



Original Article

Smoking behavioral changes and subsequent mortality during a 18-year follow-up in Kinmen, Taiwan

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Abstract

Background: The aim of this study was to examine the changes in smoking behavior over 6 years and to relate these changes to mortality risk during 18 years' follow-up.

Methods: We followed a cohort for 6 years (1991–1997) to assess changes in smoking behavior and then for an additional 12 years (1997–2008) to relate these findings to mortality in 4986 Chinese individuals. Participants were classified as never smokers, long-term quitters, new smokers, new quitters, and continuing smokers. Mortality was ascertained by linkage with the nationwide death registry.

Results: Compared with never smokers, continuing smokers had the highest risk of 1.84 [95% confidence interval (CI): 1.38, 2.45] for all-cause mortality, new quitters had a risk of 1.49 (95% CI: 1.04, 2.15), new smokers had a risk of 1.26 (95% CI: 0.59, 2.68), and long-term quitters had a risk of 1.11 (95% CI: 0.64, 1.91). There was a significant 19% risk reduction in all-cause mortality for new quitters.

Conclusion: Smoking cessation was associated with a significant reduction in mortality risk within approximately 6 years, while no significantly increased risk was observed for long-term quitters.

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Keywords: Chinese; mortality; repeated assessment; smoking; smoking behavior

1. Introduction

It is well-established that smoking is hazardous to human health,¹ and is a major preventable cause of premature deaths. In many developing Asian countries, the awareness of tobacco-related health risks remains low, and smoking is increasing in popularity. In fact, tobacco-related diseases have

become a leading health problem ahead of infectious diseases in many of these Asian countries.² Previous cohort studies on the association between smoking and subsequent mortality in Asian populations^{3–6} have had a methodological limitation because the smoking behavior was only measured at baseline. As a result, changes in smoking behavior during follow-up could result in misclassification bias. Consequently, the results according to smoking behavior at baseline only tend to have sick-quitter bias or survivor bias. This common problem in prior cohort studies can be overcome by repeated assessment of smoking behavior. Our cohort provided an opportunity to examine changes in smoking behavior between 1991 and 1997 and to relate these changes to mortality risk during 1998–2008, with a total follow-up of 18 years.

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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2. Methods

2.1. Study population

The Kinmen Study is a Chinese population survey, which started in 1991. A number of population-based studies have been conducted in Kinmen,^{7–15} and the details of the methods have been reported previously.^{16,17} From 1991 to 1992, a baseline survey was conducted among 11,338 registered residents aged > 30 years in Kinmen, Taiwan. Follow-up interviews were conducted from 1997 to 1998, with a total of 5136 participants successfully re-contacted. Participants whose responses were inconsistent ($n = 124$) and former smokers who resumed smoking at the follow-up interview ($n = 26$) were excluded, leaving a total of 4986 participants included in this study. This study was approved by the Institutional Review Board of National Yang-Ming University, Taipei, Taiwan.

2.2. Smoking and smoking cessation categories

According to the smoking behavior from the baseline and follow-up interviews, participants were divided into five groups: (1) continuing smokers who were smoking at both the 1991 and 1997 interviews; (2) new quitters who were current smokers in 1991 baseline but had quit by the 1997 follow-up interview; (3) new smokers who were nonsmokers at the 1991 baseline but started smoking by the 1997 follow-up interview; (4) long-term quitters who were those who had quit smoking at both the 1991 and 1997 follow-up interviews; and (5) never smokers including those who had never smoked both in 1991 and 1997 interviews.

2.3. Ascertainment of mortality

Deaths were identified through linkage of records with the Taiwan Registry of Deaths. For the current analysis, we updated mortality data up to December 31, 2008.

