was significantly lower in restricted areas as compared to non-restricted areas. This is consistent with several previous studies, including Mulcahy et al., (2005) [10], Pellegrini et al., (2010) [49], Carpenter et al., (2011)[50], Jensen et al., (2012)[13], Azagba et al (2015) [51],and Park et al 2016[19]. All studies revealed that laws significantly reduced exposure to SHS in a variety of public places, especially bars, restaurants, and outdoor patios of these premises. These reductions in public-place exposure are observed for both smokers and non-smokers. Multivariable analysis, which showed no difference in the likelihood among various socioeconomic backgrounds to SHS exposure support the notion that smoke free areas offer protection to non-smokers from SHS exposure (Table 5).

Among the restricted areas, non-smokers reported the lowest exposure to SHS in health facilities, followed by air-conditioned shopping centers, government offices and public transports. Similar finding was also reported from the Global Adult Tobacco Survey (GATS) in the Philippines in 2010 (GATs 2010)[52]. This could be due to the majority of health personnel being aware of the dangers of smoking and SHS which translate to their attitude and behaviour toward smoking, therefore creating a non-smoking social norm among their fraternity. This reduces the likelihood of smoking behaviour and increases advising of those who smoke in the hospitals/health facilities to smoke elsewhere. The respondents who visited the hospitals /health facilities usually consist of those who seek treatment, hence their health condition might not permit them to continue their smoking behaviors. Teh et al.,(2014)[53] also reported that a majority of the public perceived that hospitals/health facilities were premises which provided treatment and therefore inappropriate for anyone to practice unhealthy lifestyle. In addition, respondents who visit the hospitals were mostly from the older age group with less likelihood to be smokers in view of the lower prevalence of smoking among older Malaysians (16.4%)[54]

The low prevalence of SHS exposure among non-smokers in the shopping centers (approximately one in ten or 10%) might be due to central air-conditioning system utilised in most Malaysian shopping centers whereby any cigarette smoking within the premises created a nuisance to the public who visited the shopping centers, and their reactions serve as a deterrent for smokers to smoke. In addition, the management personnel of these shopping centers usually try to take all necessary measures to retain their customers through a conducive and cozy environment for shopping, one of the approaches was to ensure the conducive environment for visitors via a smoke free environment. In addition, owners' of premises fear of being fined for having people smoking in their premise could be another possible reason for the finding in this study.

More than one-fifth and almost one-third of non -smokers were exposed to SHS in the last one month during their visit to a government office and use of public transportation, respectively. The high exposure was rather surprising in view of the area and the facility having been designated as smoke free since the last 20 years. This is a clear indication of noncompliance to the legislation.

Among the smoking-restricted areas, it is noteworthy that public transportations and government offices had been reported to have the highest level of SHS exposure. These findings may indicate a debilitated enforcement of smoke-free regulations in those areas. In Malaysia, the Environmental Health Officers or Assistant Environmental Health Officers (EHO/AEHO) who are involved in law enforcement, are unbale to perform their task as regularly and frequently as needed as they are overwhelmed by other routine surveillance activities for both communicable and non-communicable diseases [55]. However, further investigations from multiple angles, such as the person who smoke in the restricted areas (either government officers in government premises or drivers of public transports), level of awareness on SHS exposure among the public and assessment on the level of enforcement activities as well as adequacy of enforcement officers in anti-smoking programme are urgently needed to elucidate the contributing factors for the present findings.

There were several limitations in this study. Firstly, under reporting or over-reporting might occur as the period of the study was for the one month prior. Secondly, with seven types of public areas included, exposure in other restricted and non-restricted areas was not extensively investigated. Thirdly, the exposure to SHS was based on observation by respondents and no other indicator such as smelling of cigarette smoke or how far the distance between smoker and respondents was investigated. Future studies should include more public areas (both restricted or non-restricted) and employ objective measurement of exposure to SHS among non-smokers (e.g., carbon monoxide in the expired breath air, cotinine (a nicotine metabolite) or measurement of air quality for chemicals related to SHS. However, previous studies had found satisfactory validity of self-reported of SHS exposure [56-57]. In addition, the representativeness and the adequacy of sample size as well as the high response rate enable generalization of findings to the Malaysian population, Furthermore; face to face interview approach employed in the study will increase the quality of the data.

The findings from the study add to the body of evidence that the prohibition of smoking in public areas will reduce the exposure to SHS [19,20,40] .Therefore, more public areas should be restricted as non-smoking areas to further reduce the exposure to SHS among public and to create the environment which is not conducive for smoking. However, the sizeable reported exposure to SHS by non-smokers demands for stricter and more frequent enforcement of the provision under the current anti-smoking law to ensure all restricted areas to be 100% smoke free .

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Availability of data and materials
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Authors' contributions

LKH, TCH and MHNM, LHL wrote the manuscript, SMG and KCC carried out statistical analysis, SP , MFY, LMY design the study, NH, NZ, NDD and NI responsible for data collection, and coordination of the study. CKH manage and clean the data. LKH, TCH and LHL were involved in interpretation and implications of the analysis. All authors contributed to developing the manuscript, and read and approved the final version

Competing interests

The authors declared that they have no competing interest.

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Table 1: Social demographic characteristic of non smoking respondents aged 15 years and above in Malaysia

Demographic characteristic	n	N (in thousands)	%	95 CI	
Gender				Lower	Upper
- Male	1144	5938	56.1	52.7	59.4
- Female	2125	9887	98.7	98.0	99.1
Age group(years)					
- 15-24	605	4745	83.3	79.7	86.4
- 25-44	1284	6063	71.0	67.8	73.9
- 45-64	1026	3764	77.3	74.1	80.2
- 65+	354	1252	85.0	80.1	88.8
Residence					
Urban	1616	11485	77.3	74.6	79.8
Rural	1653	4340	75.7	73.3	78.0
Education level					
Less than primary	520	1605	80.3	75.8	84.1
Primary	834	3170	75.7	72.1	79.0
Second/high school	1031	4770	74.9	71.9	77.6
College or above	264	1472	84.7	80.1	88.4
Ethnicity					
Malay	1931	9143	75.4	72.7	77.9
Chinese	553	3226	84.6	80.5	88.0
Indian	213	1552	80.4	73.6	85.8
Other	572	1903	70.0	64.7	74.9
Quantile Income level					
Q 1	698	4941	82.9	79.3	86.0
Q 2	689	3832	80.8	76.9	84.2
Q 3	601	3004	71.8	67.1	76.0
Q 4	628	2281	73.0	68.1	77.5
Q 5	603	1578	68.0	62.9	72.7

Table 2: Exposure to SHS in at least one public places by social demographic

Demographic characteristic	n	N (in thousands)	%	95 CI	
Gender				Lower	Upper
- Male	667	3847	70.9	66.5	74.9
- Female	972	5320	59.1	55.2	62.4
Age group(years)					
- 15-24	347	3139	72.1	67.4	76.3
- 25-44	749	3759	67.9	63.8	71.5
- 45-64	441	1846	54.4	49.9	58.8
- 65+	102	423	37.3	29.1	46.1
Residence					
Urban	945	7182	67.9	64.5	71.2
Rural	694	1985	51.6	47.8	55.3
Education level*					
Less than primary	142	5010	34.0	27.8	40.7
Primary	493	2615	59.3	54.9	63.6
Second/high school	764	4448	68.1	64.2	71.7
College or above	237	1590	81.4	75.6	86.1
Ethnicity					
Malay	946	5083	63.1	59.6	66.4
Chinese	948	2192	70.8	65.9	76.0
Indian	130	1004	68.6	59.7	76.3
Other	227	887	49.1	42.6	55.6
Quintile Income level					
Q 1	476	3406	73.9	69.1	78.2
Q 2	406	2040	69.4	64.7	73.7
Q 3	308	1705	62.6	57.1	67.8
Q 4	267	1085	52.2	46.1	58.2
Q 5	179	511	36.3	30.6	42.4

Table 3: Self-reported exposure to second-hand smoke (SHS) among non-smokers in selected restricted and non restricted areas

