

A Review of Common Independent Variables Used in Tobacco Smoking Related Studies

Kaiye Gao¹, Li Qu^{1*}, Huiying Wang², Wentao Liu¹, Bin Cheng¹, Zhunan Wu¹, Ying Liu¹ and Rui Peng³

¹School of Economics and Management, Beijing Information Science and Technology University, China

²School of Economics and Management, University of Science and Technology Beijing, China

³School of Economics and Management, Beijing University of Technology, China

*Corresponding author: Li Qu, School of Economics and Management, Beijing Information Science and Technology University, China



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ABSTRACT

Aim: To provide a reference for the independent variables selection in tobacco smoking related studies.

Background: Tobacco smoking has long been one of the leading causes of preventable death worldwide. Plenty of smoking-related studies including many reviews have been conducted. However, there is still no literature that reviews the independent variables of smoking.

Objective: Review the tobacco smoking related studies according to the independent variables used.

Method: We searched the academic literatures for this review according to the different independent variables which are binary variables of smoking status, multivariate variables of smoking status, smoking amount and others including duration of smoking cessation, age at starting smoking and tobacco types.

Result: Independent variables educed from smoking status are most widely used in previous studies since the smoking status, such as smoking or not and smoking cessation or not, is easy to be collected accurately. Smoking amount is usually used to distinguish the level of smoking, that is, how heavy are smokers' smoking behaviors.

Conclusion: According to our review, we found that it is needed to construct some new forms for the independent variables of smoking to analyze the effect of smoking on the advance.

Keywords: Tobacco Smoking; Independent Variable; Smoking Status; Smoking Amount; Smoking Cessation; Tobacco Types

Introduction

Tobacco is the only legal drug, killing many of tobacco users when used exactly as intended by its manufacturers. According to the report of World Health Organization, tobacco use including smoking and smokeless is currently responsible for about six million deaths across the world each year [1]. This figure includes about 600,000 people who may die from the effects of second-hand smoke. Tobacco smoking has been proved associated with ill health, disability and death from non-communicable chronic

diseases. However, it also leads to an increased risk of death from communicable diseases. Thus, tobacco use is still one of the biggest preventable causes of diseases and premature deaths until now. Although smoking rates fell in the higher income countries during the 1970s and 1980s, evidence shows that this trend is levelling out [2]. The importance of revealing studying and evaluating the effects of smoking on health is obvious. Herein, the effects of tobacco smoking on specific diseases such as chronic obstructive

pulmonary disorders, cardiovascular diseases, respiratory diseases, as well as cancers of lung, oral cavity, larynx, oesophagus, stomach, pancreas, colorectum, bladder and kidney etc. have been found for many years [3].

However, researchers conducted studies using different independent variables for different areas. Most studies used a binary variable to indicate the smoking or smoking cessation [4-16]. Some researchers further classified the variable into three groups including never smokers, ex-smokers and current smokers [17-23]. Furthermore, some researchers used the conception of smoking amount like the cigarettes smoked per day to classify the study population into some subgroups when they study the effects of smoking [24-32]. Moreover, there also some other forms of independent variables have been used such as duration of smoking cessation [33-38], age at starting smoking [39-41] and tobacco types [14,15,31,42]. Although there already have been plenty of tobacco smoking related reviews, the independent variables used in the studies of tobacco smoking still have not been systematic reviewed. With the development of the technology and the theory, health care can be implemented in many different ways, such as the semantic Web of Things [43] which promotes the secure semantic smart health care [44] and the facial expression recognition [45] which promotes the smart psychological health management. As a results, the health information has been increasingly complicated and then it is important to choose the reasonable variables for analyses.

Herein, this study will review the independent variables used in previous smoking studies. The regular questions to collect the relating independent variables will be summarized. The appropriate regression models as well as their advantages and disadvantages will be listed. This study may help the researchers of tobacco smoking to choose the appropriate independent variables

for their studies. The remaining of this paper is arranged as follows. Section 2, Section 3, Section 4 and Section 5 summarize the studies relating binary variables of smoking, multivariate variables of smoking, smoking amount, and others including duration of smoking cessation, age of starting smoking and tobacco types. Section 6 concludes this study. Section 7 points out some future works.