2.4. Statistical analysis

Multivariable Cox proportional hazard regression models were used to examine the association between the changes in smoking behaviors and the risk of all-cause mortality. The covariates in the model were sex, age, education, body mass index (< 18.5 kg/m², from 18.5 kg/m² to < 24 kg/m², from 24 kg/m² to < 27 kg/m², and ≥ 27 kg/m²), alcohol consumption, dietary patterns (more meat than vegetables, equal amounts of meat and vegetables, and more vegetables), and a history of diabetes mellitus, hypertension, cardiovascular disease, or chronic liver disease during follow-up interview. The interaction between smoking and sex was tested and, as it was not significant, men and women were analyzed together with an adjustment for sex. All the reported p -values are two-sided, and $p < 0.05$ was considered statistically significant. The statistical software SPSS for Windows, version 19.0 (SPSS Inc., Chicago, IL, USA) was used for the analysis.

3. Results

Among the 4986 participants in the analysis, 608 were continuing smokers (12.2%), 349 were new quitters (7.0%), 104 were new smokers (2.1%), 187 were long-term quitters (3.8%), and 3738 were never smokers (75.0%). In relation to all-cause mortality, there was statistical significance for sex, age, education, body mass index, smoking status, and alcohol consumption (Table 1). For morbidity with all-cause mortality, there was the expected statistical significance for diabetes mellitus, hypertension, and cardiovascular disease ($p < 0.001$), but not for chronic liver disease (Table 2). When considering morbidity with the change in smoking status, there was statistical significance for hypertension, cardiovascular disease, and chronic liver disease but not for diabetes mellitus (Table 3). Long-term quitters had the highest rates of diabetes mellitus, hypertension, and cardiovascular disease.

Table 4 showed the adjusted hazard ratio for all-cause mortality. We examined the association between the changes in smoking behavior and mortality, with the inclusion of age, lifestyle factors, and comorbidities as potential confounders. Compared with never smokers, continuing smokers had the highest risk of 1.84 [95% confidence interval (CI): 1.38, 2.45] for all-cause mortality, new quitters had a risk of 1.49 (95% CI: 1.04, 2.15), new smokers had a risk of 1.26 (95% CI: 0.59, 2.68), and long-term quitters had a risk of 1.11 (95% CI: 0.64, 1.91). Compared with continuing smokers, there was a significant 19% [(1.84–1.49) \times 100/1.84] risk reduction in mortality for new quitters, while no significantly increased risk was observed for long-term quitters.

4. Discussion

In this study, we compared all-cause mortality among continuing smokers, new quitters, new smokers, long-term quitters, and never smokers. No significantly increased risk was observed for long-term quitters, and the excess risk decreased to the level of never smokers. There was a significant 19% risk reduction in all-cause mortality for new quitters. Smoking cessation was associated with a significant reduction of mortality risk within approximately 6 years. These results show that the smoking-related mortality risk can diminish upon smoking cessation.

Over the past decade, there have been only seven cohort studies with repeated measures of smoking status, which used different classifications for changes in smoking status.^{18–24} In a large study of 104,519 women aged 30–55 years in the USA, a greater number of years since quitting were associated with a reduction in all-cause mortality.²⁰ A study in the USA with 14,200 participants with a follow-up over 17 years showed that early age at smoking initiation was independently associated with increased cardiovascular risk among all participants, irrespective of race.²² Two studies in Israel²¹ and Scotland²³ that categorized smoking intensity as increased, maintained, reduced, or stopped concluded that reducing cigarette consumption should not be promoted as a means of reducing mortality, although it may have a valuable role as a

Table 1
Characteristics of participants with all-cause mortality.

