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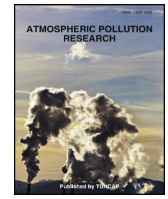

Original Article

Is traffic accident related to air pollution? A case report from an island of Taihu Lake, China

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A R T I C L E I N F O

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A B S T R A C T

Air pollution has negative short- and long-term impacts on humans, particularly in terms of health, mood, cognition, and behavior. Air pollution may affect driving behavior through psychological and physiological pathways and cause the haze to reduce visibility of road. Our objective here is to explore whether daily traffic accident is related to the environmental air pollutant while other factors, including weather and time variables, are controlled. We used particulate matters (PM_{10} and $PM_{2.5}$, which are the two main air pollutants in China) to quantify air pollution. We collected daily traffic accident data of a small island of Taihu Lake, in Suzhou City, China. Four types of count models, namely, Poisson, negative binomial (NB), zero-inflated Poisson, and zero-inflated negative binomial (ZINB) regression were applied to fit data. PM10 and PM2.5 were respectively included in the four count models. The four models revealed a similar result that daily traffic accident was positively related to PM10 and PM2.5. If PM10 and PM2.5 increased from the Chinese Ambient Air Quality Standards-Grade I to Grade II, then traffic accidents increased by nearly 35% and 11.1%.Our results confirmed that daily risk of traffic accident was related to PM (PM10 and PM2.5) and increase the social burden. But the possible psychological and physiological pathways should be further studied.

1. Introduction

Traffic accident on the road is a life-threatening danger to human life and causes direct enormous economic loss. WHO (2018) reported that the total number of road fatalities worldwide has reached 1.35 million per year. Pedestrians, cyclists, and motorcyclists, especially those living in developing countries, bear a disproportionate burden. Traffic accidents are complex events that are mainly caused by human and environmental factors. Many studies have been made to find the relevant factors of road accidents and their impact (Factor et al., 2008; Theofilatos and Yannis, 2014). Some important human factors that lead to traffic accident include incorrect driving behavior, such as speeding, drunk driving, and fatigue. A large number of studies have shown that the incidence of incorrect driving behavior is related to personal characteristics, such as gender, age, and educational background (Miaou and Lum, 1993; Haddon Jr, 1999; Factor et al., 2008; Zhang et al., 2013).

Environmental contributing factors that induce traffic accident incorporate traffic characteristics, such as flow and weather characteristics (e.g., precipitation) (Theofilatos and Yannis, 2014). Wang et al. (2013) applied several classical count outcome and spatial models to explore the effect of traffic congestion on road safety. The results suggested that increased traffic congestion is associated with increased killed and severely injured accidents but has minimal impact on slightly injured accidents. Ceder and Livneh (1978) suggested that the total accident density increases with the increase in the average daily traffic (ADT) after analyzing the relationship between the accident measurement (density and rate) and ADT on intercity sections. Many studies have reported that precipitation is associated with the increase in traffic accidents (Theofilatos et al., 2014). Andrey and Yagar (1993) used the matched sample approach to examine collision accident data, and the results suggested the overall accident risk under rainfall conditions is 70% higher than normal. Eisenberg and Warner (2005) used negative binomial (NB) regressions to study the effects of snowfall on crash counts. The results showed that snow days have fewer fatal crashes than dry days but have more nonfatal-injury and property-damage-only crashes.

Air pollution is a major public health problem worldwide. A large and growing literature reports negative short-term and long-term impacts of air pollution on a wide range of individual outcomes, including health, mood, cognition, and even behavior (Block et al., 2012; Rajper et al., 2018). Epidemiologic studies have reported the associations of

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outdoor air pollution with increased risk of various adverse health outcomes (Pope and Dockery, 2006). Pope Iii et al. (2002) used an extension of the standard Cox proportional hazard survival model to study the health effects of long-term particulate air pollution. The results showed that long-term exposure to combustion-related fine particulate air pollution is an important environmental risk factor of cardiopulmonary and lung cancer mortality. Buxton et al. (2019) stated that exposure to PM_{10} is associated with immunologic responses in the systemic circulation and lower reproductive tract. Air pollution is also a risk factor for healthy people. For instance, Rich et al. (2012) reported that inflammation, blood pressure, and heart rate of 125 healthy young adults are statistically significantly associated with the changes in air pollution levels during the Beijing Olympics.

