Original Article
Smoking cessation protects against COPD in an elderly population

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Abstract: Background: This study hypothesized that smoking cessation, among elderly population, has positive health effects with respect to risks of coronary artery disease (CAD), diabetes, and chronic obstructive pulmonary disease (COPD). To test this hypothesis, current smokers were compared with former smokers. Methods: In this research, 719 elderly current smokers and 349 elderly former smokers were evaluated. Propensity score matching (PSM) was used to reduce confounding bias between the groups. Additionally, logistic regression analysis was performed on matched data to evaluate disease risks. Results: A total of 277 pairs of current and former smokers were matched. Logistic regression analysis demonstrated that, relative to current smokers, former smokers had lower risks of CAD (OR: 0.97, 95% CI: 0.68-1.38), diabetes (OR: 0.85, 95% CI: 0.57-1.26), and COPD (OR: 0.45, 95% CI: 0.30-0.69). However, only the difference for COPD was significant. Conclusion: Smoking cessation may have protective effects against COPD, among elderly people, and this study's findings demonstrate the importance of implementing smoking prevention programs to educate the elderly.

Keywords: Smoking cessation, chronic obstructive pulmonary disease, elderly population, Chinese

Introduction

Tobacco smoking is one of the most serious health problems worldwide [1, 2]. It creates a heavy disease burden. Among men, tobacco smoking is linked to a 50% higher all-cause mortality rate [3]. Previous studies have shown that smoking cessation can reduce risks of cardiovascular disease, respiratory disease and infections, and cancer death. This protective effect has been demonstrated in the United States and several European countries that have promoted national tobacco control projects for nearly 30 years, reducing tobacco-related cardiovascular disease and tumor deaths by nearly 40% [1, 4]. Regarding health strategies that nations can implement, smoking cessation has been identified, by the WHO, as one of the most cost-efficient public health interventions [5]. In China, tobacco smoking produces a great burden as the country is the world's largest tobacco grower and consumer, with 350 million smokers [6, 7]. Furthermore, there is low awareness of the health benefits of

smoking cessation in China [8] and Chinese smokers have many misconceptions regarding smoking cessation [9]. In particular, the elderly believe that long-term smokers cannot suddenly quit smoking, that smoking helps to prevent dementia and improve work efficiency, and that the longevity of many centenarians can be attributed to their smoking habits. Moreover, a few individuals believe that smoking cessation among the elderly can negatively affect health and lead to premature death.

To the best of our knowledge, only a few studies have investigated health effects of smoking cessation among a Chinese population. One cohort study [10] evaluated retired men in Xi'an and demonstrated that, compared with current smokers, former smokers who had quit more than two years ago exhibited 56% and 93% reduction in overall death risk and risk of death from coronary artery disease (CAD), respectively. However, this study did not observe the protective effects of smoking cessation on chronic obstructive pulmonary disease (COPD) and

Table 1. General participant characteristics of the two groups before matching

Characteristics	Current smokers (n=719)	Former smokers (n=349)	P
Age (years)	n (%)		<0.001
60-69	368 (51.2)	101 (28.9)	
70-79	305 (42.4)	200 (57.3)	
≥80	46 (6.4)	48 (13.8)	
Gender			0.152
Male	551 (76.6)	281 (80.5)	
Female	168 (23.4)	68 (19.5)	
Marital status			0.949
Married	617 (85.8)	300 (86.0)	
Single, divorced or widowed	102 (14.2)	49 (14.0)	
Occupation			0.182
White collar	289 (40.2)	120 (34.4)	
Light physical labor	276 (38.4)	145 (41.5)	
Hard physical labor	154 (21.4)	84 (24.1)	
Education level (years)			<0.001
0-6	301 (41.9)	105 (30.1)	
7-12	251 (34.9)	114 (32.7)	
13 or more	167 (23.2)	130 (37.2)	
BMI			0.004
<23.00	199 (27.7)	72 (20.6)	
23.00-24.99	164 (22.8)	67 (19.2)	
≥25.00	356 (49.5)	210 (60.2)	
Alcohol use			<0.001
No	463 (64.4)	160 (45.8)	
Yes	256 (35.6)	189 (54.2)	
Daily physical exercise			<0.001
>3 hours/day	159 (22.1)	63 (18.1)	
1-3 hours/day	380 (52.9)	248 (71.1)	
<1 hours/day	180 (25.0)	38 (10.9)	

ing in the Wanshoulu district. Of the 3,560 participants (1,478 men and 2,082 women), 2,492 people who had never smoked (646 men and 1,846 women) were excluded. The remaining 1,068 participants included 719 current smokers (551 men and 168 women) and 349 former smokers (281 men and 68 women).

