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SMOKING CESSATION IN INDONESIA: KICK THE HABIT TODAY OR IS IT WISER TO HOLD ON FOREVER?

ABSTRACT

Smoking substantially adds to chronic illnesses and healthcare expenditures. Current smokers typically incur substantial annual costs, whereas former smokers have distinct health hazards associated with their previous tobacco consumption. This study utilizes IFLS data (2014) to examine healthcare expenditures between current and former smokers in Indonesia. This study used propensity score matching (PSM) to mitigate sample selection bias in smoking cessation. There are two groups in the PSM procedures, with former smokers considered as the treatment group and current smokers as the control group in the baseline model. By accounting for health status and other covariates commonly associated with smoking behaviour, the analysis offers indicative evidence that smoking status may influence healthcare costs. The results suggest that individuals who have quit smoking tend to incur higher medical expenses, a pattern that appears consistent across different matching methods. One potential explanation for the elevated costs among former smokers is the occurrence of health shocks that may have triggered smoking cessation, resulting in increased medical needs at the time of quitting. These findings highlight the importance of implementing early health screening initiatives, particularly for individuals with a history of smoking.

Keywords: healthcare expenditure, smoking cessation, smoking-related disease, PSM
JEL Classification: D12, I12, I10, C21

INTRODUCTION

Smoking poses a significant risk, and given that nonsmokers exhibit superior health compared to smokers, it follows logically that abstaining from smoking would result in reduced healthcare expenditures. Smoking is a major health risk, and since nonsmokers tend to be healthier than smokers, quitting smoking is expected to lower healthcare costs. In economic analyses of health care, it has proven challenging to ascertain who incurs greater expenses. Smokers, who generally experience a wider range of diseases. Nonsmokers, who may accumulate higher health care costs due to increased longevity, or former smokers, who may exhibit a blend of both trends as a result of their previous smoking behavior. Cigarette smoking is recognized as a causative factor for lung cancer, coronary heart

disease, cerebrovascular disease, chronic bronchitis, and emphysema, and it exacerbates the morbidity and mortality associated with these and other diseases (USDHHS, 1989). Previous indicate that current smokers possess a greater risk of mortality than non-smokers. Comorbidities, such as coronary heart disease, diabetes, cancer, cardiovascular diseases, peripheral arterial disease, pulmonary diseases, and stroke—classified as non-communicable diseases (NCDs)—increased the mortality risk (Holipah et al., 2020; USDHHS, 2004; Chan et al, 2022; Steinberg et al., 2010; Kristina et al., 2018).

Individuals with chronic diseases typically seek healthcare services for treatment. Smoking is widely seen as imposing a significant financial burden on healthcare systems due to its detrimental health impacts. Individuals who smoke at any age necessitate greater medical attention than those who have never smoked (Choi et al., 2019; Kamangar & Islami, 2020) and exhibit diminished life expectancy (USDHS, 1989). The correlation between healthcare expenditure and smoking underscores the substantial burden that smokers impose on healthcare systems, as demonstrated by their increased utilization of medical care in comparison to nonsmokers (Firmansyah et al., 2022). The heightened use is seen in the significant economic burden of smoking, with men representing a bigger proportion of costs due to elevated smoking prevalence and an increased risk of smoking-related illnesses (Alcaraz et al., 2024). Current smokers are more likely to have had multiple outpatient visits, with studies indicating that they are 1.5 to 2 times more likely to have four or more visits compared to non-smokers (Kahende et al., 2009).

On the other hand, the overall health cost of smokers is less than that of nonsmokers (Darden & Kaestner, 2022). Although smokers exhibit elevated annual medical care usage rates, their reduced life expectancy counterbalances this expense. The findings suggest that smoking does not substantially elevate overall medical care costs and may even

decrease them due to the reduced lifetime of smokers (Leu & Schaub, 1983; Lo et al., 2023). Despite smokers exhibiting elevated annual healthcare consumption rates, these expenses are somewhat counterbalanced by the greater life expectancy of nonsmokers. Consequently, due to the longer lifespan of nonsmokers, they are anticipated to incur higher overall medical costs than smokers, who generally have a shorter life expectancy. Lippiatt (1990) asserts that smoking reduces lifelong medical expenses. The lifetime medical costs associated with smoking are regarded as lower because the data utilized tend to underestimate expenditures for smoking-related diseases among smokers and overestimate medical costs during the extended lifespan of nonsmokers.

While the long-term healthcare costs of smokers may be lower due to reduced life expectancy, the financial burden of tobacco consumption remains substantial at the household level, particularly in countries like Indonesia. Tobacco use is widespread in Indonesia, with 34.5% of the adult population engaging in consumption and 60% of households indicating expenditures on tobacco products (WHO, 2021; Swarnata et al., 2024). In Indonesia, households that smoke allocate a considerable portion of their resources to tobacco, with an average of approximately 10.7% of the monthly budget spent on cigarettes and other tobacco products. This expenditure surpasses the allocations for staples, which stand at 10.4%, and for meat, at 6.15% (Swarnata et al., 2024).

Individual's daily activities determine their health, which, along with smoking status, influences whether their medical costs are high or low. Behavioral risk factors significantly contributed to increased NCD incidence, multimorbidity, and healthcare expenditures (Ihyauddin et al., 2022) Being a former smoker and physically inactive led to higher rates of healthcare cost and missed workdays. Both former smoking and physical inactivity are associated with reduced overall health, leading to more frequent healthcare

visits, higher medical expenses, and an increased likelihood of missed workdays due to illness or treatment.

This study aims to evaluate healthcare expenditures between individuals who quit smoking and those who continue smoking by analyzing their health history, including smoking-related chronic diseases, physical activity, BMI, and sociodemographic characteristics.

Research Problem

The Indonesian Family Life Survey (IFLS) data indicate that 93.72% of people who did not smoke in 2007 continued to do so in 2014, indicating a permanent phenomenon. Meanwhile, 6.28% of people started smoking in 2014. Approximately 12.24% of people who smoked in 2007 quit smoking in 2014. More people quit smoking than those who started smoking during the observed period. Generally, this means there is a positive behavioral change trend, where some smokers decided to quit the habit, although a small portion of individuals still started smoking. The majority of individuals maintained their smoking status over the seven-year period (93.72% for non-smokers and 87.76% for smokers).

Table 1 Crosstabulation of smoking status for the years 2007 and 2014

		Year 2014		
		Non Smoker	***Smoker***	**Total**
Year 2007	***Non smoker***	14.488 (93,72%)	971 (6,28%)	**15.459 (100%)**
	Smoker	893 (12,24%)	6.402 (87,76%)	**7.295 (100%)**
	Total	**15.381**	**7.373**	**22.754**

Source: Author's computation using data from IFLS 2007 and 2014

The smoking status of an individual—whether they are a never smoker, former smoker, or current smoker—is significantly correlated with the healthcare expenses incurred. Former smokers showed a significant impact on medical expenses, with the influence decreasing over time post-cessation

(Huang et al, 2021). There would be a short-term reduction in health care expenses if people quit smoking (Barendregt et al., 1997). Quitting smoking would eventually result in higher medical expenses because nonsmokers live longer, they cost society more in the long run.

