ORIGINAL ARTICLE

Smoking and mortality in 81 344 drivers in Guangzhou, China

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Objectives: Previous studies on drivers focused on the effect of their exposure to vehicle exhaust and there is little evidence of the effect of smoking. This cohort analytical study aimed to examine the mortality of drivers relative to smoking and professional driving in Guangzhou, China.
Methods: Information on demographic characteristics, type of driver (professional and non-professional), smoking, and drinking were retrieved from medical records of drivers who applied for driving licences from March to December 1992. Vital status and causes of death of 81 344 men aged 30 or above were ascertained to the end of September 1999 (follow up, mean=7.14 years, median=7.17 years).
Results: At baseline, the mean (SD) age was 40.8 (5.6) years. One third were professional drivers; 49.0% were daily smokers. 858 Deaths were identified. The relative risk of overall mortality for ever smoking was 1.24 (95% confidence interval (95% CI) 1.07 to 1.44) after adjusting for age, alcohol drinking, education, and type of drivers. Compared with non-professional drivers, professional drivers had similar risks of death, and their relative risk of overall mortality for ever smoking was 1.35 (1.06 to 1.71).
Conclusions: Smoking is a more important cause of death than professional driving itself. The results show serious public health problems in the early stage of the tobacco epidemic and support urgent measures to help drivers stop smoking.

Most reported prospective studies on the health of drivers are focused on a comparison of their mortality pattern with that in the general population.[1 3] Some studies compared a cohort of drivers with another cohort of unskilled male laborers[3] or other employed men.[5] The main aim was to detect whether there was any excess mortality in drivers and if so the results would be interpreted as supportive evidence for the harmful effects of exposure to vehicle exhaust. However, drivers tend to have higher prevalence ratios of smoking than the general population,[1] and the risk estimates from most studies were not adjusted for the individual driver's smoking habit.[3–5] There is little evidence of the effect of smoking on mortality of drivers. The objective of the present study was to examine the mortality of drivers relative to smoking and to compare the mortality of professional drivers with that of non-professional drivers in Guangzhou, China.

METHODS

Guangzhou is the provincial capital of Guangdong Province in the south east part of the People's Republic of China. The Guangzhou Occupational Diseases Prevention and Treatment Centre is responsible for occupational health surveillance of workers. Drivers are required to have an annual medical examination and be certified fit when they apply for or renew a driving licence. The Centre is also responsible for the administration and supervision of the medical examination of drivers.[6]

A standardised record form was designed to abstract information from medical records, including identity number, age, sex, educational level, type of driver (professional and non-professional), smoking, alcohol drinking, and the results of the medical examinations. A daily smoker was defined as one who had smoked at least one cigarette a day for 6 months or more. Occasional smokers were those who smoked less than one cigarette a day, and ex-smokers were those who had stopped smoking for 6 months or more. These three categories were also grouped as ever smokers.

Since 1 March 1992, 13 driver examination stations and three substations were set up. Two main stations and three substations had inadequate record systems and were excluded. The remaining 11 stations were included and these stations covered over three quarters of all the eligible drivers who were Guangzhou residents. The records of all drivers who were examined from 1 March to 31 December 1992 and were aged 30 years or above were retrieved by a team of two trained researchers and the station chief. The data were entered on intelligent character recognition forms, checked, and scanned into the computer. The computer data file was checked again and errors were corrected by referring to the original records. The checked computer data file was sent to the Guangzhou Public Security Bureau Population Information Centre. With the unique identity number in our data file to match with the data files in the Centre, those who had died up to September 1999 were identified by this method. For those who were identified as dead, the causes of death were ascertained from local police stations, public health bureau statistics offices, and funeral homes. Those who were not known to have died were considered to be alive in September 1999. Causes of death were coded according to the ninth revision of the international classification of diseases by two physicians together and checked by an epidemiologist.