Information was collected for variables representing each participant's gender, age, marital status, occupation, education level, alcohol consumption, body mass index (BMI), exercise status, and current disease (CAD, diabetes, and COPD) status.

Measurements

A current smoker was defined as a person who smoked tobacco products, regularly, at the time of the survey. A former smoker was defined as a person who had previously smoked, daily, for at least six months but, at the time of the survey, had not used tobacco products for at least two years [13].

Information on current disease (CAD, diabetes, and COPD) status of participants was collected from their medical records. Statuses were verified by doctors at Chinese PLA General Hospital, utilizing general diagnostic criteria and recommendations of Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases (MONICA) Project [14] and the American Diabetes Association (ADA) [15], as well as standards for diagnosis and care of patients with COPD [16].

Statistical analysis

SPSS version 19.0 was used for data analysis. Significance level for all tests was set at a two-tailed α value of 0.05. Differences in means and proportions were evaluated using Student's t-test and Chi-square test, respectively. Logistic

other chronic diseases. It was limited by the study population and short observation time. Thus, the current study was performed to observe health effects of smoking cessation on three chronic diseases (CAD, diabetes, and COPD), among the elderly. To increase comparability between the two groups (current smokers and former smokers) and to reduce the influence of confounding factors, propensity score matching (PSM) was used [11].

Materials and methods

Study sample

Data from a previous cross-sectional survey [12] was used, containing information describing elderly individuals (≥60 years old) liv-

Table 2. General participant characteristics of the two groups after matching

Characteristics	Current smokers (n=277)	Former smokers (n=277)	P
Age (years)			0.630
60-69	105 (37.9)	97 (35.0)	
70-79	150 (54.2)	161 (58.1)	
≥80	22 (7.9)	19 (6.9)	
Gender			0.277
Male	230 (83.0)	220 (79.4)	
Female	47 (17.0)	57 (20.6)	
Marital status			0.362
Married	247 (89.2)	240 (86.6)	
Single, divorced or widowed	30 (10.8)	37 (13.4)	
Occupation			0.825
White collar	108 (39.0)	101 (36.5)	
Light physical labor	100 (36.1)	105 (37.9)	
Hard physical labor	69 (24.9)	71 (25.6)	
Education level (years)			0.706
0-6	86 (31.0)	93 (33.6)	
7-12	106 (38.3)	97 (35.0)	
13 or more	85 (30.7)	87 (31.4)	
BMI			0.373
<23.00	48 (17.3)	60 (21.7)	
23.00-24.99	71 (25.6)	62 (22.4)	
≥25.00	158 (57.0)	155 (56.0)	
Alcohol use			0.799
No	138 (49.8)	141 (50.9)	
Yes	139 (50.2)	136 (49.1)	
Daily physical exercise			0.164
>3 hours/day	57 (20.6)	45 (16.2)	
1-3 hours/day	176 (63.5)	197 (71.1)	
<1 hours/day	44 (15.9)	35 (12.6)	

each involved participant signed an informed consent form.

Results

A total of 719 current smokers (551 men and 168 women) and 349 former smokers (281 men and 68 women) completed the survey and were introduced into this study. The average number of years since former smokers had quit smoking was 18.05±12.05 years (range 2-59 years). General characteristics (age, gender, marital status, occupation, education level, BMI, alcohol use, and daily physical exercise) are presented in **Table 1**. Compared to current smokers, former smokers were younger, more physically active, more educated, had higher BMIs, and greater alcohol use (P<0.05). Based on PSM, the average number of years since former smokers had quit smoking was 17.86±12.19 years (range 2-59 years).

After PSM, a total of 277 participant pairs were matched. Current smoker and former smoker groups were balanced for age, education level, BMI, alcohol use, and daily physical exercise (**Table 2**).

regression models were used to identify the health effects of smoking cessation.

PSM [17] was used to match current smoker and former smoker groups and was conducted using SPSS 19.0 PSM process extension. Gender, age, marital status, occupation, education level, alcohol use, BMI, and exercise status were included as covariates. We used nearest-neighbor matching to match former smokers to current smokers in a 1:1 ratio with a caliper width of 0.2 [18].