Numerous studies indicate that former smokers incur higher healthcare expenses than current smokers (Swedler et al., 2019; Wagner et al., 1995;) for up to four years post-cessation (Fishman et al., 2003). Former smoking households had the highest incidence of CHE, higher than both current smoking and non-smoking households (Zhong et al., 2020). Former smokers incur more medical costs than both current and never smokers, reflecting the impact of health shocks that lead to cessation (Darden and Kaestner, 2022; Xin et al., 2009). Smokers who experienced a cardiovascular health shock were more likely to quit smoking, particularly when they had higher out-of-pocket spending (Marti and Richards, 2016). Higher health care use among smokers was a strong indicator that they would quit smoking the next year (Martinson et al., 2003). This paradox is likely due to the "teachable moments" effect of illness and hospitalization, which makes sicker people more willing to stop. Thus, healthcare costs may rise due to the severity of the underlying condition that caused stopping, not abstinence. Although cessation from cigarettes provides immediate physiologic benefits, it may take time for smoking-related disorders such chronic obstructive pulmonary disease to improve or stop declining, which could reduce health care costs.

In Indonesia, research on smoking habits has been widely conducted; nevertheless, the majority of studies are either cross-sectional or conducted at a singular time point (Swarnata et al., 2024). This study seeks to solve the research gap by addressing the limitations of studies that focus solely on specific age groups or classifications of certain residency in Indonesia (Firmansyah et al., 2022).

LITERATURE REVIEW

In modelling the economic behaviour surrounding smoking and healthcare use, Darden and Kaestner (2022) propose a dynamic framework in which individuals are assumed to maximize their intertemporal utility. Within this model, agents make decisions about cigarette consumption and outpatient care over time, with health status acting as a central state variable. This health stock is influenced by prior health behaviour (including smoking), age, and healthcare use. Smoking cessation in this context is interpreted as a rational response to declining health or increasing marginal costs of continued smoking, aligning with standard economic assumptions of forward-looking agents.

However, this rational-agent perspective may not fully reflect actual consumer behaviour, particularly in the presence of persistent harmful habits such as smoking. A complementary perspective is offered by behavioural economics, which introduces the possibility of **time-inconsistent preferences** and **present-biased decision-making**. Freebairn (2010) draws on these behavioural concepts (particularly **hyperbolic discounting**) to argue that consumers often intend to reduce harmful consumption (e.g., of high-calorie food or tobacco), but fail to follow through due to a lack of willpower or the overvaluation of immediate gratification. In such cases, individuals may be aware of the long-term consequences of smoking but continue due to impulsive preferences and behavioural inertia.

This conceptual shift helps bridge the gap between the Darden-Kaestner model and real-world behaviour. While Darden and Kaestner model smoking cessation as a health-maximizing response, Freebairn shows that many individuals may persist in smoking despite declining health due to **present-biased preferences.** Consequently, even when marginal costs from illness increase, individuals may delay quitting. When they eventually quit, often after a health shock, the accumulated burden of untreated illness

leads to elevated healthcare expenditures.

Integrating these two perspectives allows for a more comprehensive theoretical understanding of smoking behaviour and its relationship to healthcare expenditure. Former smokers, for instance, may reflect a delayed response to prior health shocks (consistent with Darden's framework) but also exhibit patterns of delayed cessation and accumulated disease burden due to previously **time-inconsistent** behaviour, as described by Freebairn. This dual framework is particularly useful in explaining empirical findings where former smokers incur higher healthcare costs shortly after quitting, driven not only by medical need but also by structural and behavioural delays in cessation.

By adapting this model, this study uses the concept of **total healthcare expenditures** as the outcome variable. Total healthcare expenditures represent the overall costs incurred for medical services, including outpatient visits, inpatient care, and prescribed medications. This broader measure captures the full economic burden of healthcare use, offering a more comprehensive view of the financial implications associated with smoking-related health outcomes. Healthcare expenditures are influenced by various factors such as socioeconomic status, comorbidities, insurance coverage, and frequency of healthcare visits (Alemayehu et al., 2023).

RESEARCH METHOD

This study utilized data from the two most recent iterations of the IFLS, specifically those conducted in 2007 and 2014. This analysis concentrates on all-cause healthcare expenditures due to the detrimental effects of smoking on every organ and its role in causing or aggravating various health disorders (USDHHS, 2012).

The Baseline Model:

$$HCE_{it} = \gamma_0 + \gamma_1 QuitSmoking_{it} + \gamma_2 HealthCond_{it} + \gamma_3 SocialDemo_{it} + \varepsilon_{it} \quad (1)$$

In the baseline model, annual healthcare expenditure (HCE_{it}) depends on respondent's smoking status categorized as current smokers vs former smokers (1 if ceased smoking, 0 if continued smoking); socio-demographic attributes ($SocialDemo$), including gender (male or female), age, ethnicity (Javanese or other), education attainment (years of schooling), marital status (not currently married or currently married), the region of residency, health insurance coverage (yes or no); and health conditions ($HealthCond$), including BMI, physical activity, and smoking-related diseases.

BMI was computed utilizing weight and height, adhering to the WHO's Asian-Pacific cut-off points (underweight, BMI<18,5 kg/m2; normal weight, BMI 18.5≤22,9 kg/m2; overweight, BMI 23≤24,9 kg/m2; or obese, BMI ≥25 kg/m2) (WHO, 2000). Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) scoring system (IPAQ, 2005). Participants were categorized as exhibiting inactive, minimally active, or HEPA active of physical activity. Smoking-related illness was a self-reported non-communicable disease (NCDs) that an individual may possess (1 if present, 0 if absent). Socio-demographic parameters and health condition indicators were utilized as controls for confounding variables potentially linked to both health expenditures and cigarette smoking.

This study employ propensity score matching (PSM) to analyze the relationships between smoking behavior and healthcare costs. This method is employed to mitigate sample selection bias frequently seen in observational studies (mostly because smoking cessation is not random). Propensity Score Matching (PSM) creates matched pairs between treatment and control groups by balancing the distributions of observed covariates (Pan and Bai, 2015). Propensity Score Matching (PSM) offers a robust method for evaluating treatment effects in observational studies lacking controlled randomization (Rosenbaum and Rubin, 1983). The estimated scores indicate the

conditional chance of each study participant being allocated to either the treated or untreated group for comparison purposes. It describes the distribution of vectors of the observed covariates among all individuals (Garrido et al., 2014). PSM matches individuals from both groups according to pertinent baseline attributes to mitigate selection bias.

In observational data, individuals who quit smoking (treatment group) may have different characteristics than those who continued smoking (control group). Covariate characteristics such as sociodemographic status, BMI, physical activity, and smoking-related chronic diseases may differ across smoking status.

The first stage involves employing a logit or probit model to estimate the propensity score, which represents the likelihood of a respondent being allocated to the treatment group based on the matching variables. The author aims to guarantee that the sole distinction between the treatment and control groups pertains exclusively to the smoking behavior, while all other observed covariates are matched.