Demographic Characteristic	Self-reported exposure to second-hand smoke, % (95% CI)								
	Restricted area					Non restricted area			
	At least one	Government office	Health-care facilities	Indoor shopping complexes	Public Transportation	At least one	Restaurants	Bar/nightclubs	Cafes/coffee shops/Bistros
Overall	22.9(20.4-25.5)	20.0(16.4-24.2)	8.7(6.9-10.8)	13.6(11.7-15.7)	27.9(22.5-34.0)	81.9(79.5-84.1)	71.0(67.7-74.0)	78.7(64.2-88.4)	84.9(52.1-87.3)
Gender									
Male	21.4(18.6-24.4)	20.1(16.0-25.0)	7.8(5.4-11.2)	11.7(9.2-14.9)	33.5(23.4-45.4)	87.6(85.0-89.8)	73.1(69.2-76.6)	81.4(62.4-92.0)	85.0(81.7-87.8)
Female	23.2(20.2-26.6)	19.8(14.7-26.2)	9.4(7.1-12.4)	15.4(12.9-18.3)	25.4(19.6-32.2)	80.5(77.1-83.4)	68.4(63.8-72.8)	70.2(46.6-86.4)	84.7(80.8-87.9)
Age group(years)									
15-24	30.2(25.6-35.3)	24.1(16.2-34.3)(	2.3(7.9-18.7)	17.8(13.7-22.6)	31.8(23.2-41.7)	86.0(82.1-89.2)	72.6(66.7-77.8)	81.2(58.7-92.9)	86.3(81.1-90.3)
25-44	21.9(19.0-25.0)	20.9(16.3-26.4)	8.4(5.9-11.6)	12.6(10.3-15.4)	30.12(22.1-39.6)	85.3(82.3-87.9)	72.6(68.4-76.3)	80.3(61.5-91.2)	83.9(79.4-87.5)
45-64	14.4(11.7-17.6)	14.4 (9.6-20.9)	6.3(4.3-9.1)	8.8(6.5-11.9)	14.7(9.0-23.2)	83.6(80.0-86.6)	67.6(61.9-72.7)	-	86.9(82.8-90.1)
65+	16.8(10.9-24.8)	23.3 (12.7.-39.7)	7.9(3.6-16.5)	19.0(9.8-33.5)	20.2(8.8-39.9)	70.8(60.0-79.7)	55.4(39.9-70.0)	-	75.1(63.5-83.9)
Residence									
Urban	23.2(20.5-26.0)	21.5(17.0-26.9)	9.2(7.0-12.1)	14.3(12.1-16.9)	27.5(20.8-35.4)	85.8(83.3-88.1)	71.3(67.4-75.0)	80.8(64.1-90.8)	85.6(82.0-88.6)
Rural	19.7(16.8-23.1)	15.4(11.4-20.6)	7.3(5.3-10.0)	10.9(8.4-14.1)	29.1(22.4-36.9)	80.2(76.9-83.1)	69.6(64.9-74.0)	63.3(36.9-83.6)	82.5(79.1-85.4)
Education level*									
Less than* primary	14.7(10.6-19.9)	16.0(7.7-30.2)	5.6(3.1-10.1)	14.2(8.4-23.0)	17.2(9.6-28.8)	81.6(74.1-87.3)	68.8(55.3-79.7)	-	82.4(73.7-88.6)
Primary	19.1(15.7-23.1)	24.3(16.6-34.0)	7.4(4.8-11.3)	12.3(9.1-16.4)	22.9(14.8-33.6)	82.8(78.4-86.4)	67.9(61.6-73.5)	-	84.3(78.6-88.8)
Second/high	19.1(16.2-22.5)	17.5(13.1-	8.0(5.4-11.8)	10.0(7.9-12.6)	29.3(20.0-	85.0(81.9-	72.3(67.5-	88.5(74.5-	85.9(82.1-

school		22.9)			40.6)	87.7)	76.6)	95.3)	88.9)
College or above	22.5(16.9-29.3)	18.4(11.4-28.3)	8.9(4.9-15.7)	15.2(10.4-21.7)	20.7(17.4-45.8)	83.3(77.5-87.9)	68.4(60.4-75.5)		80.4(71.1-87.3)
Ethnicity									
Malay	22.6(19.9-25.6)	22.6(18.2-27.6)	8.8(6.8-11.4)	12.7(10.4-15.4)	27.9(21.3-35.6)	84.6(82.2-86.7)	75.1(71.2-78.6)	64.1(40.6-82.3)	84.0(80.5-87.0)
Chinese	18.7(14.7-23.6)	12.8(6.8-22.8)	7.7(4.5-12.7)	14.7(11.0-19.4)	21.8(11.1-38.4)	86.9(82.5-90.3)	58.0(51.3-64.5)	86.8(61.1-96.5)	88.3(82.8-92.6)
Indian	30.2(22.5-39.1)	18.3(9.5-32.1)	14.9(7.3-28.1)	17.9(11.0-27.6)	35.1(22.6-50.1)	84.4(76.9-89.8)	74.8(65.0-82.7)		79.4(68.8-87.1)
Other	20.2(16.0-25.3)	16.4(8.9-28.2)	3.8(1.7-8.6)	12.9(8.6-18.8)	28.0(20.3-37.4)	79.6(73.1-83.1)	69.8(61.8-76.7)	65.5(30.8-89.0)	87.1(80.2-91.9)
Income level									
Q 1	24.3(20.6-28.3)	17.9(12.4-25.2)	8.7(5.7-13.2)	15.5(11.9-19.9)	26.9(16.7-40.3)	85.5(81.8-88.6)	68.3(62.5-73.7)	76.4(54.2-89.8)	85.1(79.9-89.1)
Q 2	24.5(20.4-29.1)	19.7(13.4-28.0)	7.7(4.6-12.7)	15.7(12.0-20.3)	30.1(20.6-41.6)	84.3(80.7-87.4)	67.8(61.7-73.4)	-	83.1(77.3-87.0)
Q 3	19.7(16.0-24.2)	25.4(16.7-36.7)	10.0(5.9-16.5)	14.9(10.9-20.0)	31.6(20.0-46.2)	84.5(80.5-87.8)	68.1(61.1-74.4)	-	86.4(79.3-91.4)
Q 4	19.3(15.2-24.2)	15.8(8.1-28.7)	10.4(5.7-18.0)	10.9(7.0-16.6)	23.8(14.6-36.2)	85.3(79.8-89.5)	72.1(62.1-80.3)	-	84.1(75.4-91.1)
Q 5	21.1(16.0-27.2)	18.3(7.8-37.3	5.9(3.2-10.8)	12.3(5.7-24.7)	24.3(16.5-3434)	81.0(74.2-86.3)	65.0(52.6-75.7)	-	79.2(66.0-88.1)

Table 4: Multivariable analysis of non-smoker exposure to Second Hand Smoke in restricted and non-restricted public area

Variable	Exposure to Second-hand smoke					
	Restricted area			Non Restricted area		
	AOR	95% CI		AOR	95% CI	
		Lower	upper		Lower	Upper
Gender						
Male	0.89	0.66	1.12	1.46	1.03	2.05
Female	Ref			Ref		
Locality						
Urban	Ref			Ref		
Rural	0.90	0.67	1.21	0.79	0.57	1.10
Ethnicity						
Malay	1.18	0.80	1.73	0.70	0.48	1.03
Chinese	Ref			Ref		
Indian	1.72	0.98	1.64	0.86	0.46	1.59
Others	1.03	0.65	1.64	0.49	0.28	0.85
Education Attainment						
No formal education	0.56	0.29	1.08	1.62	0.78	3.40
Primary school	0.69	0.44	1.07	1.16	0.69	1.98
Secondary school	0.64	0.43	0.94	1.14	0.76	1.74
College and above	Ref			Ref		
Age group						
15-24	1.59	0.68	3.75	5.07	2.18	1.73
25-44	1.32	0.70	2.50	3.12	1.51	6.45
45-64	0.82	0.45	1.49	2.08	1.10	3.93
65+	Ref			Ref		
Marital Status						
Married	Ref			Ref		
Single	1.36	0.86	2.15	0.92	0.51	1.65
Widow/er/separated	1.24	0.76	2.03	0.68	0.44	1.06
Quintile income group						

Quintile 1	Ref			Ref		
Quintile 2	1.12	0.79	1.60	0.95	0.65	1.39
Quintile 3	1.05	0.70	1.57	1.04	0.67	1.64
Quintile 4	0.74	0.49	1.13	1.15	0.65	2.03
Quintile 5	1.05	0.66	1.69	0.74	0.39	1.38

Table 5: Previous studies showed the effectiveness of smoking free regulation

Author/s	Approach	Finding
Jensen et al (2010)	Measurement of urine Cotinine and total 4-(methylnitrosamino)-1-(3- pyridyl)-1-butanone, 4-(methylnitrosamino)-1-(3-pyridyl)- 1-butanol (NNAL) and its glucuronides (NNAL-Glucs) among 24 restaurant and Bar worker before and after implementation of anti smoking law in Minnesota, USA	More than 50% reduction of total urine cotinine was reported among 79% of workers (19 out of 24). In addition, 13 out of 23 workers (54%) reported at leasta 50% reduction in total 4-(methylnitrosamino)-1-(3- pyridyl)-1-butanone, 4-(methylnitrosamino)-1-(3-pyridyl)- 1-butanol (NNAL) and its glucuronides (NNAL-Glucs),
Azahba (2015)	Regression modelling was carried out on from 89,743 respondents participated in 2005–2012 Canadian Tobacco Use Monitoring Survey to determine the effect of smoke free regulation.	A reduction of 25% and 21% of SHS was reported in Alberta and Nova Scotia after the implementation of Smoke free regulation.
Park et al.,(2016)	Urine cotinine concentration was investigated among 4612 non-smoking Korean citizens (aged 19 or older) who participated in the first stage of the Korean National Environmental Health Survey between 2009 and 2011.	The total decrease of 2.79 ng/ml (54.7%) urine cotinine concentration between 2009 and 2011 among non smokers who participated in the study.
Pellegrini et al (2010).	Urine and hair cotinine level were measured among 372 Italian young adolescents, between 10 and 16 years of age city of Sicily, Palermo. After implementation of the anti smoking law between November 2005 and May 2006,	Only 8.6% of respondents exposed to high and very high exposure to SHS, whilst 11.8% of the study participants presented as not exposed to SHS, 65.6% at low exposure to SHS, 13.9% at medium exposure after implementation of the law.
Mulcahy et al., 2005	A study on SHS exposure a cohort of workers from a sample of city hotels in Ireland before and after the enforcement of smoke free policies. Salivary cotinine concentrations (ng/ml) and	Reduction of 69%/ of Salivary Cotinine concentrations was reported (from1.6 ng/ml to 0.5 ng/ml median. Almost two third of the respondents (60%) showing half of concentration of cotinine after

	duration of self-reported exposure to SHS was also assessed using the questionnaire. City centre bars stratified by size (range 400–5000 square feet) was randomly selected and tested for air nicotine concentrations using passive samplers before and after the smoke ban policies.	the implementation and 74% of respondents experienced decrease in of salivary cotinine (range 16–99%), Self reported exposure to SHS at work by questionnaire revealed no exposure to SHS after implementation of smoke free ban compared to medium of a median 30 hours a week prior to the ban. The significant reduction of air nicotine was observed (35.5 µg/m^3 to 5.95 µg/m^3 –a 83% reduction)($p < 0.001$).