Ethical considerations

The Medical Ethics Committee of the Chinese PLA General Hospital examined and approved this study. Before completing questionnaires,

Using logistic regression, we found that, relative to current smokers, former smokers had lower risks of CAD (OR: 0.97, 95% CI: 0.68-1.38), diabetes (OR: 0.85, 95% CI: 0.57-1.26), and COPD (OR: 0.45, 95% CI: 0.30-0.69). However, only the difference for COPD was significant. After adjusting for age, gender, marital status, occupation, education level, BMI, alcohol use, and daily physical exercise, we found that adjusted ORs were similar and reduced risk of COPD among former smokers, compared to current smokers, was still significant (P<0.001) (**Table 3**).

Table 4 presents associations between years after smoking cessation and risks of CVD, diabetes, and COPD. For patients with at least 10

Table 3. Health effects of smoking cessation on CAD, diabetes, and COPD

		Patients (%)	Crude OR	Adjusted OR1	Adjusted OR2
CAD	Current smokers	92 (33.2)	1	1	1
	Former smokers	90 (32.5)	0.97 (0.68-1.38)	0.84 (0.67-1.38)	0.99 (0.69-1.43)
	P		0.856	0.843	0.974
Diabetes	Current smokers	69 (24.9)	1	1	1
	Former smokers	61 (22.0)	0.85 (0.57-1.26)	0.85 (0.57-1.26)	0.87 (0.58-1.30)
	P		0.423	0.404	0.503
COPD	Current smokers	77 (27.8)	1	1	1
	Former smokers	41 (14.8)	0.45 (0.30-0.69)	0.42 (0.27-0.65)	0.42 (0.27-0.66)
	P		<0.001	<0.001	<0.001

Crude OR: Unadjusted. Adjusted OR1: Adjusted for age, gender, marital status, occupation, and education level. Adjusted OR2: Adjusted for age, gender, marital status, occupation, education level, BMI, alcohol use, and daily physical exercise.

Table 4. Health effects of years after smoking cessation on CAD, diabetes, and COPD

		Patients (%)	Crude OR	Adjusted OR1	Adjusted OR2
CAD	Current smokers	92 (33.2)	1	1	1
	Smoking cessation for <10 years	33 (38.4)	1.25 (0.76-2.07)	1.35 (0.81-2.26)	1.37 (0.81-2.31)
	Smoking cessation for ≥10 years	57 (29.8)	0.86 (0.57-1.27)	0.79 (0.53-1.19)	0.84 (0.55-1.27)
	P		0.501	0.330	0.475
Diabetes	Current smokers	69 (24.9)	1	1	1
	Smoking cessation for <10 years	17 (19.8)	0.74 (0.41-1.35)	0.73 (0.40-1.34)	0.71 (0.39-1.31)
	Smoking cessation for ≥10 years	44 (23.0)	0.90 (0.59-1.39)	0.90 (0.58-1.39)	0.94 (0.60-1.46)
	P		0.594	0.572	0.702
COPD	Current smokers	77 (27.8)	1	1	1
	Smoking cessation for <10 years	10 (11.6)	0.34 (0.17-0.70)	0.32 (0.15-0.67)	0.33 (0.16-0.70)
	Smoking cessation for ≥10 years	31 (16.2)	0.50 (0.32-0.80)	0.45 (0.28-0.74)	0.46 (0.28-0.75)
	P		0.002	0.001	0.001

Crude OR: Unadjusted. Adjusted OR1: Adjusted for age, gender, marital status, occupation, and education level. Adjusted OR2: Adjusted for age, gender, marital status, occupation, education level, BMI, alcohol use, and daily physical exercise.

years after smoking cessation, ORs for CAD, diabetes, and COPD were 0.84 (95% CI: 0.55-1.27), 0.94 (95% CI: 0.60-1.46), and 0.46 (95% CI: 0.28-0.75), respectively, after adjusting for age, gender, marital status, occupation, education level, BMI, alcohol use, and daily physical exercise (**Table 4**).

Discussion

Tobacco smoking is an important and potentially preventable health problem among the elderly. However, to date, few epidemiological studies have focused on the protective health effects of smoking cessation among the elderly. Furthermore, some misconceptions are common among the Chinese elderly population. For example, some believe that long-term smokers cannot suddenly stop smoking and that smoking helps prevent dementia and improve work efficiency. Also, many centenarians are smokers. Thus, this study was performed to observe the health effects of smoking cessation on chronic diseases (CAD, diabetes, and COPD) among elderly Chinese subjects. An estimate of the health effects obtained from simply comparing outcomes among current and former smokers would bias our results, however. Therefore, we used PSM to reduce bias produced by confounding variables of age, gender, marital status, occupation, education level, BMI, alcohol use, and physical training time. The final study sample was composed of 277 matched pairs of current and former smokers.