Altogether, information on all the 86 404 drivers (81 344 men and 5060 women) were retrieved and entered. As there were few deaths in women, the present report only includes men. The number of person-years was enormous with relatively few deaths occurred during the study period. As the number of person-years was relatively constant over time, a proportional hazards model is in general equivalent to a Poisson regression model with a fixed intercept.[7]

Abbreviations: RR, relative risk

Table 1 Characteristics of drivers in Guangzhou in 1992

	Type of driver					
	Non-professional (n=52974)		Professional (n=28370)		Total (n=81344)	
	n	%	n	%	n	%
Age (y):						
30–39	29265	55.2	16673	58.8	45938	56.5
40–49	19705	37.2	9113	32.1	28818	35.4
50–59	3721	7.0	2425	8.5	6146	7.6
≥60	283	0.5	159	0.6	442	0.5
Education:						
Primary or below	2286	4.3	2340	8.3	4626	5.7
Secondary	40301	76.5	25243	89.7	65544	81.1
Tertiary or above	10095	19.2	554	2.0	10649	13.2
Marital status:						
Married	52491	99.8	28091	99.8	80582	99.8
Alcohol drinking:						
Ever	5824	11.0	3933	13.9	9757	12.0
Smoking habits:						
Never smoker	25022	47.5	11590	41.1	36612	45.2
Ex-smoker	33	0.1	18	0.1	51	0.1
Occasional smoker	2607	4.9	2030	7.2	4637	5.7
Daily smoker	25063	47.5	14572	51.7	39635	49.0
Smoking amount, cigarettes/day:						
Never smoker	25022	50.3	11590	44.6	36612	48.3
≤10	3437	6.9	1857	7.1	5294	7.0
11–19	14214	28.6	7616	29.3	21830	28.8
≥20	7093	14.3	4922	18.9	12015	15.9
Smoking duration (y):						
Never smoker	25022	49.9	11590	44.1	36612	47.9
<10	8178	16.3	4005	15.2	12183	15.9
10–19	12242	24.4	7225	27.5	19467	25.5
≥20	4725	9.4	3454	13.1	8179	10.7

All data were analyzed with SPSS 10.0 and Cox's proportional hazards model was used to calculate the hazard ratio, which estimates relative risk (RR) of mortality for smoking, and type of drivers (professional *v* non-professional) after adjusting for each other, age, educational level, and alcohol drinking.

Ethical approval was obtained from the ethics committee, Faculty of Medicine, The University of Hong Kong.

RESULTS

The total follow up was 580 983 person-years and the mean (SD) duration of follow up was 7.14 (0.34) years; the median duration of follow up was 7.17 years. Up to September 1999, there were 858 deaths, and causes of death were known for 807 deaths (94.1%). The mean (SD) age at baseline was 40.8 (5.6) years.

Table 1 shows that 57% of the drivers were aged 35–39 years, and 35%, 40–49 years. Almost all had secondary education or above. About one third were professional drivers. The prevalence of daily smokers was 49.0% (95% confidence interval (95% CI) 48.6% to 49.3%) (table 1). Among daily smokers, the mean (SD) number of cigarettes smoked daily was 13.6 (6.0), and the mean duration of smoking was 12.4 (7.2) years. About 12% were ever drinkers.

Professional drivers had a higher prevalence of daily smokers than non-professional drivers (51.7% *v* 47.5%), and they tended to smoke more heavily and have a longer duration of smoking. More non-professional drivers had attained tertiary educational level or above than professional drivers (19.2% *v* 2.0%).

Over the total duration of follow up, the crude death rates in ever and never smokers were 16.7 and 12.6/10 000 person-years, respectively and the crude RR (95% CI) for ever smoking was 1.32 (1.15 to 1.52).

Table 2 Adjusted relative risks for selected causes of death by smoking and by type of driver in Guangzhou 1992–99

		All drivers, ever smokers		Professional *v* non-professional	
Causes of death	Deaths n	RR	95% CI	RR	95% CI
All causes	858	1.24	1.07 to 1.44**	1.10	0.95 to 1.27
All cancers	414	1.22	0.99 to 1.50	0.96	0.78 to 1.18
Lung cancer	90	1.41	0.90 to 2.22	0.70	0.44 to 1.13
Respiratory	33	1.22	0.60 to 2.47	0.82	0.40 to 1.70
Vascular	129	1.22	0.83 to 1.79	1.07	0.74 to 1.55
Others	231	1.26	0.95 to 1.67	1.43	1.09 to 1.87*
Injury	50	0.89	0.49 to 1.61	1.49	0.82 to 2.68

*p<0.05; **p<0.01.
RR, relative risks for smoking and type of driver were adjusted for each other, age, alcohol drinking, and education.
Others, causes of death other than malignant neoplasm, respiratory, or vascular.