SMOKING RESTRICTED AREAS IN MALAYSIA AND YEAR GAZETTED (FROM 1993-2017)

No.	Area	Year gazetted								
		1993	1997	2004	2008	2009	2011	2012	2014	2017
	Type of area									
1	In any entertainment center or theater, except any pub, discotheque, night club or casino, at any time when such place is open to the public	x	x	x	x	x	x	x	x	
2	In any hospital or clinic	x	x	x	x	x	x	x	x	
3	In any public lift	x	x	x	x	x	x	x	x	
4	In any public vehicle	x	x	x	x	x	x	x	x	
5	In any area in a petrol station	x	x	x	x	x	x	x	x	
6	In any hall		x	x	x	x	x	x	x	
7	In any higher educational institution		x	x	x	x	x	x	x	
8	In any area in a nursery		x	x	x	x	x	x	x	
9	In any school		x	x	x	x	x	x	x	
10	In any public transport terminal		x	x	x	x	x	x	x	
11	In any bank counter and financing institution, Telekom Malaysia Berhad, Tenaga Nasional Bhd and Pos Malaysia Bhd.		x	x	x	x	x	x	x	
12	In any shopping complex		x	x	x	x	x	x	x	
13	In any sport complex		x	x	x	x	x	x	x	
14	In any stadium		x	x	x	x	x	x	x	
15	In any public toilet		x	x	x	x	x	x	x	
16	In any air-conditioned eating place or shop		x	x	x	x	x	x	x	
17	In any airport		x	x	x	x	x	x	x	
18	In any government premise		x	x	x	x	x	x	x	

19	In any area which is used for any assembly activity in a building other than private or residential building			x	x	x	x	x	x	
20	In any school bus			x	x	x	x	x	x	
21	In any area in a petrol station			x	x	x	x	x	x	
22	In any fitness centre or gymnasium			x	x	x	x	x	x	
23	In any building or public place which is used for religious purposes			x	x	x	x	x	x	
24	In any area in a library			x	x	x	x	x	x	
25	In any area in an internet cafe			x	x	x	x	x	x	
26	In any area of national service health center				x	x	x	x	x	
27	In any workplace with centralised air conditioning					x	x	x	x	
28	Rest and recreational areas								x	
29.	Public park, state park, national park and camp site									x
	Selected building or areas									
1	Island &Peninsular building, Kuala Lumpur	x	x	x	x	x	x	x	x	
2	Esso Tower Building, Kuala Lumpur	x	x	x	x	x	x	x	x	
3	Selected areas in the state of Melaka - World Heritage City Melaka - Melaka Raya - Melaka International Trade Centre (MITC) - Alor Gajah City - Jasin City						x	x	x	
4	Selected areas in the state of Penang - "Hutan Bandar Mutiara Rini" Penang. - Municipality garden, George Town, Penang - Botanical Gardens, Penang							x	x	

	- Air Hitam Dam,Penang - Mengkuang Dam, Penang - Taman Ampang Jajar, Penang - Telok Bahang Dam, Penang									
5	Selected areas in the state of Johor - Endau National Park, Rompin, Johor - Johor National Park, Gunung Ledang - Johor National Park, Pulau Kukup - Johor National Park, Tanjung Piai - Town Park 3 Recreation Park, Taman Seri Austin, Johor								x	
6.	Selected state of Kelantan - Tambatan Diraja, - Jalan Tengku Puteri - Flat Buluh Kubu - Jalan Parit Dalam Tengku Besar - Ketereh-Kompleks Pasar Saidina Ali - Kok Lanas - Pasar Beris Kubu Besar Bachok and surrounding areas - Dataran Air Moleh, Pasir Mas - Bandar Baru Pasir Mas - Apam Putra, Pasir Mas - Laman Tamu - Taman Kuala Krai - PKT supermarket and surrounding areas - Guchil Kuala Krai - Pasar Besar Tanah Merah and surrounding areas, - Dataran Puchong									x

Appendix I

SMOKING RESTRICTED AREAS IN MALAYSIA AND YEAR GAZETTED (FROM 1993-2017)

No.	Area	Year gazetted								
		1993	1997	2004	2008	2009	2011	2012	2014	2017
	Type of area									
1	In any entertainment center or theater, except any pub, discotheque, night club or casino, at any time when such place is open to the public	x	x	x	x	x	x	x	x	
2	In any hospital or clinic	x	x	x	x	x	x	x	x	
3	In any public lift	x	x	x	x	x	x	x	x	
4	In any public vehicle	x	x	x	x	x	x	x	x	
5	In any area in a petrol station	x	x	x	x	x	x	x	x	

6	In any hall		x	x	x	x	x	x	x	
7	In any higher educational institution		x	x	x	x	x	x	x	
8	In any area in a nursery		x	x	x	x	x	x	x	
9	In any school		x	x	x	x	x	x	x	
10	In any public transport terminal		x	x	x	x	x	x	x	
11	In any bank counter and financing institution, Telekom Malaysia Berhad, Tenaga Nasional Bhd and Pos Malaysia Bhd.		x	x	x	x	x	x	x	
12	In any shopping complex		x	x	x	x	x	x	x	
13	In any sport complex		x	x	x	x	x	x	x	
14	In any stadium		x	x	x	x	x	x	x	
15	In any public toilet		x	x	x	x	x	x	x	
16	In any air-conditioned eating place or shop		x	x	x	x	x	x	x	
17	In any airport		x	x	x	x	x	x	x	
18	In any government premise		x	x	x	x	x	x	x	
19	In any area which is used for any assembly activity in a building other than private or residential building			x	x	x	x	x	x	
20	In any school bus			x	x	x	x	x	x	
21	In any area in a petrol station			x	x	x	x	x	x	
22	In any fitness centre or gymnasium			x	x	x	x	x	x	
23	In any building or public place which is used for religious purposes			x	x	x	x	x	x	
24	In any area in a library			x	x	x	x	x	x	
25	In any area in an internet cafe			x	x	x	x	x	x	
26	In any area of national service health center				x	x	x	x	x	
27	In any workplace with centralize air conditioning					x	x	x	x	
28	Rest and recreational areas								x	

29.	Public park, state park, national park and camp site									x
	Selected building or areas									
1	Island &Peninsular building, Kuala Lumpur	x	x	x	x	x	x	x	x	
2	Esso Tower Building, Kuala Lumpur.	x	x	x	x	x	x	x	x	
3	Selected areas in the state of Malacca - World Heritage city of Malacca city - "Melaka Raya" - Melaka International Trade Centre (MITC) - Alor Gajah City - Jasin City						x	x	x	
4	Selected areas in the state of Penang - "Hutan Bandar Mutiara Rini" Penang. - Municipality garden, George Town, Penang - Botanical Gardens, Penang - Air Hitam Dam,Penang - Mengkuang Dam, Penang - Taman Ampang Jajar, Penang - Telok Bahang Dam, Penang							x	x	
5	Selected areas in the state of Johor - Endau National Park, Rompin, Johor - Johor National Park, Gunung Ledang - Johor National Park, Pulau Kukup - Johor National Park, Tanjung Piai - Town Park 3 Recreation Park, Taman Seri Austin, Johor								x	

6.	Selected state of Kelantan - Tambatan Diraja, - Jalan Tengku Puteri - Flat Buluh Kubu - Jalan Parit Dalam Tengku Besar - Ketereh-Kompleks Pasar Saidina Ali - Kok Lanas - Pasar Beris Kubu Besar Bachok and surrounding areas - Dataran Air Moleh, Pasir Mas - Bandar Baru Pasir Mas - Apam Putra, Pasir Mas - Laman Tamu - Taman Kuala Krai - PKT supermarket and surrounding areas - Guchil Kuala Krai - Pasar Besar Tanah Merah and surrounding areas, - Dataran Puchong									x