1st Step (Estimate Propensity Score): we used a logit model to predict the probability of smoking status. Outcome variable: a dummy variable (1 if quit smoking, 0 if continued smoking).

$$Pr(T_i = 1|x) = \Phi(\beta_0 + \beta_1 SmokingDisease_{it} + \beta_2 BMI_{it} + \beta_3 PhysicalActivity_{it} + \beta_4 SocialDemo_{it}) \quad (2)$$

Secondly, the author will check the common support and then compare the distribution of variables between the treatment and control groups using statistical tests, such as standardized mean difference (SMD) or t-tests, to ensure balance. Thirdly, every individual who ceased smoking (treatment) is matched with those who persisted in smoking (control) based on their propensity score utilizing the psmatch2 command (STATA 18.0). Four propensity score matching (PSM) methods will be employed: nearest neighbour (NN), radius, kernel and stratification matching, to determine

which technique achieves the most optimal balance across all covariates. Fourthly, this study will use the average treatment effect on the treated (ATT) in order to assess the impact of healthcare spending between treatment and control groups. Lastly, a robustness test was conducted to assess the consistency of the model by comparing several matching methods. This study also employs First Differencing to calculate the difference in smoking status and healthcare expenditures between 2014 and 2007 for each individual, thereby eliminating individual fixed effects. FD refines the PSM results by controlling for unobserved individual fixed effects, leveraging time variation, and reducing remaining selection bias. This combination provides a more robust estimation of treatment effects, particularly for analysing the impact of changes in smoking status on healthcare expenditures.

RESULT

In 2014, only 13,07% of the sample were identified as former smokers, compared to 7,38% in 2007. This low proportion reflects the tendency of individuals to maintain their smoking status over the seven-year observation period, with smokers continuing to smoke and non-smokers remaining abstinent (Table 1). Tables 2 and 3 show that the proportion of former smokers increased in 2014, indicating that more individuals had quit smoking, which may reflect growing health awareness. The observed increases in average age, BMI, and consumption expenditure between 2007 and 2014 may suggest underlying demographic and socioeconomic shifts, such as population aging and improved purchasing power.

Table 2. Summary statistics of respondent characteristics from IFLS 2014

Variables	Obs.	Mean	Std. Dev.	Min	Max
Treatment variables					
Smoking Status	11.397	0,131	0,337	0	1
Outcome variables					
Total OOP	31.769	2,039	4,846	0	28,324
Covariates					
Age	31.769	38,277	15,719	15	95

Table 2. Summary statistics of respondent characteristics from IFLS 2014

Variables	Obs.	Mean	Std. Dev.	Min	Max
BMI	31.769	22,976	4,187	11,429	43,390
Chronic conditions	31.611	0,062	0,242	0	1
Marital status	31.769	0,721	0,448	0	1
Years of schooling	31.769	9,287	5,475	0	22
Physical activity:					
Minimally active	30.336	0,433	0,495	0	1
HEPA active	30.336	0,206	0,404	0	1
Consumption exp.	31.769	8,753	8,095	0	20,723
Residency	31.769	0,585	0,492	0	1

Source: author's calculation

Table 3. Summary statistics of respondent characteristics from IFLS 2007

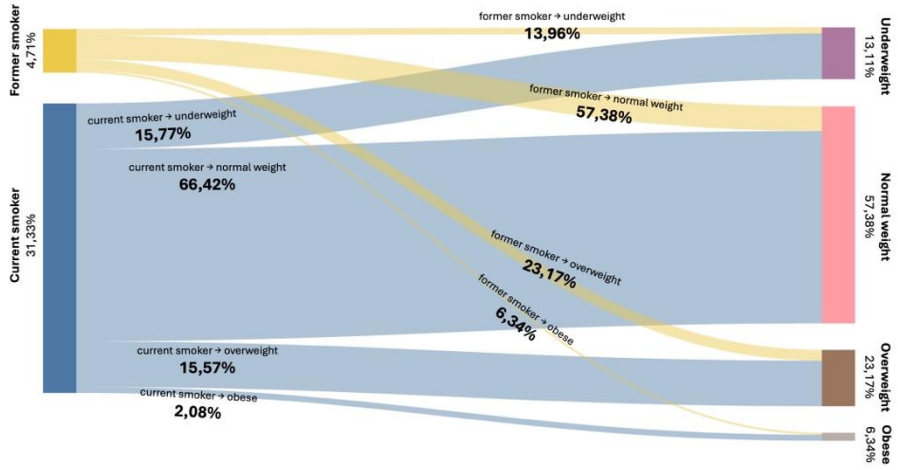
Variables	Obs.	Mean	Std. Dev.	Min	Max
Treatment variables					
Smoking Status	9.550	0,074	0,261	0	1
Outcome variables					
Total OOP	28.053	1,834	4,529	0	21,649
Covariates					
Age	28.053	37,409	15,971	15	90
BMI	28.052	22,105	3,784	8,447	40,931
Chronic conditions	10.258	0,081	0,272	0	1
Marital status	28.053	0,693	0,461	0	1
Years of schooling	28.053	8,357	5,269	0	22
Physical activity:					
Minimally active	27.320	0,487	0,499	0	1
HEPA active	27.320	0,288	0,452	0	1
Consumption exp.	28.053	8,462	7,717	0	20,723
Residency	28.053	0,527	0,499	0	1

Source: author's calculation

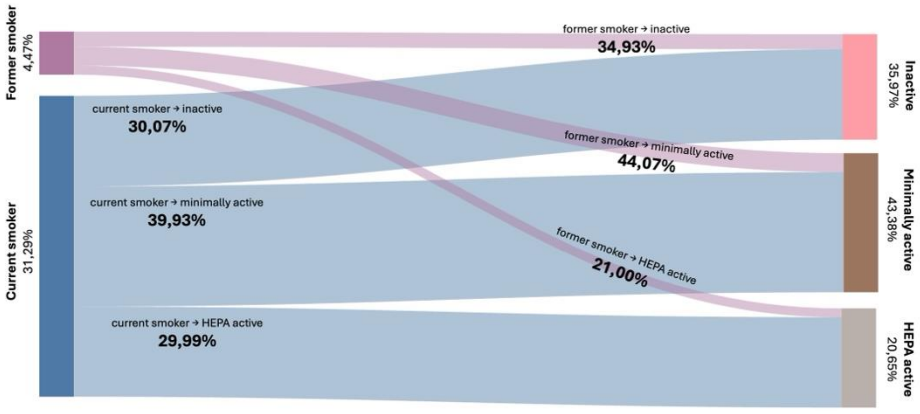
When viewed from the perspective of smoking status—specifically comparing former smokers and current smokers as examined in this study—former smokers exhibit a higher prevalence of obesity compared to current smokers (see Figure 1). This may suggest post-cessation weight gain, a phenomenon supported by several studies indicating that individuals who quit smoking often experience increased appetite and metabolic changes (Larowe et al., 2009).

Furthermore, former smokers tend to have a higher proportion of individuals categorized as physically inactive—representing the lowest level of physical activity—compared to their current smoking counterparts. Interestingly, former smokers also show a greater prevalence of smoking-related chronic conditions, possibly reflecting the long-term health consequences of prior tobacco use.