Table 3 Adjusted relative risks for selected causes of death by smoking amount and duration in drivers in Guangzhou 1992–99

	Cigarettes/day							Duration of smoking (y)						
	1–9		10–19		≥20			<10		10–19		≥20		
Causes of death	RR	95% CI	RR	95% CI	RR	95% CI	p Value for trend	RR	95% CI	RR	95% CI	RR	95% CI	p Value for trend
All causes	1.12	0.83 to 1.52	1.16	0.97 to 1.38	1.45	1.20 to 1.75	0.0003	0.89	0.70 to 1.15	1.36	1.14 to 1.63	1.42	1.16 to 1.74	<0.0001
All cancer	1.17	0.77 to 1.78	1.03	0.80 to 1.33	1.49	1.13 to 1.94	0.02	0.73	0.50 to 1.07	1.37	1.07 to 1.76	1.36	1.01 to 1.82	0.01
Lung cancer	0.75	0.23 to 2.47	0.83	0.45 to 1.55	2.36	1.39 to 4.00	0.01	0.66	0.25 to 1.71	1.55	0.89 to 2.71	1.59	0.88 to 2.84	0.06
Respiratory		—	1.56	0.70 to 3.47	1.58	0.65 to 3.84	0.20	1.11	0.31 to 3.98	1.78	0.76 to 4.19	1.13	0.44 to 2.91	0.48
Vascular	1.35	0.65 to 2.78	1.07	0.67 to 1.70	1.40	0.87 to 2.30	0.25	1.54	0.86 to 2.71	1.03	0.62 to 1.71	1.39	0.85 to 2.27	0.30
Others	1.02	0.56 to 1.88	1.38	1.00 to 1.91	1.22	0.82 to 1.80	0.11	0.86	0.53 to 1.39	1.36	0.96 to 1.92	1.63	1.10 to 2.41	0.01
Injury	0.32	0.04 to 2.41	0.84	0.40 to 1.75	1.25	0.56 to 2.80	0.81	0.66	0.25 to 1.77	0.88	0.41 to 1.88	1.26	0.47 to 3.34	0.93

RR, relative risks adjusted for age, alcohol drinking, education, and type of driver.
Others, causes of death other than malignant neoplasm, respiratory or vascular.

Table 2 shows that professional drivers had similar risks of death due to most causes when compared with non-professional drivers, except for deaths due to other causes for which the RR for professional drivers was 1.43 (1.09 to 1.87). This was partly due to the excess risk of death due to injury (RR=1.49) in professional drivers.

For deaths from all causes combined or overall mortality, the RR (95% CI) from ever smoking was significantly increased 1.24 (1.07 to 1.44), after adjusting for age, alcohol drinking, education, and type of driver. The RRs were greater than unity for all cancers, all respiratory, all vascular, and all other causes (other than cancer, respiratory and vascular) of death but were not significant. The RR for lung cancer was the highest (1.41 (0.90 to 2.22)).

The adjusted RR of overall mortality for ever smoking was 1.35 (1.06 to 1.71) in professional drivers and 1.18 (0.98 to 1.42) in non-professional drivers.

Significant linear trends were found with RRs increasing with amount smoked daily for all causes combined, all cancers, and lung cancer, and with RR increasing with duration of smoking for all causes, all cancers, and other causes (table 3).

DISCUSSION

To the best of our knowledge, this is one of the largest cohort studies on drivers, one third (about 28 000) of whom were professional drivers. The most prominent finding was that the risks of mortality in professional drivers were not higher than those in non-professional drivers after adjusting for smoking. Smoking was found to be associated with a 24% excess risk of overall mortality in this young cohort (mean age of 40.8 years) after a follow up of only 7 years.

Previous prospective studies on professional drivers, which based their standardised mortality ratio on the comparison of the mortality of drivers with those in the general population, showed inconsistent results. An excess of deaths from lung cancer was found by Borgia *et al*[2] in taxi drivers in Rome compared with regional rates but they had difficulty in interpreting the association. However, Rafnsson and Gunnarsdottir[1] found an increased standardised mortality ratio from lung cancer among truck drivers in Reykjavik compared with the Iceland national rates. The authors suggested exposure to engine exhaust gases as the possible cause, but the role of smoking cannot be excluded. Paradis *et al*[3] compared bus drivers with the male population of Montreal and found no excess deaths from lung cancer and a small increase in ischaemic heart disease.