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page / Line
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1(Line 3)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3 and 4,
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4 (Line 7-9).
Methods			
Study design	4	Present key elements of study design early in the paper	Pafe 5 (line 2-5)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5 (line 6-11)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 5 (13-19)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	*Page 5 (line 30-48)* *Page 6 (Line 1-10)*
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	*Page 5 (line 33-48) Page 6 (line 1-2)* *Page 6 (Line 4-13)*
Bias	9	Describe any efforts to address potential sources of bias	Page 5 (line 16-21) Page 6 (Line 15-17)
Study size	10	Explain how the study size was arrived at	Page 5 (Line 15-17)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen	

		and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 6 (line 15-24)
		(*b*) Describe any methods used to examine subgroups and interactions	(page 6, line 15-24)
		(*c*) Explain how missing data were addressed	Page 5 (ine 43-44)
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	Page 5 (line 18-25)
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	Page 7 (line 3-4)
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 7 (line5-12) Page 17 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	Page 17 (Table 1)
Outcome data	15*	Report numbers of outcome events or summary measures	Page 7 (line 14-41) Page 18 (Table 2) Page 19-20 (Table 3) Page 21-22 (Table 4)
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	Page 7(36-41) Page 21-22 (Table 4)
		(*b*) Report category boundaries when continuous variables were categorized	NA

		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 7 (line 14-41) page 8 (Line 6)
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	Page 10 (line 14-22)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 10 (27-33)
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 10 (line 23-26)
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	Pafe 11 (Line 6-7)

*Give information separately for exposed and unexposed groups.

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.

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Exposure to tobacco secondhand smoke and its associated factors among non-smoking adults in smoking-restricted and non-restricted areas: Findings from a nationwide study in Malaysia

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Exposure to tobacco secondhand smoke and its associated factors among non-smoking adults in smoking-restricted and non-restricted areas: Findings from a nationwide study in Malaysia

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Abstract

Objectives Secondhand smoke (SHS) has been associated with increased morbidity and mortality. Therefore, the aims of the paper are to assess SHS exposure among non-smoking adults in Malaysia attending various smoking-restricted and non-restricted public areas according to the Control of Tobacco Product Regulations (CTPR) as well as its relation with various sociodemographic variables.

Design: Data were extracted from a cross-sectional study, the Global Adults Tobacco Survey (GATS) 2011 which involved 3269 non-smokers in Malaysia. Data was obtained through face-to-face interviews using a validated pre- tested questionnaire. Factors associated with exposure to SHS were identified via multivariable analysis.

Results: The study revealed that almost two-third of respondents were exposed to SHS in at least one public area in the past one month, with a significantly higher exposure among males (70.6%), those with higher educational attainment (81.4%) and higher income (Quintile 1 – 73.9%). Besides, the exposure to SHS was almost four times higher in non-restricted areas compared to restricted areas under the CTPR (81.9 % vs 22.9). Multivariable analysis revealed that males and younger adults at non-restricted areas were more likely to be exposed to SHS whilst no significant associated factors of SHS exposure was observed in restricted areas.

Conclusions: The study revealed the prevalence of SHS exposure were higher among Malaysian adults. Although smoke-free laws offer protection to non-smokers from exposure to SHS, enforcement activities in restricted area should be enhanced to ensure strict public abidance. In addition, legislation of restricted areas should also be extended to greatly reduce the SHS exposure among non-smokers in Malaysia.

Strength and limitation of the study:

The representativeness and adequacy of sample size as well as the high response rate enable generalization of findings to the Malaysian population

Face to face interview approach employed in the study will increase the quality of the data.

Under reporting or over-reporting might occur as the period of the study was for the one month prior.

Only Seven “types of public areas” were included in the study , exposure in other restricted and non-restricted areas was not extensively investigated.

Objective measurement of exposure to SHS among non-smokers (e.g., carbon monoxide in expired breath air, cotinine (a nicotine metabolite) was not carried out.

Introduction

Second-hand smoke (SHS) is composed of side stream smoke (the smoke released from the burning end of a cigarette) and exhaled mainstream smoke (the smoke exhaled by the smoker)[1]. There are more than 200 of these chemicals confirmed carcinogens and respiratory toxins (eg., benzene, 1,3-butadiene, formaldehyde, mercury and hydrogen cyanide)[2]. Exposure to SHS could affect the health of an individual. Epidemiological studies revealed that SHS exposure causes an increased risk of lung cancer by 20–30%[3], heart disease by 25–30%[4], stroke by up to 82%[5] and an increased risk of other non-fatal respiratory illnesses[4]. In additions also has been shown to have adverse effects on reproduction and associated with sudden infant death syndrome (SIDS)[3,4] . Furthermore, SHS has also been associated with recurrent wheezing, respiratory illnesses, decreased lung function, and asthma [6,7], as well as chronic respiratory symptoms among adults[8]. Annually 600,000 deaths were reported globally due to exposure to the SHS[9,10.]

Prohibition of smoking in public areas was among the public health policies to reduce exposure to SHS in public areas apart from de-normalizing smoking behaviour. Studies revealed that the implementation of this policy has reduced the exposure of adults and children in Scotland to SHS by 39%[11], reduce the active smoking rate among smokers[12] In addition, the implementation of smoke free policies has also significantly reduced the salivary and urinary cotinine (a metabolite of nicotine) among non smoker in all countries, namely United States of America, Canada, Scotland Uruguay, and Ireland [13-18]. Furthermore, the measurement of air quality in public areas revealed a significant reduction of several chemical components available in SHS [19,20] Furthermore, smoke free laws also reduced the quantity of cigarettes smoked[21], increased the intention to quit smoking among smokers[22] and increase the proportion of smoking cessation [23]. More importantly, smoke free regulation has been shown to significantly reduce the number of hospital admissions for heart attacks and asthma-related diseases, and premature births [24-26]. Systematic review of Frazer et al in 2010 and 2016 revealed that the smoke free policy significantly reduces the mortality related to smoking illness and improve the outcome of cardiovascular health outcome[12.27] The policy had been identified as a non-price measures which will reduce the mortality and morbidity due to smoking related diseases [28].

The Malaysian government through the Ministry of Health, also implemented similar measures to protect non-smokers from exposure to SHS in public areas with the introduction of smoking prohibition in public areas via the Control of Tobacco Product Regulations (CTPR) 1993. Eight areas were restricted (entertainment centre or theater, hospital or health clinic, public lift, air-conditioned eating place, public vehicles, building of Island & Peninsular Kuala Lumpur, and in any area of petrol station and Esso tower building, Kuala Lumpur). This was later expanded to other public areas through the amendment of the provision to the CTPR in 1997 until 2017 [29-37]. The expansion of smoke free public areas was in line with the provision of Article 8 of the Framework Convention on Tobacco Control (FCTC) [38] which was rectified by the Malaysian government in 2005. As of the year 2017, 29 types of public areas and nine localities had been declared as smoking restricted areas (Appendix 1). This regulation was supported by enforcement by authorised officers with frequent visits to ensure that the public abides by this provision.

Although the smoking prohibition policy had been implemented since the last two decades and studies elsewhere show its efficacy to reduce the exposure of non-smokers to SHS [20 22], The effect of smoke free policies on SHS exposure in Malaysia has not been studied. Knowledge on the effect of exposure to SHS will assist policy makers in planning and formulating suitable policies, as well as measuring and strengthening existing policies and regulations. In addition, it will ensure the allocation of human and material resources to reduce SHS among the Malaysian public. This paper intends to narrow the knowledge gap with the illustration of SHS exposure in various public areas (restricted and non-restricted) and social demographic variation of exposure among Malaysians to SHS.

Methods

Data for this write-up was derived from the Malaysian Global Adult Tobacco Survey(GATS) which was carried out from October 2011 to January 2012.The study utilised a cross sectional design and three stage sampling proportionate to size to obtain a representative sample of Malaysians aged 15 years and above. First strata consist of 15 states in Malaysia whilst second stage was the division of urban and rural areas by each state. Enumeration blocks (EBs) which is an artificial geographical area created by the Department of Statistics consisted of 80-120 living quarters based on 2010 population census was the primary sampling unit (PSU) and living quarters (LQs) were the secondary sampling unit. One household member aged 15 years and above from the selected LQs will be selected by the simple random sampling method based on a random number generated by hand-held devices.

Face-to-face interview approach by trained research assistants was used to obtain data from selected respondents. Detailed information regarding the purpose of the survey was explained to the respondents. Their participation was based on a voluntary basis and they have the right not to answer any question as well as withdrawing from the study at any juncture. All information given was treated as confidential and utilised for research purposes only. The interview session only started after written consent was obtained from the selected respondents. For respondents aged below 18 years old, written consent was obtained from their parent or guardian in addition to permission by the respondent. Detail of the methodology is published by Azahadi et al., 2015[39]. Ethical approval was granted by Malaysia Research Ethical Committee, Ministry of Health, Malaysia.