Questions of Data Collection

In this section, we provide two examples of questionnaire to show the regular questions about smoking, which can be used to collect the data for the independent variables of smoking for analysis. The first example is from the questionnaire of Chinese Health and Nutrition Survey (CHNS), which is a longitudinal survey organized by the Carolina Population Centre at the University of North Carolina at Chapel Hill, USA, and the National Institute of Nutrition and Food Safety at the Chinese Centre for Disease Control and Prevention. Table 1 shows the part of smoking in the questionnaire of CHNS. As shown in Table 1, the researchers can obtain the smoking status including never smoker, current smokers, ex-smokers (questions 1 and 3), smoking amount (cigarettes smoked per day) (question 4), the age of starting smoking (question 2), as well as the duration of smoking cessation (question 5). However, CHNS questionnaire did not provide the definition of smoking. Then, we present another questionnaire of a longitudinal survey which focuses on smoking. This survey is organized by Chinese Center for Disease Control and Prevention. The section of smoking in questionnaire of this survey are shown in Table 2. As shown in Table 2, this questionnaire is more detailed. In addition to smoking status (questions 1 and 2), smoking amount (question 5), age of starting smoking (question 3) and duration of smoking cessation (question 8), we can also have the tobacco types smoked (question 5) and the reason for smoking cessation (question 7).

Table 1: The questions about smoking in CHNS questionnaire.

Number	Question	Answers
1	Have you ever smoked cigarettes (including hand-rolled or device -rolled)	0. never smoked (skip to the next section) 1. yes 2. unknown (skip to the next section)
2	How old were you when you started to smoked? (years)	-
3	Do you still smoke cigarettes now?	0. never smoked (skip to Question 5) 1. yes 2. unknown (skip to Question 5)
4	How many cigarettes do you smoked per day?	- (Skip to the next section)
5	How long ago did you stop smoking? (months)	If unknown, just record -99

Table 2: The questions about smoking in a Chinese longitudinal smoking survey*.

Number	Question	Answers
1	Do you smoke now?	0. no 1. yes If yes, go to Question 3
2	Did you ever smoked before	0. no 1. yes If no, go to next section

3	At about what age did you first start smoking?	-
4	Have you ever habitually smoked factory cigarettes?	0. no 1. yes
4(1)	If so: at about what age did you start?	-
5	About how much tobacco did you usually smoke?	1. Pipe or water pipe (Liang/month) 2. Hand-rolled cigarettes (Liang/month) 3. Cigars (Number/day) 4. Non-filter cigarettes (Number/day) 5. Filter cigarettes (Number/day)
6	Have you ever stopped smoking before	0. No 1. Yes
6(1)	If so: when was it?	1. Less than half-year ago 2. Not less than half-year ago
7	What was your main reason for stopping?	1. Illness 2. Money 3. Family pressure 4. Health education 5. Other
8	How many years have you stopped smoking	-

Note: *Definition of smoking: smoking on most days for at least half a year

Binary Variables of Smoking Status

This section provides a review of studies using the binary variable of smoking status. The binary variable of smoking status usually classifies the study sample in three cases, that is, smokers and never smokers/non-smokers, current smokers and never smokers/non-smokers, or smokers and ex-smokers. Binary variables of smoking status are easy to be obtained. They are the basic information of smoking in a survey questionnaire. Thus, they are most widely used in the smoking-related studies and most of them are basic qualitative analysis, as below.

Smokers versus Never Smokers/Non-Smokers

By separating the volunteers into smokers and never smokers/non-smokers, many researchers studied the relationship between smoking and specific diseases. Amaral et al. improved the method of early diagnosis of smoking-induced respiratory changes using machine learning algorithms [4]. Feldman and Anderson revealed the relationship between the cigarette smoking and mechanisms of susceptibility to infections of the respiratory tract and other organ systems [5]. Ayyagari and Kessler studied the association between smoking and cognitive functioning at older ages according to the evidence from the health and retirement study [6]. Brody et al. studied the effect of cigarette smoking on a marker for neuroinflammation with a [11C] DAA1106 positron emission tomography study [7].