Reference groups, which were presumed to be more comparable with drivers than the general population were also used in a few studies. Alfredsson *et al*[5] compared mortality in male bus drivers with that in other employed men and found no increased relative risk of lung cancer in the bus drivers. However, drivers had an increased incidence of myocardial infarction. Hansen[4] compared mortality of truck drivers and unskilled male labourers and found an increased SMR of lung cancer in drivers. Exposure to diesel exhaust was the alleged cause. It should be noted that all of these studies[1–5] did not have individual smoking data in the cohorts of drivers.[1–5]

Our comparison of professional drivers and other drivers showed that the professional drivers had a lower level of education and a higher prevalence of smoking. After adjusting for these differences, professional drivers did not have a significant excess in overall mortality (RR=1.10) or in specific causes of death when compared with non-professional drivers, except for deaths from other causes (RR=1.43). The excess risks from injury (RR=1.49), although not significant, could be explained by the excess risks from traffic accidents as a result of more driving. We did not have data on the nature of the accidents. As professional drivers had smoked more and for a longer period,

Main messages

- In Guangzhou, China, professional drivers smoked more heavily than non-professional drivers.
- The risks of mortality for professional drivers were similar to those of non-professional drivers after adjusting for smoking.
- Mortality of drivers who smoked was 24% higher than that of never smokers even in early middle age.

Policy implications

- Stopping smoking should be an important strategy in occupational health services for drivers who smoke.
- Stopping smoking in professional drivers may also benefit the passengers by reducing their exposure to passive smoke.

their relative risk for smoking was higher (RR=1.31) than that in non-professional drivers (RR=1.18).

The number of motor vehicles in China has an annual growth of about 15%. The proportion of Guangzhou people owning a driver's license increased from about 1/15 (450 000 / 6 500 000) in 1992 to 1/10 (800 000 / 8 000 000) in 2000. In Guangzhou, vehicular emissions have reached alarming concentrations and constitute more than 40% of the air pollutants—such as carbon monoxide and oxides of nitrogen.[8]

If professional driving is considered as an indicator of exposure to air pollution from vehicle exhaust because of the longer time they spend on the roads, our results strongly suggest that smoking is a much more important health hazard than vehicular air pollution in this group of workers. However, it should be noted that non-professional drivers, mostly motorcyclists, are also exposed, although to a lesser extent, to vehicle exhaust when they drive to work and back to home, and using them as a reference may underestimate any risks in professional drivers. Standardised mortality ratio analysis with the Guangzhou population as a reference is an alternative analytical method but smoking and other lifestyle and demographic factors (such as education) cannot be taken into account. Our previous study on smoking in workers in Guangzhou showed that smoking prevalence increased with occupational exposures but decreased with increasing educational level.[9] Furthermore, many non-drivers in the Guangzhou population are cyclists. Because cycling is slower, cyclists spend more time on the roads than motorcyclists and may be more exposed. Future studies should take into account the type of vehicles usually driven, the duration of driving each day, and the total years of driving.

Our relative risk of overall mortality for smoking was consistent with but slightly higher than that from a Chinese national cohort study of 224 500 men aged 40 or above who were followed up from 1990–1 to January 1996 (RR=1.19 (1.13 to 1.25)).[10] In Guangzhou drivers the population attributable risk was 12%, based on the RR of 1.24 and the prevalence of ever smoking of 54.8%. For professional drivers with an RR of 1.31 and prevalence of 58.9%, the population attributed risk was 15%. As the duration of follow up increases, greater relative risks and more deaths due to smoking would be expected.[11] The scale of the problem as found in the present study reflects only the early stage of the growing tobacco epidemic in China and other developing countries.

Stopping smoking should be an important strategy to promote the health of the drivers in Guangzhou. The present study should provide strong evidence to convince drivers to stop smoking before it is too late. Stopping smoking in professional drivers, particularly drivers of passenger vehicles would also benefit the passengers and prevent the health hazards from exposure to passive smoking.

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