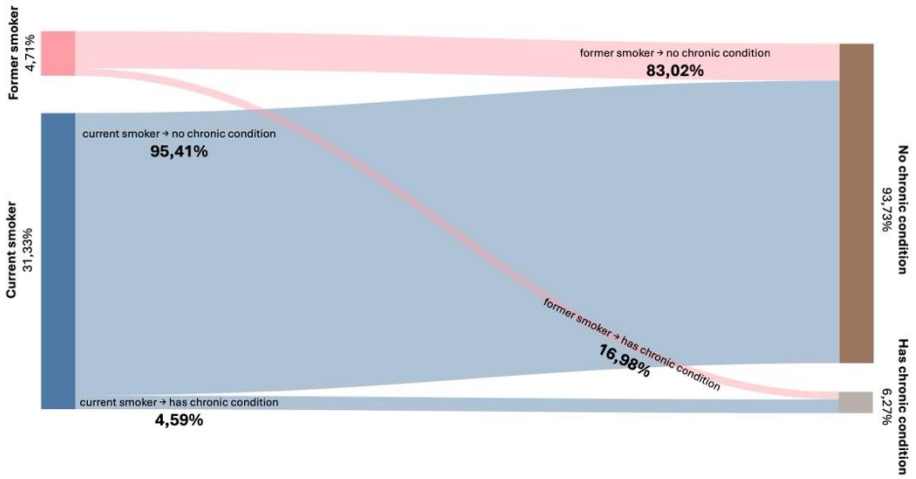
Figure 1. Smoking status across health indicators



(a) Smoking status and body mass index (BMI) category, 2014



(b) Smoking status and levels of physical activity, 2014



(c) Smoking status and chronic conditions, 2014

Building upon the insights from Figure 1, it is evident that a notable proportion of former smokers have been diagnosed with chronic conditions. However, the precise timing of these health events remains unclear—whether individuals quit smoking as a response to illness, or whether they developed illness after cessation due to delayed health screening. This ambiguity underscores the complexity of interpreting the causal relationship between smoking cessation and chronic disease onset. The role of health insurance in this context is further explored in Figure 2, which illustrates how insurance status may influence healthcare-seeking behaviour among former smokers.

Figure 2. Health insurance coverage among former smokers with and without chronic conditions

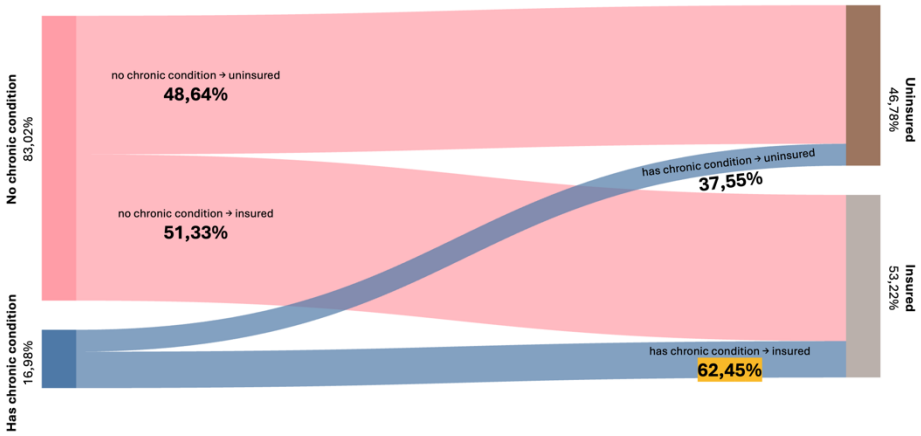
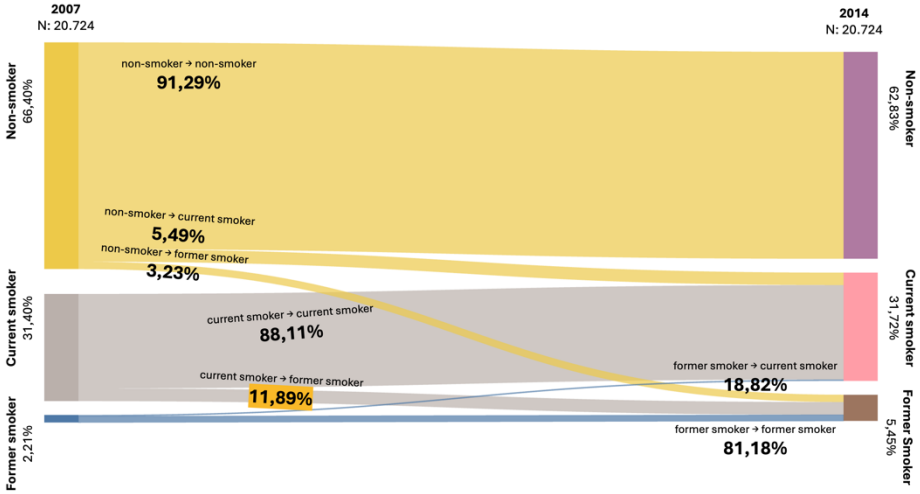


Figure 2 reveals a complex relationship between chronic health conditions and insurance coverage among former smokers. A majority (62,45%) of those with chronic illnesses were insured, possibly indicating adverse selection—where individuals seek insurance after falling ill—or reflecting a detection effect, in which insured individuals are more likely to be diagnosed due to better access to medical screenings. However, 37,55% of former smokers with chronic conditions remained uninsured, pointing to persistent gaps in health protection that may stem from limited awareness, financial barriers, or reluctance to engage with healthcare systems. Among former smokers without chronic conditions, over half (51,33%) still held insurance, which could reflect preventive behaviour, yet nearly 49% remained uninsured and potentially vulnerable to future health shocks without adequate financial safeguards.

After examining the profile of smoking status in each respective year, we can observe the longitudinal dynamics of individual transitions in **Figure 3**. This figure visualizes how individuals' smoking statuses evolved over the seven-year period, enabling us to track whether they remained consistent in their behaviour or experienced a shift. Notably, the majority of individuals who were classified as former smokers

in 2007 (approximately **81,18%)** maintained their non-smoking status in 2014. This suggests a strong level of behavioural consistency and reinforces the notion that smoking cessation, once initiated and sustained over a certain period, tends to persist over time, at least within this subpopulation.

Figure 3. Smoking status transitions between 2007 and 2014



However, the data also reveal that **18,82% of former smokers in 2007 had relapsed by 2014**, returning to smoking. This relapse rate is non-negligible and highlights the need for continuous post-cessation support, particularly in preventing recidivism after initial success. An additional dynamic worth noting is the influx of new former smokers during the observation window, particularly the **11,89% of current smokers in 2007 who successfully transitioned to former smokers by 2014**. This group represents individuals who quit smoking within the seven-year interval and is central to the analysis of post-cessation healthcare expenditures.

Before examining the differences in health expenditures across smoking statuses, the factors that characterize a smoker are analysed using a logit estimation in Equation 2. The results are presented in Table 4. The logit estimation results presented in Table 4 show that several variables consistently have a significant influence on the probability of an individual becoming a

former smoker, both in 2014 and 2007. The variable *age* shows a significant positive effect in both years, indicating that as individuals grow older, they are more likely to quit smoking. This finding aligns with the literature suggesting that older individuals tend to be more aware of the health impacts of smoking behaviour (Zhou et al., 2009; Hughes et al., 2004).