Variables	Total				Men				Women			
	Total No.	No.	Rate (%)	<i>p</i>	Total No.	No.	Rate (%)	<i>p</i>	Total No.	No.	Rate (%)	<i>p</i>
Gender												
Male	2061	160	7.8	<0.001								
Female	2925	139	4.8									
Age (y)												
30–40	1511	21	1.4	<0.001	486	8	1.6	<0.001	1025	13	1.3	<0.001
40–50	1307	23	1.8		537	12	2.2		770	11	1.4	
50–60	1264	92	7.3		636	56	8.8		628	36	5.7	
60–70	707	106	15.0		310	56	18.1		397	50	12.6	
≥70	197	57	28.9		92	28	30.4		105	29	27.6	
Education												
University	359	10	2.8	<0.001	272	9	3.3	<0.001	87	1	1.1	<0.001
Senior	512	8	1.6		322	8	2.5		190	0	0.0	
Junior	595	21	3.5		324	15	4.6		271	6	2.2	
Elementary	1362	65	4.8		566	48	8.5		796	17	2.1	
Uneducated	2158	195	9.0		577	80	13.9		1581	115	7.3	
BMI (kg/m ²)												
<18.5	224	17	7.6	0.039	71	10	14.1	0.260	153	7	4.6	0.002
18.5–24	2770	149	5.4		1172	87	7.4		1598	62	3.9	
24–27	1317	78	5.9		575	45	7.8		742	33	4.4	
≥27	675	55	8.1		243	18	7.4		432	37	8.6	
Smoking status												
Never smokers	3738	175	4.7	<0.001	917	47	5.1	<0.001	2821	128	4.5	0.033
Long-term quitters	187	14	7.5		167	12	7.2		20	2	10.0	
New smokers	104	7	6.7		76	4	5.3		28	3	10.7	
New quitters	349	36	10.3		314	32	10.2		35	4	11.4	
Continuing smokers	608	67	11.0		587	65	11.1		21	2	9.5	
Drinking												
Yes	917	68	7.4	0.045	832	65	7.8	0.579	85	3	3.5	0.863
Quitted	73	7	9.6		65	7	10.8		8	0	0.0	
No	3996	224	5.6		1164	88	7.6		2832	136	4.8	
Dietary patterns												
More meats	462	33	7.1	0.325	329	27	8.8	0.523	133	6	4.5	0.516
Equal	1937	106	5.5		898	63	7.0		1039	43	4.1	
More vegetables	2587	160	6.2		834	70	8.4		1753	90	5.1	

Table 2
Characteristics of morbidity with all-cause mortality.

Variables	Total				Men				Women			
	Total No.	No.	Rate (%)	<i>p</i>	Total No.	No.	Rate (%)	<i>p</i>	Total No.	No.	Rate (%)	<i>p</i>
Diabetes mellitus												
Yes	75	16	21.3	<0.001	26	5	19.2	0.046	49	11	22.4	<0.001
No	4911	283	5.8		2035	155	7.6		2876	128	4.5	
Hypertension												
Yes	488	69	14.1	<0.001	228	30	13.2	0.002	260	39	15.0	<0.001
No	4498	230	5.1		1833	130	7.1		2665	100	3.8	
Cardiovascular disease												
Yes	207	25	12.1	0.001	72	10	13.9	0.067	135	15	11.1	0.002
No	4779	274	5.7		1989	150	7.5		2790	124	4.4	
Chronic liver disease												
Yes	137	10	7.3	0.466	90	8	8.9	0.685	47	2	4.3	1.000
No	4849	289	6.0		1971	152	7.7		2878	137	4.8	

step toward smoking cessation. A study in Norway with 49,539 participants aged 40–70 years found that continuing smoking strongly increased the risk of death, whereas smoking cessation reduced the risk.¹⁹ None of these studies were conducted in Asian populations or used classifications for changes in smoking status that were similar to the present study.

There have been only two studies with repeated measures of smoking status conducted in Asian populations.^{18,24} A study in Singapore involving 48,255 Chinese participants classified as never-smokers, long-term quitters, new quitters, and current smokers showed that new quitters had a 16% reduction in all-cause mortality, whereas the long-term quitters

Table 3
Morbidity for smoking status.