Current Smokers Versus Never smokers/Non-Smokers

Some researches separated the study population into current smokers and never smokers/non-smokers. Yoshida et al. discussed the effects of tiotropium on lung function among current smokers and never smokers with bronchial asthma [8]. Torén et al. founded reference values of fractional excretion of exhaled nitric oxide among non-smokers and current smokers [9].

Current Smokers Versus Ex-Smokers (former Smokers)

Some researchers studied the effects of smoking cessation by grouping the smokers into current smokers and ex-smokers (former smokers). Au et al. studied the effects of smoking cessation on the risk of chronic obstructive pulmonary disease exacerbations [10]. O'Hara et al. provided the evidence for the early and late weight gain following smoking cessation in the lung health study [11]. Campling et al. studied the disparity in age at lung cancer diagnosis between current and former smokers [12]. Mccarthy et al. found the social disparities in unaided quit attempts among daily current and former smokers based on the results from the 2010-2011 tobacco use supplement to the current population survey [13]. Jensen et al. studied the effect of nicotine, silver acetate, and placebo chewing gum on the cessation of smoking and the influence of smoking type and nicotine dependence [14]. Pollak and Mullen presented a study for an exploration of the effects of partner smoking, type of social support, and stress on postpartum smoking in married women who stopped smoking during pregnancy [15]. Higgins et al. studied the effects of cigarette smoking cessation on breastfeeding duration [16].

Multivariate Variables of Smoking Status

This section provides studies review of the multivariate variables of smoking status. The multivariate variables of smoking status usually classify the study samples in three groups which are never smokers/non-smokers, current smokers and ex-smokers/former smokers. The multivariate variables of smoking status are also easy to be collected. In this case, we can further classify the population into more than two groups according to the smoking status. Most of the relating studies are qualitative analysis, as below. Many researchers conducted studies for current smokers, never smokers/non-smokers and ex-smokers/former smokers. Jones et al. studied the disease severity for different populations of

smoking with axial spondyloarthritis according to the results from the Scotland registry for ankylosing spondylitis [17]. Morabia and Wynder discussed the dietary habits of smokers, people who never smoked, and ex-smokers [18]. Yi et al. revealed the probability of developing coronary atherosclerosis among ex-smokers and never smokers from the coronary CT angiography findings based on smoking status [19]. Frank et al. studied the relationship between smoking, respiratory symptoms and likely asthma in young people based on the evidence from postal questionnaire surveys in the Wythenshawe Community Asthma Project [20]. Crispo et al. studied the cumulative risk of lung cancer among current, ex- and never-smokers in European men [21]. Hobbs et al. found that the low incidence of surgery for non-cardiac vascular disease in UK Asians may be explained by a low prevalence of disease [22]. Tanni et al. studied the association between smoking status and tumor necrosis factor-alpha mediated systemic inflammation in COPD patients [23].

Smoking Amount

This section provides studies review of the smoking amount. Smoking amount measures the level of smoking, so it can be used in two ways in the smoking-related studies. The first way is to directly use the smoking amount as a continuous independent variable. The other way is to use the smoking amount to classify the smokers into several groups such as light smokers, moderate smokers and heavy smokers. Smoking amount usually are not easy to be recorded accurately since it is an ambiguous, inconstant variable. In this case, it is recommended to use smoking amount jointly with other independent variables like smoking status. For example, the never smokers can be seen as a reference group when the smokers are classified into light smokers and heavy smokers according to smoking amount to study the effect of smoking on the risks of some specific diseases.