Higher BMI may indirectly increase the likelihood of becoming a former smoker, as deteriorating health encourages individuals to quit smoking. The study conducted by Larowe et al., (2009) revealed that treatment-seeking smokers and ex-smokers exhibited a considerably higher likelihood of obesity compared to current smokers within a general population sample. Moreover, persons who smoke excessively may exhibit higher body weight (Chiolero et al., 2007), maybe attributable to weight cycling (Chiolero et al., 2008) resulting from prior cessation attempts (Filozof et al., 2004). This aligns with the dual effects of smoking, namely heightened energy expenditure and diminished hunger, both of which are negated upon cessation of smoking (Filozof et al., 2004).

Individuals with poor health conditions, such as chronic illnesses, are more likely to be motivated to quit smoking in order to improve their quality of life. For example, smokers who experienced a cardiovascular health shock were more likely to quit smoking (Marti and Richards, 2016). In line with the research by Cutler and Lleras-Muney (2010), higher levels of education are also associated with greater awareness of the health risks of smoking, thereby increasing the likelihood of quitting.

Overall, these results indicate that there are distinct differences in characteristics between former smokers and current smokers. Therefore, it is important to apply the PSM method to ensure that comparisons of impacts on health expenditures are conducted fairly and are not biased due to baseline characteristic differences between the groups.

Table 4. Logit estimation for covariate selection in determining the counterfactual

Covariates	Coef.	Std. err.	z	P > |z|
2014:				
Age	0,036	0,002	16,53	0,000***
BMI	0,069	0,008	8,27	0,000***
Chronic condition (dummy)	0,944	0,096	9,81	0,000***
Marital status (dummy)	0,074	0,083	0,89	0,372
Years of schooling	0,045	0,006	7,60	0,000***
Minimally active (dummy)	-0,087	0,069	-1,26	0,206
HEPA active (dummy)	-0,336	0,083	-4,05	0,000***
Consumption exp.	-0,015	0.004	-3,57	0,000***
Residency (dummy)	0,116	0,064	1,81	0,071*
Constant	-5,387	0,223	-24,13	0,000***
Number of obs.:	10,846		Prob > chi2: 0,000***	
Pseudo R^2	0,0845			
2007:				
Age	0,043	0,005	7,99	0,000***
BMI	0,065	0,015	4,32	0,000***
Chronic condition (dummy)	1,059	0,148	7,15	0,000***
Marital status (dummy)	-0,203	0,151	-1,35	0,177
Years of schooling	0,049	0,010	4,71	0,000***
Minimally active (dummy)	-0,071	0,124	-0,57	0,567
HEPA active (dummy)	-0,688	0,154	-4,47	0,000***
Consumption exp.	-0,018	0,008	-2,26	0,024**
Residency (dummy)	0,278	0,111	2,51	0,012**
Constant	-5,872	0,567	-10,35	0,000***
Number of obs.:	4,080		Prob > chi2: 0,000***	
Pseudo R^2	0,1010			

Note(s): ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

After the PSM assumptions are satisfied, the next analysis involves estimating the baseline estimation using simple linear regression without control variables (Model 1) and with control variables (Model 2). All previously mentioned sociodemographic factors and health conditions across smoking statuses are included as control variables and covariates in all subsequent analyses. The results of linear regression (Table 5) show that the findings are statistically

significant both with and without control variables for both observed years. Although the results are statistically significant, there is a possibility of bias (selection bias) due to differences in characteristics among smokers for Model 1. While Model 2 may be prone to biases resulting from potential model misspecification. Accordingly, PSM is implemented to mitigate both concerns.

Table 5 also presents the estimated Average Treatment Effect on the Treated (ATT) of smoking status on health expenditures. In 2014, all matching methods yield positive and statistically significant ATT results at the 1% significance level ($p < 0,01$), indicating that the estimation is robust. These results indicate that former smokers tend to have significantly higher health expenditures compared to current smokers after adjusting for relevant covariate characteristics. A similar trend is also observed in the 2007 data, where the ATT remains positive and significant across all matching methods. This may be linked to the possibility that former smokers begin to experience or become more aware of the long-term health effects of their past smoking habits, which ultimately leads to greater medical needs and higher healthcare costs.

These findings are consistent with the literature stating that former smokers have higher health risks compared to current smoker and non-smokers (Darden & Kaestner, 2022; Swedler et al., 2019; Ihyauddin et al., 2022), particularly during the transitional period after quitting smoking (Zhou et al., 2009; Barendregt et al., 1997). The rise in healthcare spending appears to start even before individuals actually quit smoking, suggesting that the decision to stop may be triggered by an expensive health issue. This pattern implies that early signs of worsening health may influence the choice to quit smoking, and these warning signs could be linked to the major health event that causes the sharp increase in healthcare costs shortly after cessation.

Table 5. Estimation of the ATT of smoking status on healthcare expenditure using various matching algorithms

Est. Methods	Obs.	ATT	Std. Err.	T-stat	P > |T|
2014:					
Model 1	11.397	0,883	0,118	7,50	0,000***
Model 2	10.846	0,751	0,129	5,79	0,000***
Nearest Neighbour	2.509	0,641	0,204	3,14	0,001***
Kernel	10.846	0,756	0,156	4,83	0,000***
Stratification	2.509	0,641	0,204	3,14	0,001***
Radius	10.846	1,071	0,151	7,10	0,000***
2007:					
Model 1	9.550	1,692	0,151	11,18	0,000***
Model 2	4.080	1,166	0,209	5,56	0,000***
Nearest Neighbour	874	1,254	0,348	3.61	0,000***
Kernel	4.080	1,233	0,269	4,58	0,000***
Stratification	874	1,253	0,348	3,61	0,000***
Radius	4.080	1,648	0,252	6,53	0,000***

Note(s): ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Robustness Test

The bootstrap is a widely recognized resampling procedure for estimating the standard errors of statistical estimators and constructing confidence intervals, involving repeated sampling with replacement from the original dataset to create samples of equal size (Efron & Tibshirani, 1993). Using 999 bootstrap replications, the coefficient remains statistically significant, and the exclusion of zero from the resulting confidence interval indicates a robust effect of smoking cessation on healthcare expenditure (Table 6).

Table 6. Bootstrap standard errors

Year	Obs.	ATT	Std. Err.	t	p > |t|	95% CI
2014	2509	0,641	0,231	2,776	0,005***	0,1899751 - 1,113915
2007	873	1,254	0,363	3,452	0,000***	0,5546291 - 1,956854

Note(s): ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Bootstrap specification: 999 replications for nearest neighbour matching only.

The subsequent robustness test involves employing various matching methods by adjusting the number of neighbours in the Nearest Neighbour Matching technique, as well as utilizing the Inverse Probability Weighted Regression Adjustment (IPWRA) method (Caldera, 2019). Overall, the results (Table 7) demonstrate that the impact of smoking cessation on healthcare expenditure is both statistically and substantively significant, and remains robust across different matching techniques and time periods. The consistent direction and magnitude of the effects suggest that quitting smoking, while beneficial in the long term, may initially be associated with increased use of healthcare services, possibly due to the treatment of latent health conditions.