Variables	Total No.	Diabetes mellitus			Hypertension			CVD			Chronic liver disease		
		No.	Rate (%)	<i>p</i>	No.	Rate (%)	<i>p</i>	No.	Rate (%)	<i>p</i>	No.	Rate (%)	<i>p</i>
Smoking status													
Never smokers	3738	61	1.6	0.648	361	9.7	0.006	166	4.4	0.008	87	2.3	0.007
Long-term quitters	187	3	1.6		32	17.1		13	7.0		8	4.3	
New smokers	104	0	0.0		6	5.8		0	0.0		7	6.7	
New quitters	349	5	1.4		39	11.2		9	2.6		15	4.3	
Continuing smokers	608	6	1.0		50	8.2		19	3.1		20	3.3	

CVD = cardiovascular disease.

Table 4
Cox proportional hazard model for adjusted hazard ratios for all-cause mortality.

Variables	Hazard ratio	95% confidence interval
Age (y)		
30–40	1	
40–50	1.22	0.67–2.20
50–60	4.51	2.79–7.28
60–70	9.33	5.80–15.0
≥70	19.0	11.4–31.6
Hypertension		
Yes	1.73	1.31–2.27
No	1	
Smoking status		
Never smokers	1	
Long-term quitters	1.11	0.64–1.91
New smokers	1.26	0.59–2.68
New quitters	1.49	1.04–2.15
Continuing smokers	1.84	1.38–2.45
Diabetes mellitus		
Yes	2.20	1.32–3.66
No	1	

Model adjusted for gender, education, BMI, alcohol drinking, dietary patterns, cardiovascular disease and chronic liver disease.

had a 39% reduction in all-cause mortality.¹⁸ This study investigated the middle-aged, and elderly people and new smokers were not included. In a study of 1494 Chinese participants in China, new quitters who had stopped smoking for 2–7 years had an 11% reduction in all-cause mortality, and those who had stopped smoking for at least 8 years had a 36% reduction in all-cause mortality.²⁴ That study differed from ours in including fewer participants and focusing on new quitters who recalled the number of years since they ceased smoking.

In the present study, the long-term quitters had the highest prevalence of diabetes mellitus, hypertension, and cardiovascular disease. This was similar to the findings of the Singapore Chinese Health Study.¹⁸ No significantly increased risk was observed for long-term quitters and the excess risk decreased to the level of never smokers. The result was the same as found in other studies, namely that a greater number of years since quitting were associated with a reduction in all-cause mortality.^{18,20} The risk of new smokers did not reach the highest risk of continuing smokers, which could be due to the shorter smoking time. In the Nurses' Health Study, the earlier the current smokers started smoking, the more

hazards they encountered.²⁰ In addition, new quitters had a significant 19% risk reduction in all-cause mortality. In the Singapore Chinese Health study, new quitters had the same 16% reduction in all-cause mortality.¹⁸ In the study of 1494 Chinese participants described earlier, new quitters who had stopped smoking for 2–7 years had an 11% reduction in all-cause mortality.²⁴ Therefore, our findings were consistent with those of these two studies.^{18,24} Smoking cessation is associated with significant reduction of mortality risk within approximately 6 years.

The strengths of this study were the repeated assessments of smoking status and the long-term follow-up in Asian populations, which were genuinely rare in the literature. There were, however, certain limitations. First, the limited number of participants with repeated assessments formed a relatively small sample size that did not allow for additional cause-specific mortality and subgroup analysis. Second, the percentage of the participants who were successfully re-contacted in the follow-up interview was not high, which could lead to selection bias. However, it was not easy to re-contact participants in the real field study after a 6-year time interval. A third limitation was the lack of data on changes in smoking behavior from 1998 to 2008. Fourth, although analyses were adjusted for socio-demographic variables, lifestyles such as dietary patterns and alcohol drinking, and comorbidities such as diabetes mellitus, hypertension, cardiovascular disease, and chronic liver disease, it was the limitation to fully control of physical activity and other smoking-related diseases.

In conclusion, smoking cessation was associated with a significant reduction in mortality risk within approximately 6 years, while no significantly increased risk was observed for long-term quitters. The results show that the smoking-related mortality risk can diminish upon cessation. Hence, smokers should be encouraged to quit smoking as soon as possible.

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