Study instrument was a questionnaire adopted from GATS, translated and pre-tested before use. It consists of 8 components, namely social demographics, smoking status, type of tobacco product used, exposure to SHS at home, work and selected public areas, expenditure on cigarettes, knowledge of smoking hazards and SHS, intention to quit , exposure to tobacco product advertisement and information regarding the hazards of tobacco products.

Smoking status of respondents was evaluated by several items (1)“Do you currently smoke (2) “Do you use any smokeless tobacco” (3) Do you use any sisha (4) Do you use any bidi (5) Do you use any electronic cigarettes”?. Respondents who answered “not at all” to all the items were classified as “non-smokers” whilst those who answered “daily or less than daily” were categorised as “current smokers”. Only non-smokers were included in the analysis for exposure to SHS. Exposure to SHS was determined by items “Have you visited these public areas: (1) government office (2) health facilities (including a hospital or clinic) (3) public transport terminal (4) air-conditioned shopping complex (5) bar or night club(6) cafe/ coffee shop/bistro and (7) non-air-conditioned restaurant “during the last one month”.Respondents who answered “No”, “Don’t know” and “refused to answer” were excluded from further analysis. Those who answered “Yes” to any area/s mentioned were asked if they had seen anyone smoking during their visit(s) in any of those seven areas. Respondents who answered “Yes” were considered as being exposed to SHS. Those who were exposed to SHS at government offices/health facilities/ public transport terminal / air conditioning shopping complexes were further categorised as exposed to SHS in restricted non-smoking areas. In the same note, those who answered “Yes” to (1) bar or night club (2) cafes / coffee shop/bistro and (3) restaurant without air-conditioning were classified as exposure to SHS at non-restricted areas.

The independent variables were social demographics, namely, gender, ethnicity, education attainment (which was divided into four categories;“No formal education”, primary

education, secondary school and tertiary"), age group (15-24 years old, 25-44 years old , 45-64 years old and 65+), locality (urban/ rural), while income level was measured using Wealth index, a proxy measure for respondents' socioeconomic status was constructed using principal component analysis with information on household ownership of assets[40]. Assets included were electricity, flush toilet, fixed telephone, cellular telephone, television, radio, refrigerator, car, moped/scooter/motorcycle, washing machine, etc. The sample was divided into Quintiles, from quintile one (highest) to quintile five (lowest). Marital status of respondents was classified as single, married and widow/widower/separated.

Data was cleaned prior to analyses. It was weighted, by taking into account study design, non-response and social characteristics (gender, residence, age group, education attainment, ethnicity) based on Malaysia population census 2010. Descriptive statistics were utilised to describe the social demographic characteristics of the respondents. Cross tabulation was used to describe proportion of respondents to SHS exposure at various public places. Multivariable Logistic Regression was run to determine the association between various social demographic backgrounds with SHS exposure in restricted and non- restricted public areas. We reported 95% confidence intervals without p values as the large sample size could generate significant results even if statistical differences or associations were small. All analyses were carried out by using SPSS statistical software version 20.

Results

A total of 5112 eligible Malaysian adults aged 15 years and above were recruited into the study and 4250 of them consented to participate and completed the interview, given a response rate of 83.1%. Out of the 4250 respondents, 3269 of them were non-smokers (76.9%, 95% CI 74.8-78.8). The proportion of female non-smokers was significantly higher compared to males (98.7%, 95% CI 98.0-99.1 vs 56.1%, 95% CI 52.7 – 58.9). Those from the youngest (15-24 years; 83.3%, 95% CI 79.7-86.4)) and oldest age group (65+; 85.0%, 95% CI 80.1-88.8) also reported a significantly higher proportion of non-smokers compared to those of 25-44 years old (71.0%, 95% CI 67.8-73.9). Similarly, the proportion of non-smoking participants were higher in those with tertiary education attainment (84.7%, 95% CI 80.1-88.4) and higher income group (Quintile 1: 82.9%, 95% CI 79.3-86 and Quintile 2: 80.8%, 95% CI 76.9-84.2) (Table 1).

Table 2 shows that almost two thirds of non-smokers (63.6%, 95% CI 60.6-66.2)were exposed to SHS at one or more public area during the last one month. The exposure among males was significantly higher compared to that among females (70.9%, 95% CI 66.5-74.9 vs 59.1%, 95% CI 55.7-62.4).In addition, respondents from urban areas, with higher education attainment and income also reported a higher proportion of exposure to SHS. However, older respondents reported lower exposure compared to their younger counterparts (15-24 years, 72.1% , 95% CI 67.4-76.3, 25-44 years, 67.9%, 95% CI 63.8%, 95% CI 63.8-71.5, 45-64 years, 54.4%, 95 CI% 49.9-58.8; and 65 +,37.3%, 95% CI 29.1-46.1%).

Exposure of non-smokers to SHS was significantly higher in non-restricted public areas compared to restricted areas, in which the proportion of exposure was approximately four times higher than that reported in restricted areas (81.9%, 95% CI 79.5-84.1 vs. 22.9 %, 95 CI% 20.4-25.5). Further analysis of exposure to SHS in restricted areas revealed that the level of exposure was significantly lower in health care facilities (8.7%, 95% CI 6.9-10.8) compared to indoor shopping complexes (13.6%, 95% CI 11.7-15.7), government offices (20.0%, 95% CI 16.4-24.2) and public transport (27.9%, 95% CI 22.5-34.0). No significant difference was observed among all social demographic characteristics to SHS in non-restricted areas except for the younger age group of 15-24 years (30.2%, 95% CI 25.6-35.3). The study also revealed that the level of SHS exposure on the three non-restricted smoking areas were almost similar for all respondents from different social demographic backgrounds (Table 3)

Multivariable Logistic regression analysis revealed that the likelihood of exposure to SHS in restricted public areas were almost similar across all social demographic variables, whilst for non-restricted area, non-smokers from the younger age group (15-24, AOR 5.07, 95% CI 2.18-11.7, 25-44. AOR 3.12, 95% CI 1.51-6.45, 45-64, AOR 2.08, 95% CI 1.10-3.93, 65+ as reference) and males (AOR 1.46, 95% CI 1.03-2.05) were more likely to be exposed to SHS in the last one month (Table 4).

Discussions

This is to our knowledge the first report on exposure to SHS in various public areas among a representative sample of Malaysian adult population after two decades of anti smoking law implementation.. The study reveals that almost two out of three (66.7%) Malaysian adolescents (below the age of 19 years old) and adults were exposed to SHS in at least one public area investigated during the one month prior to the study. This is similar (66%) to that reported in Spain [41], but lower as compared to that reported by Xiao et al., (2010) [42] among non-smokers aged 15 years and above in China; 72.4% (95% CI, 70.4-74). Interestingly, it is higher than that reported among non-smokers in Cambodia [43] and European union (EU)[44], which were 37.4% and 29.0%, respectively. The proportion of SHS exposure by gender was almost two times higher compared to that reported globally (70% vs. 33% for males; 59% vs. 31% for females) [45]. The different proportion of exposure might be due to different social norms in related countries, an existing anti-smoking norm might reduce the likelihood of smoking in public areas. In addition, different anti-smoking laws /policies might be another contributing factor for this difference in proportion of exposure to SHS. Hence, further studies are required to elucidate the real factors for the differences in exposure to SHS reported.

There were no significant differences in SHS exposure in restricted areas among urban and rural dwellers, after controlling for potential confounders. In contrast, urban dwellers were significantly more likely to expose to SHS in non-restricted areas as compared to their rural counterparts. This could be possibly due to the fact that restaurants, bar/night clubs and cafes/coffee shops/bistros were less readily accessible in rural areas. On the other hand, no significant differences in SHS exposure were observed across ethnics, in both restricted and no-restricted areas. One of the possible explanations is that, regardless of ethnicity, most of the restricted areas (healthcare facilities, indoor shopping complexes and public transportations) and non-restricted areas (restaurants and cafes/coffee shops/bistros) were commonly visited or patronised by Malaysians.

Respondents from the younger age group reported higher exposure to SHS in non-restricted areas. This finding is in line with that by Li et al. (2015) among women in China[46], in which the level of exposure decreased from 66.8% in those aged 18-24 to 38.9% among those aged 65 and above. The finding might due to the respondents of younger age group mostly consist of those who are productive and economically active, therefore they are more mobile and visit public areas more often compared to their counterparts from lower education, lower income and older age group. Furthermore, the public areas under investigation (e.g., coffee house and bistro) were premises which were tailored to attract the younger age group.

Male respondents were more likely to be exposed to SHS in non -restricted areas in univariate and multivariate analysis compared to females. The finding is in-line with Rudatsikira et al., (2008)[43], Li et al., (2015)[46] and Desalu et al.,(2011)[47] who reported a higher proportion of SHS exposure among non smoking males in Cambodia adults residing two cities in Nigeria and adults in North East China, respectively. This might due to males being more mobile compared to females in view of their nature of occupation which require them to travel more. In Malaysia, males tend to socialize more as compared to females as it is the patriarchal society. In addition, non-smoking males might befriend those who are

smokers in view of the high prevalence of smokers among males (45%) in Malaysia and therefore increases the likelihood of exposure to secondhand smoke [48].