Table 7. Different matching method (common support)

Matching Methods	Obs.	ATE	ATT	Std. Err.	T-stat	p-value
2014:						
1-nearest neighbour	2.355	0,761***	0,641	0,204	3,14	0,001***
5-nearest neighbour	5.472	0,593***	0,709	0,166	4,26	0,000***
10-nearest neighbour	7.476	0,635***	0,725	0,162	4,47	0,000***
15-nearest neighbour	8.581	0,675***	0,732	0,160	4,57	0,000***
20-nearest neighbour	9.252	0,695***	0,697	0,159	4,38	0,000***
IPWRA	10.846	0,676***	0,738	0,161	4,58	0,000***
2007:						
1-nearest neighbour	817	0,954***	1,254	0,203	3,61	0,000***
5-nearest neighbour	1.886	1,362***	1,236	0,287	4,30	0,000***
10-nearest neighbour	2.543	1,337***	1,155	0,279	4,14	0,000***
15-nearest neighbour	2.952	1,266***	1,252	0,276	4,53	0,000***
20-nearest neighbour	3.244	1,181***	1,237	0,275	4,51	0,000***
IPWRA	4.080	1,325***	1,198	0,278	4,30	0,000***

Note(s): ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Post-Regression Results

The final part of this analysis involves combining the previously separated 2007 and 2014 datasets—initially analysed using Propensity Score Matching (PSM)—into a panel dataset. This allows the use of a First Difference (FD) approach to examine changes in individual's smoking status over time. FD 1 represents the baseline specification without control variables, while FD 2 includes relevant covariates to adjust for observed individual-level differences. The result indicates that even after adjusting for potential confounders, former smokers still incur higher healthcare costs than current smokers. The result reinforces earlier findings that smoking-related health conditions may become more visible or require more treatment following cessation.

Table 8. Panel regression

Healthcare Expenditure	**Former vs Current Smoker**	
	FD 1	**FD 2**
Coefficient	**1,119*** **	**0,882** **
Std. err.	**0,238**	**0,382**
t-stat	**4,79**	**2,31**
Number of obs.	**12.956**	**8.879**

Note(s): ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

CONCLUSION

By accounting for health status and other covariates commonly associated with smoking behaviour, the analysis offers indicative evidence that smoking status may influence healthcare costs. The results suggest that individuals who have quit smoking tend to incur higher medical expenses, a pattern that appears consistent across different matching methods. Nonetheless, these findings should be interpreted with caution, as there remains the possibility that unobserved factors or residual biases

may affect the estimates. One potential explanation for the elevated costs among former smokers is the occurrence of health shocks that may have triggered smoking cessation, resulting in increased medical needs at the time of quitting. This could potentially lead to an overestimation of post-cessation healthcare expenditures.

These findings highlight the importance of implementing early health screening initiatives, particularly for individuals with a history of smoking. By identifying potential health issues before they escalate, former smokers may be encouraged to quit prior to the onset of serious illness. This preventive approach could help mitigate the surge in healthcare expenditures often observed following smoking cessation due to late-stage diagnoses. Promoting early detection and proactive health monitoring may ultimately reduce both individual and systemic financial burdens while supporting more timely cessation decisions.

This study is limited by the inability to fully distinguish between individuals who are sick and diagnosed versus those who are ill but undiagnosed, potentially leading to underestimation of health risks. Additionally, the dataset does not provide detailed information on insurance coverage, meaning the out-of-pocket (OOP) expenditure variable may include costs already covered by insurance, especially for insured respondents. This limits the accuracy of measuring the true financial burden. Lastly, while subgroup and heterogeneity analyses were conducted, limited statistical power—especially in small subsamples—may affect the significance of interaction tests.

To address this limitation, future studies could explore more precisely the timing and health events that lead individuals to quit smoking. A deeper understanding of the average duration of exposure to tobacco before cessation, and whether cessation is typically triggered by acute health shocks or gradual health deterioration, would enrich the literature on smoking behaviour and its health consequences. Collecting or linking to longitudinal

data that records the specific year of smoking cessation and associated medical events would enable researchers to trace causal pathways more effectively and quantify the delayed health burden among former smokers.

REFERENCES

Abadie, A., & Imbens, G. W. (2006). Large sample properties of matching estimators for average treatment effects. *Econometrica, 76*(4), 1071–1102. https://scholar.harvard.edu/files/imbens/files/large_sample_properties_of_matching_estimators_for_average_treatment_effects.pdf

Alasmari, A., & Almudarra, S. S. (2023). Socio-demographic Characteristics Associated with Tobacco Consumption among Smokers Attended Ministry of Health Smoking Cessation Clinics in Jeddah, Saudi Arabia during 2018. *Journal of Pharmaceutical Research International*. https://doi.org/10.9734/jpri/2023/v35i217410

Alcaraz, A., Lazo, E., Casarini, A., Rodriguez-Cairoli, F., Augustovski, F., Bardach, A., Perelli, L., Palacios, A., Pichón-Rivière, A., & Espinola, N. (2024). Exploring gender disparities in the disease and economic tobacco-attributable burden in Latin America. *Frontiers in Public Health*. https://doi.org/10.3389/fpubh.2023.1321319.

Alemayehu, M., Addis, B., & Hagos, T. (2023). Out-of-pocket health expenditure and associated factors among patients with hypertension in Debre-Tabor Comprehensive Specialized Hospital, South Gondar zone, Northwest Ethiopia, 2020. *Frontiers in Public Health, 11*, 1014364. https://doi.org/10.3389/fpubh.2023.1014364

Barendregt, J. J., Bonneux, L., & van der Maas, P. J. (1997). The health care costs of smoking. *The New England Journal of Medicine, 337*(15), 1052–1057. https://doi.org/10.1056/NEJM199710093371506

Caliendo, M., & Kopeinig, S. (2008). *Some practical guidance for the implementation of propensity score matching*. **Journal of Economic Surveys, 22**(1), 31–72. https://doi.org/10.1111/j.1467-6419.2007.00527.x

Chan, K. H., Wright, N., Xiao, D., Guo, Y., Chen, Y., Du, H., & Chen, Z. (2022). Tobacco smoking and risks of more than 470 diseases in China: A prospective cohort study. The Lancet Public Health, 7, e1014-e1026. https://doi.org/10.1016/S2468-2667(22)00227-4.

Choi W, Kim S-H, Kang S-H, Park JJ, Yoon C-H, Youn T-J, et al. (2019) Differential impact of smoking on cardiac or non-cardiac death according to age. PLoS ONE 14(10): e0224486. https://doi.org/10.1371/journal.pone.0224486.

Darden ME, Kaestner R (2022). Smoking, Selection, and Medical Care Expenditures. *Journal of Risk and Uncertainty*, 64, 251–285. https://doi.org/10.1007/s11166-022-09378-9.

Firmansyah, C. A., Renaldi, R. G., Monikka, D., & Sihaloho, E. D. (2022). The effect of smoking behavior on health expenditure in Indonesia's rural areas. *Jurnal Ekonomi Kesehatan Indonesia*, 7(1), 5. https://doi.org/10.7454/eki.v7i1.5401.