Previous studies on psychology and economics have documented the relationships between air pollution and observable cognitive impairment and depressed mood (Perera et al., 2006; Freire et al., 2010; Power et al., 2011; Stafford, 2015; Tzivian et al., 2015; Zijlema et al., 2016). Siddique et al. (2011) stated that ambient PM_{10} is positively correlated with attention-deficit hyperactivity disorder in children. Chen et al. (2017) studied the association between cohort living near major roads and the incidence of three neurological diseases. The results suggested that living close to heavy traffic is associated with a high incidence of dementia but not with Parkinson's disease or multiple sclerosis, and $PM_{2.5}$ is associated with dementia and Parkinson's disease. In another study, Power et al. (2011) stated that ambient traffic-related air pollution is associated with cognitive decline after cognitive tests on older men. Ambient air pollution is associated with depressed mood and increased emergency department visits for depression among individuals with cardiovascular and respiratory disease (Cho et al., 2014; Zijlema et al., 2016).

There is no literature that has analyzed the relationship between daily traffic accidents and air pollution from the perspective of environmental factors. Although it seems that air pollution has nothing to do with traffic accidents. But in developing countries where air pollution is a serious problem, the haze caused by air pollution can reduce road visibility, which can make driving difficult. Therefore, we assumed that air pollution, as an environmental factor, increases traffic accidents by reducing visibility. At the same time, air pollution will have a negative impact on drivers' health, cognition and mood, leading to an increase of traffic accidents. Based on above hypotheses, we hypothesized that air pollution would lead to an increase in traffic accidents.

As we mentioned earlier, many factors can lead to traffic accidents. Thus, we need to minimize the influence of unknown factors. The discrete, isolated nature of islands makes them useful units in the fields of ecology, evolution, and biogeography ecological studies (Whittaker and Fernández-Palacios, 2007; Lomolino and H. Brown, 2009). Island biogeography apply islands as a research tool to develop the equilibrium theory of species richness (Weigelt and Kreft, 2013). To assess the relationships between traffic-related air pollutant and daily traffic accident in consideration of time and weather conditions, we chose a small island that is surrounded by Taihu Lake in Suzhou, China. The isolation of the island from the main body of the city can greatly reduce the interference of external human factors and can thus help us better understand whether traffic accident correlates with air pollutant.

2. Methods

2.1. Data collection

Aggregate daily emergency calls of traffic accidents were obtained from the public blogs maintained by the Jinting Police Station in Jinting Town, Suzhou City from November 1, 2014 to August 31, 2017. The database does not cover traffic accident without police reports. For each day, we collected meteorological and air pollution data. The meteorological data regarding weather, temperature, humidity, and wind speed were obtained from website (http://www.tianqihoubao.com/).

Table 1
Number of days when six pollutants exceed the standard.

Air pollutant	Days	Air Quality Standards-Grade I
SO_2	9	50 μg/m^3
NO_2	73	80 μg/m^3
CO	0	4 mg/m^3
O_3	15	100 μg/m^3
PM10	929	50 μg/m^3
PM2.5	833	35 μg/m^3

The data of air pollutants were collected from website (https://www.aqistudy.cn/).

Particulate pollutants currently considered the leading environmental risk factor in China. I counted the date when the air pollutants exceeded the Chinese Ambient Air Quality Standards-Grade I (Table 1). PM2.5 and PM10 exceeded the standard about 3/4 of the days (1281 days in total), while the other four pollutants were basically within the standard range. Therefore, PM10 and PM2.5 were selected as indicators of air pollution in this paper.

In accordance with the traffic police reports, the following time of accidents, meteorological variables, and air pollution index were investigated as independent variables. Time of accidents: 1. Year, 2. Season, 3. Month, 4. Days of week, 5. Work day (work day or off day); Meteorological variables: 6. Weather condition (sunny; cloudy; rainy or snowy), 7. Wind speed (six levels), 8. Average temperature (°C), 9. Humidity (%); Air Pollution variables: 10. $PM_{2.5}$ (μg/m^3), 11. PM_{10} (μg/m^3). Table 3 shows the descriptive statistics of environmental variables.