After matching, any significant protective health effects of smoking cessation against COPD, among elderly Chinese population, were observed. This observation remained after adjusting for confounding factors. A number of stud-

ies have shown that cigarette smoking is an important risk factor for COPD [1, 19, 20] and that smoking cessation can help alleviate symptoms of COPD [21, 22]. Furthermore, many studies have demonstrated that smoking cessation can reduce pathological bronchial epithelial transformations [23], macrophage polarization changes, and inflammatory reactions [24] that can lead to progression of pathophysiological changes in COPD. Thus, physiological evidence shows that smoking cessation can protect against COPD. Additionally, most studies evaluating smoking cessation as an intervention approach were performed in a clinic and considered only COPD patients. Few field studies have evaluated the health effects of smoking cessation on COPD. One field study by Murray et al. found that smoking cessation played a protective role against chronic lung diseases [1]. To the best of our knowledge, this present study is the first to observe health effects of smoking cessation in an elderly community population. These results may reveal that. even in an elderly population, smoking cessation still protects against COPD.

This present study, additionally, showed that former smokers had lower risk of CAD and diabetes than current smokers, but these results were not significant. A previous cohort study found that smoking cessation could reduce CAD deaths by 56%, among retired men [25]. The current study did not observe a significant health effect of smoking cessation on CAD, perhaps due to the small sample size and because some former smokers chose to quit as a result of smoking-related illnesses.

Health effects of smoking cessation on diabetes have not been clearly established. A prior study, conducted in Guangdong Province, demonstrated that incidence of diabetes among former smokers and current smokers was 5.4% and 2.5%, respectively [26]. In a cohort study, an analysis of long-term risk of diabetes after smoking cessation indicated that the highest risk occurred during the first 3 years (hazard ratio, 1.91 [95% CI, 1.19 to 3.05]) and that this risk gradually decreased to 0 within 12 years after smoking cessation [27]. In the current study, no significant health effects of smoking cessation on diabetes were found.

One major limitation of this study, which is inherent to cross-sectional studies, was that a causal relationship between smoking cessation and reduced COPD risk could not be confirmed. Another limitation was that certain former smokers quit smoking due to illness. This phenomenon could have caused an underestimation of the health effects of smoking cessation. The third limitation was that lung function and CO level tests were not used to confirm smoking cessation status. Smoking cessation status, however, was checked face to face or by telephone with relatives living with the participants.

In summary, this present study was the first to examine the health effects of smoking cessation on chronic diseases (CAD, diabetes, and COPD), among an elderly Chinese population. Improved comparability of current and former smokers was ensured using the PSM method. It was found that smoking cessation may have protective effects against COPD, among the elderly. Further cohort studies should be conducted to verify the causal relationship. This study's findings demonstrate the importance of implementing smoking prevention programs to educate the elderly.

Acknowledgements

Disclosure of conflict of interest

None.

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References

[1] US Department of Health and Human Services: The health consequences of smoking-50 years of progress: a report of the surgeon general. In. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.

[2] Watson WL, Conte AJ. Smoking and lung cancer. Cancer 1954; 7: 245-249.

[3] Lam TH. Absolute risk of tobacco deaths: one in two smokers will be killed by smoking: com-

ment on "smoking and all-cause mortality in older people". Arch Intern Med 2012; 172: 845-846.

[4] US Department of Health and Human Services: The health benefits of smoking cessation. In. Rockville, MD: Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 1990.

[5] Cairney P, Studlar DT, Mamudu HM. The WHO framework convention on tobacco control.

[6] Yang Y, Wang JJ, Wang CX, Li Q, Yang GH. Awareness of tobacco-related health hazards among adults in China. Biomed Environ Sci 2010; 23: 437-444.

[7] Yang GH, Ma JM, Liu N, Zhou LN. Smoking and passive smoking in Chinese, 2002. Zhonghua Liu Xing Bing Xue Za Zhi 2005; 26: 77-83.

[8] Yang GH, Qiang LI, Wang CX, Hsia J, Yan Y, Lin X, Jie Y, Zhao LH, Jian Z, Li X. Findings from 2010 global adult tobacco survey: implementation of Mpower policy in China. Biomed Environ Sci 2010; 23: 422-429.