Exposure to SHS was significantly lower in restricted areas as compared to non-restricted areas. This is consistent with several previous studies[19,49-53]. All studies revealed that laws significantly reduced exposure to SHS in a variety of public places, especially bars, restaurants, and outdoor patios of these premises. These reductions in public-place exposure are observed for both smokers and non-smokers. Multivariable analysis, which showed no difference in the likelihood among various socioeconomic backgrounds to SHS exposure support the notion that smoke free areas offer protection to non-smokers from SHS exposure (Table 5).

Among the restricted areas, non-smokers reported the lowest exposure to SHS in health facilities, followed by air-conditioned shopping centers, government offices and public transports. Similar finding was also reported from the Global Adult Tobacco Survey (GATS) in the Philippines in 2010 (GATs 2010)[54]. This could be due to the majority of health personnel being aware of the dangers of smoking and SHS which translate to their attitude and behaviour toward smoking, therefore creating a non-smoking social norm among their fraternity. This reduces the likelihood of smoking behaviour and increases advising of those who smoke in the hospitals/health facilities to smoke elsewhere. The respondents who visited the hospitals /health facilities usually consist of those who seek treatment, hence their health condition might not permit them to continue their smoking behaviors. Teh et al.,(2014)[55] also reported that a majority of the public perceived that hospitals/health facilities were premises which provided treatment and therefore inappropriate for anyone to practice unhealthy lifestyle. In addition, respondents who visit the hospitals were mostly from the older age group with less likelihood to be smokers in view of the lower prevalence of smoking among older Malaysians (16.4%)[56]

The low prevalence of SHS exposure among non-smokers in the shopping centers (approximately one in ten or 10%) might be due to central air-conditioning system utilised in most Malaysian shopping centers whereby any cigarette smoking within the premises created a nuisance to the public who visited the shopping centers, and their reactions serve as a deterrent for smokers to smoke. In addition, the management personnel of these shopping centers usually try to take all necessary measures to retain their customers through a conducive and cozy environment for shopping, one of the approaches was to ensure the conducive environment for visitors via a smoke free environment. In addition, owners' of premises fear of being fined for having people smoking in their premise could be another possible reason for the finding in this study.

More than one-fifth and almost one-third of non -smokers were exposed to SHS in the last one month during their visit to a government office and use of public transportation, respectively. The high exposure was rather surprising in view of the area and the facility having been designated as smoke free since the last 20 years. This is a clear indication of non-compliance to the legislation.

Among the smoking-restricted areas, it is noteworthy that public transportations and government offices had been reported to have the highest level of SHS exposure. These findings may indicate a debilitated enforcement of smoke-free regulations in those areas. In Malaysia, the Environmental Health Officers or Assistant Environmental Health Officers (EHO/AEHO) who are involved in law enforcement, are unable to perform their task as regularly and frequently as needed as they are overwhelmed by other routine surveillance activities for both communicable and non-communicable diseases [57]. However, further investigations from multiple angles, such as the person who smoke in the restricted areas (either government officers in government premises or drivers of public transports), level of awareness on SHS exposure among the public and assessment on the level of enforcement activities as well as adequacy of enforcement officers in anti-smoking programme are urgently needed to elucidate the contributing factors for the present findings.

Of note, although the present study analysed a six-year old data from GATS 2011, however, this should not be an issue of concern that the data is out-dated and may not reflect the current smoking phenomena in Malaysia since the smoking profile among Malaysia adults was comparably similar in GATS 2011 and National Health and Morbidity Survey (NHMS) in 2015. For instance, the overall prevalence of smoking was 23.1% (95% CI:) in 2011 as compared to 22.8% (95% CI:). Moreover, the prevalence of smoking also did not varied significantly by socio-demographics in 2011 and 2015. In addition, we have analysed the smoking profile in Malaysia from 1985 till 2015, the results showed that Malaysia is still at the Stage II of the cigarette epidemic model developed by Lopez et al. 1994[58], which evidently indicated that the smoking prevalence and profile have not changed since 1985. Therefore the present findings which derived from the GATS in 2011 is still valid and of relevance. Besides, there was also evidence that smoke-free regulation in Malaysia had not changed substantially from 1993 to 2017 (Appendix 1). Therefore, the effect of variation in smoke-free legislation over the years against SHS exposure would not pose a great concern in view of the insignificant changes in smoke-free regulations in Malaysia.

The strength of the present study were the representativeness and adequacy of sample size as well as a high response rate which enabled generalization of findings to the Malaysian population. Furthermore, a face-to-face interview approach compared to self-administered could also increase the quality of the data. Nonetheless, there present study was also subjected to few limitations.First, under-reporting or over-reporting might occur as this was a cross-sectional study at a one-month period. Second, a comprehensive observation and concrete conclusion on SHS exposure in smoking-restricted and non-restricted areas could not be made due to the inclusion of only seven types of public areas in the present study. Third, the exposure to SHS was determined based on the observation by respondents which was rather subjective as compared to objective measurement of SHS exposure.Therefore, future studies should include more public areas (both smoking-restricted and non-restricted) and employ objective measurement for SHS exposure to such as measurement of carbon monoxide or cotinine (a nicotine metabolite) in the expired breath air, or measurement of air quality for chemicals related to SHS. However, previous studies had found satisfactory validity of self-reported SHS exposure [59, 60].

The findings from the study add to the body of evidence that the prohibition of smoking in public areas will reduce the exposure to SHS [19,20,41].Therefore, more public areas should be restricted as non-smoking areas to further reduce the exposure to SHS among public and to create the environment which is not conducive for smoking. However, the sizeable reported exposure to SHS by non-smokers demands for stricter and more frequent enforcement of the provision under the current anti-smoking law to ensure all restricted areas to be 100% smoke free .

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Availability of data and materials

Please contact author for data requests.

Authors' contributions

LKH, TCH and MHNM, LHL wrote the manuscript, SMG and KCC carried out statistical analysis, SP , MFY, LMY design the study, NH, NZ, NDD and NI responsible for data collection, and coordination of the study. CKH manage and clean the data. LKH, TCH and LHL were involved in interpretation and implications of the analysis. All authors contributed to developing the manuscript, and read and approved the final version

Competing interests

The authors declared that they have no competing interest.

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Table 1: Sociodemographic characteristic of non-smokers respondents aged 15 years and above in Malaysia

Demographic characteristic	n*	N** (in thousands)	%	95 CI	
Gender				Lower	Upper
Male	1144	5938	56.1	52.7	59.4
Female	2125	9887	98.7	98.0	99.1
Age group(years)					
15-24	605	4745	83.3	79.7	86.4
25-44	1284	6063	71.0	67.8	73.9
45-64	1026	3764	77.3	74.1	80.2
65+	354	1252	85.0	80.1	88.8
Residence					
Urban	1616	11485	77.3	74.6	79.8
Rural	1653	4340	75.7	73.3	78.0
Education level					
Less than primary	520	1605	80.3	75.8	84.1
Primary	834	3170	75.7	72.1	79.0
Second/high school	1031	4770	74.9	71.9	77.6
College or above	264	1472	84.7	80.1	88.4
Ethnicity					
Malay	1931	9143	75.4	72.7	77.9
Chinese	553	3226	84.6	80.5	88.0
Indian	213	1552	80.4	73.6	85.8
Other	572	1903	70.0	64.7	74.9
Quintile Income level					
Q 1	698	4941	82.9	79.3	86.0
Q 2	689	3832	80.8	76.9	84.2
Q 3	601	3004	71.8	67.1	76.0
Q 4	628	2281	73.0	68.1	77.5
Q 5	603	1578	68.0	62.9	72.7

n*- sample N** -Estimated population

Table 2: Exposure to SHS in at least one public places by social demographic

Demographic characteristic	n*	N** (in thousands)	%	95 CI	
Gender				Lower	Upper
- Male	667	3847	70.9	66.5	74.9
- Female	972	5320	59.1	55.2	62.4
Age group(years)					
- 15-24	347	3139	72.1	67.4	76.3
- 25-44	749	3759	67.9	63.8	71.5
- 45-64	441	1846	54.4	49.9	58.8
- 65+	102	423	37.3	29.1	46.1
Residence					
Urban	945	7182	67.9	64.5	71.2
Rural	694	1985	51.6	47.8	55.3
Education level*					
Less than primary	142	5010	34.0	27.8	40.7
Primary	493	2615	59.3	54.9	63.6
Second/high school	764	4448	68.1	64.2	71.7
College or above	237	1590	81.4	75.6	86.1
Ethnicity					
Malay	946	5083	63.1	59.6	66.4
Chinese	948	2192	70.8	65.9	76.0
Indian	130	1004	68.6	59.7	76.3
Other	227	887	49.1	42.6	55.6
Quintile Income level					
Q 1	476	3406	73.9	69.1	78.2
Q 2	406	2040	69.4	64.7	73.7
Q 3	308	1705	62.6	57.1	67.8
Q 4	267	1085	52.2	46.1	58.2
Q 5	179	511	36.3	30.6	42.4

n*- sample N** -Estimated population

Table 3: Self-reported exposure to second-hand smoke (SHS) among non-smokers in selected restricted and non restricted areas