Fishman, P. A., Khan, Z. M., Thompson, E. E., & Curry, S. J. (2003). Health care costs among smokers, former smokers, and never smokers in an HMO. *Health services*

research, *38*(2), 733–749. https://doi.org/10.1111/1475-6773.00142.

Freebairn, J. (2010). Taxation of unhealthy food and drinks. *The Australian Economic Review*, 43(1), 54–62. https://doi.org/10.1111/j.1467-8462.2009.00581.x

Frölich, M. Matching estimators and optimal bandwidth choice. *Stat Comput* **15**, 197–215 (2005). https://doi.org/10.1007/s11222-005-1309-6

Garrido, M. M., Kelley, A. S., Paris, J., Roza, K., Meier, D. E., Morrison, R. S., & Aldridge, M. D. (2014). Methods for constructing and assessing propensity scores. *Health Services Research*, *49*(5), 1701–1720. https://doi.org/10.1111/1475-6773.12182.

Geue C, Lorgelly P, Lewsey J, Hart C, Briggs A (2015) Hospital Expenditure at the End-of-Life: What Are the Impacts of Health Status and Health Risks? *PLoS ONE* 10(3): e0119035. https://doi.org/10.1371/journal.pone.0119035.

Grossman, M. (1972). *On the concept of health capital and the demand for health*. *Journal of Political Economy*, 80(2), 223-255. https://www.jstor.org/stable/1830580

Hodgson, T. A. (1992). Cigarette smoking and lifetime medical expenditures. *The Milbank Quarterly*, 70(1), 81–125. https://www.jstor.org/stable/3350086.

Holipah, H., Sulistomo, H. W., & Maharani, A. (2020). Tobacco smoking and risk of all-cause mortality in Indonesia. *PLOS ONE*, 15(12), e0242558. https://doi.org/10.1371/journal.pone.0242558.

Huang, S., Wei, H., Yao, T., Mao, Z., Sun, Q., & Yang, L. (2021). The impact of smoking on annual healthcare cost: An econometric model analysis in China. *BMC Health Services Research*, 21, 187. https://doi.org/10.1186/s12913-021-06199-5.

Hughes, J. R., Keely, J., & Naud, S. (2004). Shape of the relapse curve and long-term abstinence among untreated smokers. *Addiction*, *99*(1), 29–38. https://doi.org/10.1111/j.1360-0443.2004.00540.x

Ihyauddin, Z., Marthias, T., Anindya, K., Ng, N., Dewi, F. S. T., Hulse, E. S. G., Aji, R. P., Putri, D. A. D., & Lee, J. T. (2022). The relative impact of underweight, overweight, smoking, and physical inactivity on health and associated costs in Indonesia: Propensity score matching of a national sample. *BMC Health Services Research*, 22, 1170. https://doi.org/10.1186/s12913-022-08546-6.

International Association for The Study of Obesity. (2000). The Asia pacifc perspective: redefning obesity and its treatment. Australia: World Health Organization Western Pacifc Region.

IPAQ. (2005). Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) – short and long forms.

Jann, B. (2017). *kmatch: Kernel matching with automatic bandwidth selection*. Paper presented at the United Kingdom Stata Users' Group Meetings 2017 (No. 11). Stata Users Group.

Kahende, J., Adhikari, B. B., Maurice, E., Rock, V., & Malarcher, A. (2009). Disparities in Health Care Utilization by Smoking Status – NHANES 1999–2004. *International Journal of Environmental Research and Public Health*, *6*(3), 1095–1106. https://doi.org/10.3390/IJERPH6031095.

Kamangar, F., & Islami, F. (2020). *Smoking, Implications of* (pp. 492–498). Academic

Press. https://doi.org/10.1016/B978-0-12-801238-3.65759-8.

Kolbe-Alexander, T. L., Conradie, J., & Lambert, E. V. (2013). Clustering of risk factors for non-communicable disease and healthcare expenditure in employees with private health insurance presenting for health risk appraisal: A cross-sectional study. *BMC Public Health, 13*, 1213. https://doi.org/10.1186/1471-2458-13-1213

Kristina, S. A., Endarti, D., Wiedyaningsih, C., Fahamsya, A., & Faizah, N. (2018). Health care cost of noncommunicable diseases related to smoking in Indonesia, 2015. Asia Pacific Journal of Public Health, 30(1), 29–35. https://doi.org/10.1177/1010539517751311.

Leu, R. E., & Schaub, T. (1983). Does smoking increase medical care expenditure? *Social Science & Medicine*, 17(23), 1907–1914. https://doi.org/10.1016/0277-9536(83)90168-5.

Lightwood J, Anderson S, Glantz SA (2020). Predictive validation and forecasts of short-term changes in healthcare expenditure associated with changes in smoking behavior in the United States. *PLoS ONE* 15(1): e0227493. https://doi.org/10.1371/journal.pone.0227493.

Lightwood J, Glantz SA (2016) Smoking Behavior and Healthcare Expenditure in the United States, 1992–2009: Panel Data Estimates. *PLoS Med* 13(5): e1002020. https://doi.org/10.1371/journal.pmed.1002020.

Lippiatt B. C. (1990). Measuring medical cost and life expectancy impacts of changes in cigarette sales. *Preventive medicine*, *19*(5), 515–532. https://doi.org/10.1016/0091-7435(90)90050-t.

Lo, W.-C., Hu, T.-H., Shih, C.-Y., Lin, H.-H., & Hwang, J.-S. (2023). Impact of healthy lifestyle factors on life expectancy and lifetime healthcare cost: a nationwide cohort study. *Innovation in Aging*, *7*, 1062–1063. https://doi.org/10.1093/geroni/igad104.3414.

Manuel DG, Bennett C, Perez R et al. (2019) Burden of health behaviours and socioeconomic position on health care expenditure in Ontario [version 2; peer review: 2 approved] *F1000Research*, 8:303. https://doi.org/10.12688/f1000research.18205.2.

Marti J, Richards MR (2016). Smoking Response to Health and Medical Spending Changes and the Role of Insurance. *Health Economics*, 26(3), 305–320. https://doi.org/10.1002/hec.3309.

Martinson, B. C., O'Connor, P. J., Pronk, N. P., & Rolnick, S. J. (2003). Smoking cessation attempts in relation to prior health care charges: the effect of antecedent smoking-related symptoms?. *American journal of health promotion : AJHP*, *18*(2), 125–132. https://doi.org/10.4278/0890-1171-18.2.125.

Muhammad, R. (2023). The Role of Socioeconomic Determinants on Individual Decision to Quit Smoking: Evidence from Indonesia. *Journal of Development Economics*. https://doi.org/10.20473/jde.v8i2.41636

Nargis, N., Yong, H.-H., Driezen, P., Mbulo, L., Zhao, L., Fong, G. T., Fong, G. T., Thompson, M. E., Borland, R., Palipudi, K., Giovino, G. A., Thrasher, J. F., & Siahpush, M. (2019). Socioeconomic patterns of smoking cessation behavior in low and middle-income countries: Emerging evidence from the Global Adult Tobacco Surveys and International Tobacco Control Surveys. *PLOS ONE*, *14*(9), 1–24. https://doi.org/10.1371/JOURNAL.PONE.0220223

Nolan, M. B., Borah, B. J., Moriarty, J. P., & Warner, D. O. (2019). Association between smoking cessation and post-hospitalization healthcare costs: A matched cohort analysis. *BMC Health Services Research, 19*(1), 924. https://doi.org/10.1186/s12913-019-4777-7.