[9] Bai J. On health communication and public health behavior optimization in China. Doctoral thesis. Wuhan, China: Wuhan University; 2012.

[10] Lam TH, He Y, Shi QL, Huang JY, Zhang F, Wan ZH, Sun CS, Li LS. Smoking, quitting, and mortality in a Chinese cohort of retired Men. Ann Epidemiol 2002; 12: 316-320.

[11] Rosenbaum PR, Rubin DB. The central role of the propoensity score in observational studies for causal effects. Biometrika 1983; 70: 41-55.

[12] Yang S, He Y, Liu M, Wang Y, Wu L, Wang J, Zhang D, Zeng J, Jiang B, Li X. Changes in and patterns of smoking exposure in an elderly urban population in Beijing: 2001-2010. PLoS One 2015; 10: e0118500.

[13] World Health Organization: Guidelines for the conduct of tobacco-smoking surveys among health professionals: report of a WHO meeting held in Winnipeg, Canada, 7-9 July 1983 in collaboration with UICC and ACS. In. Geneva: World Health Organization; 1984.

[14] Rosamond WD, Chambless LE, Folsom AR. Survival trends, coronary event rates, and the MONICA project. Monitoring trends and determinants in cardiovascular disease. Lancet 1999; 354: 862.

[15] Janus ED, Wat NM, Lam KS, Cockram CS, Siu ST, Liu LJ, Lam TH. The prevalence of diabetes, association with cardiovascular risk factors and implications of diagnostic criteria (ADA 1997 and WHO 1998) in a 1996 community-based population study in Hong Kong Chinese. Hong Kong Cardiovascular Risk Factor Steering Committee. American Diabetes Association. Diabet Med 2000; 17: 741-745.

[16] Leonardo F, Pauwels RA, Hurd SS. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: gold executive summary updated 2003. COPD 2004; 1: 103-104.

[17] Thoemmes F. Propensity score matching in SPSS. arXiv:1201.6385 2012.

[18] Austin PC. Optimal caliper widths for propensity-score matching when estimating differences in means and differences in proportions in observational studies. Pharm Stat 2011; 10: 150-161.

[19] Mannino DM, Buist AS. Global burden of COPD: risk factors, prevalence, and future trends. Lancet 2007; 370: 765-773.

[20] Lin HH, Murray M, Cohen T, Colijn C, Ezzati M. Effects of smoking and solid-fuel use on COPD, lung cancer, and tuberculosis in China: a time-based, multiple risk factor, modelling study. Lancet 2008; 372: 1473-1483.

[21] George J, Kong DCM, Santamaria NM, Ioannides-Demos LL, Stewart K. Smoking cessation: COPD patients' perspective. J Pharm Pract Res 2006, 36: 107-110.

[22] Jiménez-Ruiz CA, Fagerström KO. Smoking cessation treatment for COPD smokers: the role of pharmacological interventions. Monaldi Arch Chest Dis 2013; 79: 27-32.

[23] Lapperre TS, Sont JK, Schadewijk AV, Gosman MM, Postma DS, Bajema IM, Timens W, Mauad T, Hiemstra PS; Glucold Study Group. Smoking cessation and bronchial epithelial remodelling in COPD: a cross-Sectional Study. Respir Res 2007; 8: 85.

[24] Kunz LI, Lapperre TS, Snoeck-Stroband JB, Budulac SE, Timens W, van Wijngaarden S, Schrumpf JA, Rabe KF, Postma DS, Sterk PJ, Hiemstra PS; Groningen Leiden Universities Corticosteroids in Obstructive Lung Disease Study Group. Smoking status and anti-inflammatory macrophages in bronchoalveolar lavage and induced sputum in COPD. Respir Res 2011; 12: 34.

[25] He Y, Taihing L, Shi Q, Huang J, Zhang F, Wan Z, Li L. A prospective study on smoking, quitting and mortality in a cohort of elderly in Xi'an, China. Zhonghua Liu Xing Bing Xue Za Zhi 2002; 23: 186-189.

[26] Wu CP, Wang SY, Jing C. Study on relationship between smoking cessation and diabetes mellitus. Chin J Public Health 2004; 20: 33-34.

[27] Yeh HC, Duncan BB, Schmidt MI, Wang NY, Brancati FL. Smoking, smoking cessation, and risk for type 2 diabetes mellitus: a cohort study. Ann Intern Med 2010; 152: 10-17.