Demographic Characteristic	Self-reported exposure to second-hand smoke, % (95% CI)								
	Restricted area					Non restricted area			
	At least one	Government office	Health-care facilities	Indoor shopping complexes	Public Transportation	At least one	Restaurants	Bar/nightclubs	Cafes/coffee shops/Bistros
Overall	22.9(20.4-25.5)	20.0(16.4-24.2)	8.7(6.9-10.8)	13.6(11.7-15.7)	27.9(22.5-34.0)	81.9(79.5-84.1)	71.0(67.7-74.0)	78.7(64.2-88.4)	84.9(52.1-87.3)
Gender									
Male	21.4(18.6-24.4)	20.1(16.0-25.0)	7.8(5.4-11.2)	11.7(9.2-14.9)	33.5(23.4-45.4)	87.6(85.0-89.8)	73.1(69.2-76.6)	81.4(62.4-92.0)	85.0(81.7-87.8)
Female	23.2(20.2-26.6)	19.8(14.7-26.2)	9.4(7.1-12.4)	15.4(12.9-18.3)	25.4(19.6-32.2)	80.5(77.1-83.4)	68.4(63.8-72.8)	70.2(46.6-86.4)	84.7(80.8-87.9)
Age group(years)									
15-24	30.2(25.6-35.3)	24.1(16.2-34.3)(	2.3(7.9-18.7)	17.8(13.7-22.6)	31.8(23.2-41.7)	86.0(82.1-89.2)	72.6(66.7-77.8)	81.2(58.7-92.9)	86.3(81.1-90.3)
25-44	21.9(19.0-25.0)	20.9(16.3-26.4)	8.4(5.9-11.6)	12.6(10.3-15.4)	30.12(22.1-39.6)	85.3(82.3-87.9)	72.6(68.4-76.3)	80.3(61.5-91.2)	83.9(79.4-87.5)
45-64	14.4(11.7-17.6)	14.4 (9.6-20.9)	6.3(4.3-9.1)	8.8(6.5-11.9)	14.7(9.0-23.2)	83.6(80.0-86.6)	67.6(61.9-72.7)	-	86.9(82.8-90.1)
65+	16.8(10.9-24.8)	23.3 (12.7.-39.7)	7.9(3.6-16.5)	19.0(9.8-33.5)	20.2(8.8-39.9)	70.8(60.0-79.7)	55.4(39.9-70.0)	-	75.1(63.5-83.9)
Residence									
Urban	23.2(20.5-26.0)	21.5(17.0-26.9)	9.2(7.0-12.1)	14.3(12.1-16.9)	27.5(20.8-35.4)	85.8(83.3-88.1)	71.3(67.4-75.0)	80.8(64.1-90.8)	85.6(82.0-88.6)
Rural	19.7(16.8-23.1)	15.4(11.4-20.6)	7.3(5.3-10.0)	10.9(8.4-14.1)	29.1(22.4-36.9)	80.2(76.9-83.1)	69.6(64.9-74.0)	63.3(36.9-83.6)	82.5(79.1-85.4)
Education level*									
Less than* primary	14.7(10.6-19.9)	16.0(7.7-30.2)	5.6(3.1-10.1)	14.2(8.4-23.0)	17.2(9.6-28.8)	81.6(74.1-87.3)	68.8(55.3-79.7)	-	82.4(73.7-88.6)
Primary	19.1(15.7-23.1)	24.3(16.6-34.0)	7.4(4.8-11.3)	12.3(9.1-16.4)	22.9(14.8-33.6)	82.8(78.4-86.4)	67.9(61.6-73.5)	-	84.3(78.6-88.8)
Second/high	19.1(16.2-22.5)	17.5(13.1-	8.0(5.4-11.8)	10.0(7.9-12.6)	29.3(20.0-	85.0(81.9-	72.3(67.5-	88.5(74.5-	85.9(82.1-

school		22.9)			40.6)	87.7)	76.6)	95.3)	88.9)
College or above	22.5(16.9-29.3)	18.4(11.4-28.3)	8.9(4.9-15.7)	15.2(10.4-21.7)	20.7(17.4-45.8)	83.3(77.5-87.9)	68.4(60.4-75.5)		80.4(71.1-87.3)
Ethnicity									
Malay	22.6(19.9-25.6)	22.6(18.2-27.6)	8.8(6.8-11.4)	12.7(10.4-15.4)	27.9(21.3-35.6)	84.6(82.2-86.7)	75.1(71.2-78.6)	64.1(40.6-82.3)	84.0(80.5-87.0)
Chinese	18.7(14.7-23.6)	12.8(6.8-22.8)	7.7(4.5-12.7)	14.7(11.0-19.4)	21.8(11.1-38.4)	86.9(82.5-90.3)	58.0(51.3-64.5)	86.8(61.1-96.5)	88.3(82.8-92.6)
Indian	30.2(22.5-39.1)	18.3(9.5-32.1)	14.9(7.3-28.1)	17.9(11.0-27.6)	35.1(22.6-50.1)	84.4(76.9-89.8)	74.8(65.0-82.7)		79.4(68.8-87.1)
Other	20.2(16.0-25.3)	16.4(8.9-28.2)	3.8(1.7-8.6)	12.9(8.6-18.8)	28.0(20.3-37.4)	79.6(73.1-83.1)	69.8(61.8-76.7)	65.5(30.8-89.0)	87.1(80.2-91.9)
Income level									
Q 1	24.3(20.6-28.3)	17.9(12.4-25.2)	8.7(5.7-13.2)	15.5(11.9-19.9)	26.9(16.7-40.3)	85.5(81.8-88.6)	68.3(62.5-73.7)	76.4(54.2-89.8)	85.1(79.9-89.1)
Q 2	24.5(20.4-29.1)	19.7(13.4-28.0)	7.7(4.6-12.7)	15.7(12.0-20.3)	30.1(20.6-41.6)	84.3(80.7-87.4)	67.8(61.7-73.4)	-	83.1(77.3-87.0)
Q 3	19.7(16.0-24.2)	25.4(16.7-36.7)	10.0(5.9-16.5)	14.9(10.9-20.0)	31.6(20.0-46.2)	84.5(80.5-87.8)	68.1(61.1-74.4)	-	86.4(79.3-91.4)
Q 4	19.3(15.2-24.2)	15.8(8.1-28.7)	10.4(5.7-18.0)	10.9(7.0-16.6)	23.8(14.6-36.2)	85.3(79.8-89.5)	72.1(62.1-80.3)	-	84.1(75.4-91.1)
Q 5	21.1(16.0-27.2)	18.3(7.8-37.3	5.9(3.2-10.8)	12.3(5.7-24.7)	24.3(16.5-3434)	81.0(74.2-86.3)	65.0(52.6-75.7)	-	79.2(66.0-88.1)

Table 4: Multivariable analysis of non-smoker exposure to Second Hand Smoke in restricted and non-restricted public area

Variable	Exposure to Second-hand smoke					
	Restricted area			Non Restricted area		
	AOR	95% CI		AOR	95% CI	
		Lower	upper		Lower	Upper
Gender						
Female	Ref			ref		
Male	0.89	0.66	1.12	1.46	1.03	2.05
Locality						
Urban	Ref			Ref		
Rural	0.90	0.67	1.21	0.79	0.57	1.10
Ethnicity						
Chinese	Ref			Ref		
Malay	1.18	0.80	1.73	0.70	0.48	1.03
Indian	1.72	0.98	1.64	0.86	0.46	1.59
Others	1.03	0.65	1.64	0.49	0.28	0.85
Education Attainment						
College and above	Ref			Ref		
No formal education	0.56	0.29	1.08	1.62	0.78	3.40
Primary school	0.69	0.44	1.07	1.16	0.69	1.98
Secondary school	0.64	0.43	0.94	1.14	0.76	1.74
Age group						
65+	Ref			Ref		
15-24	1.59	0.68	3.75	5.07	2.18	1.73
25-44	1.32	0.70	2.50	3.12	1.51	6.45
45-64	0.82	0.45	1.49	2.08	1.10	3.93
Marital Status						
Married	Ref			Ref		
Single	1.36	0.86	2.15	0.92	0.51	1.65
Widow/er/separated	1.24	0.76	2.03	0.68	0.44	1.06
Quintile income group						
Quintile 1	Ref			Ref		

Quintile 2	1.12	0.79	1.60	0.95	0.65	1.39
Quintile 3	1.05	0.70	1.57	1.04	0.67	1.64
Quintile 4	0.74	0.49	1.13	1.15	0.65	2.03
Quintile 5	1.05	0.66	1.69	0.74	0.39	1.38