Pan, W., & Bai, H. (2015). Propensity score interval matching: Using bootstrap confidence intervals for accommodating estimation errors of propensity scores. *BMC Medical Research Methodology, 15*, Article 53. https://doi.org/10.1186/s12874-015-0049-3

Pan, W., & Bai, H. (2015). Propensity score interval matching: Using bootstrap confidence intervals for accommodating estimation errors of propensity scores. *BMC Medical Research Methodology, 15*, 53. https://doi.org/10.1186/s12874-015-0049-3

Pirie, K., Peto, R., Reeves, G. K., Green, J., & Beral, V. (2013). The 21st century hazards of smoking and benefits of stopping: A prospective study of one million women in the UK. *Lancet, 381*(9861), 133–141. https://doi.org/10.1016/S0140-6736(12)61720-6

Pulakka, A., Halonen, J. I., Pentti, J., Kivimäki, M., Vahtera, J., & Stenholm, S. (2019). Changes in Smoking During Retirement Transition: A Longitudinal Cohort Study. *Scandinavian journal of public health, 47*(8), 876–884. https://doi.org/10.1177/1403494818804408

Pulakka, A., Halonen, J. I., Pentti, J., Pentti, J., Kivimäki, M., Kivimäki, M., Kivimäki, M., Vahtera, J., & Stenholm, S. (2019). Changes in Smoking During Retirement Transition: A Longitudinal Cohort Study. *Scandinavian Journal of Public Health*, *47*(8), 876–884. https://doi.org/10.1177/1403494818804408

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika, 70*(1), 41–55. https://doi.org/10.1093/biomet/70.1.41

Rubin, D. B. (2001). Using propensity scores to help design observational studies: Application to the tobacco litigation. *Health Services & Outcomes Research Methodology, 2*(3-4), 169–188. https://doi.org/10.1023/A:1020363010465

Sharma, A., Kasza, K. A., O'Connor, R., & Felicione, N. J. (2024). Personal characteristics associated with switching from Cigarettes to Non-combustible tobacco and nicotine products among U.S. adults: Findings from PATH Study Wave 1 – Wave 5. *Nicotine & Tobacco Research*. https://doi.org/10.1093/ntr/ntae170

Shields, M., Garner, R. E., & Wilkins, K. (2013). Dynamics of smoking cessation and health-related quality of life among Canadians. *Health Reports, 24*, 11.

Simonavicius, E., McNeill, A. and Brose, L.S. (2020), Transitions in smoking and nicotine use from 2016 to 2017 among a UK cohort of adult smokers and ex-smokers. Drug Alcohol Rev., 39: 994-1005. https://doi.org/10.1111/dar.13063

Simonavicius, E., McNeill, A., & Brose, L. S. (2020). Transitions in smoking and nicotine use from 2016 to 2017 among a UK cohort of adult smokers and ex-smokers. *Drug and Alcohol Review*, *39*(7), 994–1005. https://doi.org/10.1111/DAR.13063

Steinberg, M. B., Schmelzer, A. C., Lin, P. N., & Garcia, G. (2010). Smoking as a chronic disease. Current Cardiovascular Risk Reports, 4(5), 413–420. https://doi.org/10.1007/s12170-010-0125-5.

Swarnata, A., Kamilah, F. Z., Melinda, G., & Adrison, V. (2024). The impoverishing effect of tobacco use in Indonesia. *Nicotine and Tobacco Research, 26*(10), 1331–1338. https://doi.org/10.1093/ntr/ntae088.

Swarnata, A., Kamilah, F. Z., Wisana, I. D. G. K., Meilissa, Y., & Kusnadi, G. (2024). Crowding-out effect of tobacco consumption in Indonesia. *Tobacco control*, *33*(Suppl 2), s81–s87. https://doi.org/10.1136/tc-2022-057843.

Swedler, D. I., Miller, T. R., Ali, B., Waeher, G., & Bernstein, S. L. (2019). National medical expenditures by smoking status in American adults: An application of Manning's two-stage model to nationally representative data. BMJ Open, 9(e026592). https://doi.org/10.1136/bmjopen-2018-026592.

Theodoulou, A., Fanshawe, T., Leavens, E. L. S., Theodoulou, E., Wu, A. D., Heath, L., Stewart, C., Nollen, N. L., Ahluwalia, J. S., Butler, A. R., Hajizadeh, A., Thomas, J., Lindson, N., & Hartmann-Boyce, J. (2025). Differences in the effectiveness of individual-level smoking cessation interventions by socioeconomic status. *The Cochrane Library*, *2025*(1). https://doi.org/10.1002/14651858.cd015120.pub2

U.S. Department of Health and Human Services. (1989). Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General. *DHHS* pub. no. (CDC) 89-8411. Washington.

U.S. Department of Health and Human Services. (2004). *The Health Consequences of Smoking: A Report of the Surgeon General.*. Report United States Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Promotion, Office on Smoking and Health, Atlanta, GA.

U.S. Department of Health and Human Services. (2012). Preventing tobacco use among youth and young adults: A report of the Surgeon General. *Centers for Disease Control and Prevention*. Atlanta, GA: U.S. Department of Health and Human Services.

U.S. Department of Health and Human Services. (2020). *Smoking cessation: A report of the Surgeon General*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

Vermote, M., Debognies, P., Demarest, S., & Braekman, E. (2024). Sociodemographic inequalities in smoking cessation: a population survey from Flanders, Belgium. *European Journal of Public Health*, *34*(Supplement_3). https://doi.org/10.1093/eurpub/ckae144.929

Wagner, E. H., Curry, S. J., Grothaus, L., Saunders, K. W., & McBride, C. M. (1995). The impact of smoking and quitting on health care use. *Archives of internal medicine*, *155*(16), 1789–1795.

World Health Organization. *2021 GATS Fact Sheet Indonesia*. 2021. https://www.who.int/publications/m/item/2021-gats-fact-sheet-indonesia. Accessed March 3, 2025.

Xin, Y., Qian, J., Xu, L., Tang, S., Gao, J., & Critchley, J. A. (2009). The impact of smoking and quitting on household expenditure patterns and medical care costs in China. *Tobacco Control*, 18(2), 150–155. https://doi.org/10.1136/tc.2008.026955.

Zhong Z, Wei H, Yang L, Yao T, Mao Z, Sun Q (2020) Catastrophic health expenditure: A comparative analysis of smoking and non-smoking households in China. *PLoS ONE* 15(5): e0233749. https://doi.org/10.1371/journal.pone.0233749.

Zhou, X., Nonnemaker, J., Sherrill, B., Gilsenan, A. W., Coste, F., & West, R. (2009). Attempts to quit smoking and relapse: factors associated with success or failure from the ATTEMPT cohort study. *Addictive behaviors*, *34*(4), 365–373. https://doi.org/10.1016/j.addbeh.2008.11.013