Buechley et al. studied the relationship of amount of cigarette smoking to coronary heart disease mortality rates in men [24]. Robinson et al. conducted a comparative study of the amount of smoke absorbed from low yield cigarettes with both non-invasive and invasive measures [25,26]. Weijenberg et al. discussed the cigarette smoking and KRAS oncogene mutations in sporadic colorectal cancer based on the results from the Netherlands Cohort Study [27]. Mulder et al. studied the effect of smoking and time since quitting on the smoking cessation and quality of life [28]. Glasgow et al. studied the self-help books and amount of therapist contact in smoking cessation programs [29]. Jonh et al. studied the relationship between nicotine dependence and lifetime amount of smoking in a population sample [30]. Hammond revealed the inhalation in relation to type and amount of smoking [31]. Gao et al. proposed a new form of independent variable deduced from the number of cigarettes smoked per day [32].

Other Variables

Except smoking status and smoking amount, there are also some other independent variables that can be used in the tobacco smoking related studies such as the duration of smoking cessation, age of starting smoking, as well as tobacco types. This section provides gives the studies review for these variables.

Duration of Smoking Cessation

The duration of smoking cessation is the time span from the smoking cessation. It is usually used to study the effects of smoking cessation. Au et al. using the duration of smoking cessation studied the effect of smoking cessation on the risk of chronic obstructive pulmonary disease exacerbations [10]. Lapperre studied the relation between duration of smoking cessation and bronchial inflammation in COPD [33]. Nishihara et al. presented a prospective study of duration of smoking cessation and colorectal cancer risk by epigenetics-related tumor classification [34]. Lee et al. discussed the cumulative smoking exposure, duration of smoking cessation, and peripheral arterial disease in middle-aged and older Korean men [35]. Kweon et al. studied the effects of cumulative smoking exposure and duration of smoking cessation on carotid artery structure [36]. Yun et al. revealed the association of smoking status, cumulative smoking, duration of smoking cessation, age of starting smoking and depression in Korean adults [37]. Hazlinda et al. studied the impact of the duration of smoking cessation on hospital admission and health-related quality of life amongst COPD patients [38].

Age of Starting Smoking

The age of starting smoking is usually used to study the long-term impact of smoking on health. Yun et al. studied the association of smoking status, cumulative smoking, duration of smoking cessation, age of starting smoking, age of starting smoking and depression in Korean adults [37]. Sax studied the relationship between age of starting smoking and number of cigarettes smoked in Catalonia, Spain [39]. Zhu et al. presented an analysis of the relationship between cigarette smoking and nasopharyngeal cancer according to age of starting smoking and age of diagnosis [40]. Schneider et al. found the trends and correlates for the average age of smoking onset in Germany [41].

Tobacco Types

The tobacco types are important for smokers since different tobacco types may have different degree of addiction and different influences on health. Natto et al. studied the effects of smoking on periodontal health for different smokers including water pipe smokers, cigarette smokers and mixed smokers. Hammond studied the inhalation in relation to type and amount of smoking [31]. Jensen et al. studied the effect of nicotine, silver acetate, and

placebo chewing gum on the cessation of smoking and the influence of smoking type and nicotine dependence [14]. Pollak and Mullen presented a study for an exploration of the effects of partner smoking, type of social support, and stress on postpartum smoking in married women who stopped smoking during pregnancy [15]. Baldassarre et al. studied the effects of timing and extent of smoking, type of cigarettes, and concomitant risk factors on the association between smoking and subclinical atherosclerosis [42].

Conclusion

This paper presents a review of independent variables of smoking used in smoking-related studies. We classify the independent variables into binary variables of smoking, multivariate variables of smoking, smoking amount and others including duration of smoking cessation, age of starting smoking and tobacco types. Independent variables deduced from smoking status are most widely used in previous studies since the smoking status, such as smoking or not and smoking cessation or not, is easy to be collected accurately. Smoking amount is usually used to distinguish the level of smoking, that is, how heavy are smokers' smoking behaviors.

Current & Future Developments

Although a lot of smoking-related studies have been carried out, more new forms of independent variables of smoking are needed to conduct smoking-related studies as research of smoking go on. In the future, the independent variable of smoking may be developed for two kinds of research: 1). the research about e-cigarettes; and 2). the research of the quantitative effects of smoking.

Conflict of Interest

There is no conflict of interest for this study.

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