Table 5: Previous studies showed the effectiveness of smoking-free regulation

Author/s	Approach	Finding
Azahba (2015)	Regression modelling based on 89,743 respondents participated in 2005–2012 Canadian Tobacco Use Monitoring Survey to determine the effect of smoke-free regulation.	A reduction of 25% and 21% of SHS was reported in Alberta and Nova Scotia, respectively after the implementation of smoke-free regulation.
Park et al.,(2016)	Urine cotinine concentration was investigated among 4612 non-smoking Korean citizens (aged 19 or older) who participated in the first stage of the Korean National Environmental Health Survey between 2009 and 2011.	A total decrease of 2.79 ng/ml (54.7%) urine cotinine among non-smokers was observed.
Sureda et al., 2014	Self-reported exposure to secondhand smoke (at home, the workplace, during leisure time, and in public/private transportation vehicles) was measured. and the metabolite of nicotine (cotinine) in the collected salivary sample was also determined among a representative sample of non-smokers (aged 16 years and above) in a cross-sectional survey was 2004-2005 prior to the implementation of smoke-free regulation and was repeated in Barcelona, Spain in 2011-2012, after the implementation of smoke-free laws	The self-reported exposure to secondhand smoke had reduced significantly from 75.7% (95%CI: 72.6 to 78.8) in 2004-2005 to 56.7% (95%CI: 53.4 to 60.0) in 2011–2012. Specifically, a reduction of 4.9%, 5.4%, 8.6% and 22.4% of SHS exposure were observed at home, work/education venue, public transport during leisure time, respectively. The geometric mean of salivary cotinine had also decreased significantly from 0.93 ng/mL at baseline (2004-2005) to 0.12 ng/mL after legislation ($p<0.001$).
Ye at al.,2014	A repeated cross-sectional study was conducted among respondents aged 16 years and above in Guangzhou, China to determine the exposure to	A significant decrease of 8.5% of overall exposure to SHS (from 58.8 to 50.3%) was reported after the implementation of smoke-free regulation, With more

	SHS (self-reported) before (2009) and after implementation of smoke-free regulation.	than 30% of reduction were reported in cultural venues, commercial venues and in government offices.
Fernández et al.,2017	Two cross-sectional studies among nationally representative sample of Spanish adults aged 18 years and above were conducted in 2006 and 2011 to determine SHS exposure to after the introduction of new smoke-free regulation.	The study revealed that there was a significant reduction of SHS exposure after the implementation of smoke-free regulation, from 71.9% (95% CI: 70.1 73.7%) in 2006 to 45.2% (95% CI: 43.1 47.3%) in 2011. Self-reported exposure of SHS at home had decreased from 29.2% to 12.7% and SHS exposure at work/education venues had reduced from 22% to 34.0% Similarly, exposure to SHS in transportation vehicles/stations also decreased from 40.6% in 2006 to 12.7% in 2015.
Kim et al.,2016	A four time point (pre- and post-regulation at bars ≥150 m^2, ≥100 m^2, and in all bars) and two time point (post-regulation of bars ≥100 m2 and post-regulation of all bars) measurement of PM 2.5 were carried out in Seoul and and Changwon, respectively using a portable real-time aerosol monitor (AM510; TSI Inc., Shoreview, MN, USA).	The geometric mean of the indoor PM2.5 concentrations at all bars had decreased from 98.4 µg/m3 pre-regulation to 79.5, 42.9, and 26.6 µg/m3 after the ban on smoking in bars of ≥150 m2, ≥100 m2, and all bars, respectively.

Appendix I

SMOKING RESTRICTED AREAS IN MALAYSIA AND YEAR GAZETTED (FROM 1993-2017)

No	Area	Year gazetted									
		1993	1997	2004	2008	2009	2011	2012	2014	2015	2017
Type of area											
1	In any entertainment center or theater, except any pub, discotheque, night club or casino, at any time when such place is open to the public	x	x	x	x	x	x	x	x	x	x
2	In any hospital or clinic	x	x	x	x	x	x	x	x	x	x
3	In any public lift	x	x	x	x	x	x	x	x	x	x
4	In any public vehicle	x	x	x	x	x	x	x	x	x	x
5	In any area in a petrol station	x	x	x	x	x	x	x	x	x	x
6	In any hall		x	x	x	x	x	x	x	x	x
7	In any higher educational institution		x	x	x	x	x	x	x	x	x
8	In any area in a nursery		x	x	x	x	x	x	x	x	x
9	In any school		x	x	x	x	x	x	x	x	x
10	In any public transport terminal		x	x	x	x	x	x	x	x	x
11	In any bank counter and financing institution, Telekom Malaysia Berhad, Tenaga Nasional Bhd and Pos Malaysia Bhd.		x	x	x	x	x	x	x	x	x
12	In any shopping complex		x	x	x	x	x	x	x	x	x

13	In any sport complex		x	x	x	x	x	x	x	x	x
14	In any stadium		x	x	x	x	x	x	x	x	x
15	In any public toilet		x	x	x	x	x	x	x	x	x
16	In any air-conditioned eating place or shop		x	x	x	x	x	x	x	x	x
17	In any airport		x	x	x	x	x	x	x	x	x
18	In any government premise		x	x	x	x	x	x	x	x	x
19	In any area which is used for any assembly activity in a building other than private or residential building			x	x	x	x	x	x	x	x
20	In any school bus			x	x	x	x	x	x	x	x
21	In any area in a petrol station			x	x	x	x	x	x	x	x
22	In any fitness centre or gymnasium			x	x	x	x	x	x	x	x
23	In any building or public place which is used for religious purposes			x	x	x	x	x	x	x	x
24	In any area in a library			x	x	x	x	x	x	x	x
25	In any area in an internet cafe			x	x	x	x	x	x	x	x
26	In any area of national service health center				x	x	x	x	x	x	x
27	In any workplace with centralised air conditioning					x	x	x	x	x	x
28	Rest and recreational areas								x	x	x
29.	Public park, state park, national park and camp site										x
	Selected building or areas										
1	Island &Peninsular building, Kuala Lumpur	x	x	x	x	x	x	x	x	x	x
2	Esso Tower Building, Kuala Lumpur	x	x	x	x	x	x	x	x	x	x
3	Selected areas in the state of Melaka - World Heritage City Melaka - Melaka Raya						x	x	x	x	x

	- Melaka International Trade Centre (MITC) - Alor Gajah City - Jasin City										
4	Selected areas in the state of Penang - "Hutan Bandar Mutiara Rini" Penang. - Municipality garden, George Town, Penang - Botanical Gardens, Penang - Air Hitam Dam,Penang - Mengkuang Dam, Penang - Taman Ampang Jajar, Penang - Telok Bahang Dam, Penang							x	x	x	x
5	Selected areas in the state of Johor - Endau National Park, Rompin, Johor - Johor National Park, Gunung Ledang - Johor National Park, Pulau Kukup - Johor National Park, Tanjung Piai - Town Park 3 Recreation Park, Taman Seri Austin, Johor								x	x	x
6.	Selected areas in the state of Penang -Georgetown world heritage site									x	x
7	Selected areas in the Federal Territory of Kuala Lumpur - All roofed walkways,roofed overhead bridge and underground pedestrian tunnel.										x

8.	Selected areas in Kelantan State - Tambatan Diraja, - Jalan Tengku Puteri - Flat Buluh Kubu - Jalan Parit Dalam Tengku Besar - Ketereh-Kompleks Pasar Saidina Ali - Kok Lanas - Pasar Beris Kubu Besar Bachok and surrounding areas - Dataran Air Moleh, Pasir Mas - Bandar Baru Pasir Mas - Apam Putra, Pasir Mas - Laman Tamu - Taman Kuala Krai - PKT supermarket and surrounding areas - Guchil Kuala Krai - Pasar Besar Tanah Merah and surrounding areas, - Dataran Puchong										x

9	Selected area in Terengganu State (Kuala Terengganu District) - Jalan Haji Busu - Jalan Persinggahan - Jalan Kelab Kerajaan. - Pantai Batu Buruk.										x

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page / Line
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1(Line 3)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3 and 4,
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4 (Line 7-9).
Methods			
Study design	4	Present key elements of study design early in the paper	Pafe 5 (line 2-5)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5 (line 6-11)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 5 (13-19)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	*Page 5 (line 30-48)* *Page 6 (Line 1-10)*
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	*Page 5 (line 33-48) Page 6 (line 1-2)* *Page 6 (Line 4-13)*
Bias	9	Describe any efforts to address potential sources of bias	Page 5 (line 16-21) Page 6 (Line 15-17)
Study size	10	Explain how the study size was arrived at	Page 5 (Line 15-17)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen	

		and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 6 (line 15-24)
		(*b*) Describe any methods used to examine subgroups and interactions	(page 6, line 15-24)
		(*c*) Explain how missing data were addressed	Page 5 (ine 43-44)
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	Page 5 (line 18-25)
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	Page 7 (line 3-4)
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 7 (line5-12) Page 17 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	Page 17 (Table 1)
Outcome data	15*	Report numbers of outcome events or summary measures	Page 7 (line 14-41) Page 18 (Table 2) Page 19-20 (Table 3) Page 21-22 (Table 4)
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	Page 7(36-41) Page 21-22 (Table 4)
		(*b*) Report category boundaries when continuous variables were categorized	NA

		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 7 (line 14-41) page 8 (Line 6)
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	Page 10 (line 14-22)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 10 (27-33)
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 10 (line 23-26)
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	Pafe 11 (Line 6-7)

*Give information separately for exposed and unexposed groups.

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.