2.2. Model specification

The variables that were considered in the model were comprehensive and excessive, need to be selected. First, time variables have serious collinearity, such as seasons and months. These collinear variables contain similar information about dependent variables. In the presence of multicollinearity, the estimate of the impact of a variable on the dependent variable Y while controlling the others tended to be less precise than if predictors were uncorrelated with one another. We assessed test of variance inflation factor (VIF) to detect the collinearity of independent variables using the car package in R software. Variables with VIF value less than 5 didn't have obvious collinearity with other variables and are suitable for retention.

Second, the importance weight of variables was obtained through random forest analysis via R software. I also used DPS software to conduct gray correlation analysis. The results (Table 2) show correlation degrees of all variables. Meanwhile, the correlation degrees of time variable were higher than PM2.5 and PM10. Gray correlation analysis showed that air pollution is not the most important variable, but it is also related to traffic accidents.

After the importance weight of collinear independent variables were

Table 2
The Gray Correlative Degrees of affecting factors.

Variable	Factor	Correlative Degrees
categorical variable	WorkDay	0.7577
	Spring	0.6505
	Rain and Snow	0.6631
	Autumn	0.6618
	Winter	0.6608
	Summer	0.6226
Continuous variable	Year	0.6440
	Temperature	0.6159
	PM10	0.5703
	PM2.5	0.5825
	Humidity	0.5930
	Wind speed	0.5547

Table 3
Descriptive statistics of all variables except factor variables.

Variables	N	Mean	St. Dev.	Min	Pctl (25)	Pctl (75)	Max
Average T (°C)	1280	18.137	8.569	−4.5	10.5	25	33.5
Humidity (%)	1280	72.258	12.793	28	64	82	97
PM2.5 (μg/m3)	1280	51.916	30.578	6	29	66	230
PM10 (μg/m3)	1280	75.735	38.589	10	48	95	283
Accidents	1280	0.69	1.021	0	0	1	8

Note: Average T is the average of the highest and lowest temperatures of the day.

compared, important explanatory variables were retained, and secondary or alternative explanatory variables were removed. Next, we applied stepwise regression to eliminate variables that lowered the interpretation of dependent variables. At last, time variables (e.g., month and day of week) and weather variables (e.g., average temperature and wind speed) were removed.

This research aimed to perceive the relationships between air pollutant and daily traffic accident in consideration of time and weather conditions. And whether air pollution has a significant negative impact on traffic accidents. We decided to apply the Multiple Regression Analysis.

The traffic accident was a discrete variable, and most value is 0 and 1. The data structure of the dependent variable conformed to the zero-inflated model in accordance with the zero ratio up to 57% displayed in Fig. 1. At the same time, dependent variable data existed overdispersion that was a common phenomenon in the count of the model. Traditional Poisson and negative binomial regression are the most common choice for discrete data. Zero-inflated models have been applied to capture the apparent “excess” zeros that commonly arise in some study (Lord et al., 2005). In accommodating zero inflation and overdispersion, Poisson, NB, zero-inflated Poisson (ZIP), and zero-inflated NB (ZINB) models were chosen to fit the data of daily traffic accident. The time and weather variables selected by screening were included in each model, and air pollutants (PM10 and PM2.5) were respectively included in the four counting models.

3. Results

The study samples with complete weather and accident data consisted of 328 days in 2014, 344 days in 2015, 360 days in 2016, and 248 days in 2017, with the exception of the days with incomplete data. The daily risk of traffic accident was highest in 2016 (1.132 ± 0.032), followed by those in 2014 (1.036 ± 0.029) and 2017 (0.934 ± 0.026), and was lowest in 2015 (0.799 ± 0.022).

Tables 4 and 5 summarize the results of $PM_{2.5}$ and PM_{10} regressions, respectively, and the four columns in each table show fitted Poisson, NB regression, ZIP, and zero-inflated ZINB regressions. We found that the coefficients of variables in the four count models were similar, but

Fig. 1. Number of daily traffic accidents from November 2014 to August 2017.

Table 4
Four count models for PM_{10} impact on daily traffic accidents.

	POISSON	NB	ZIP	ZINB
Constant	−0.033	−0.127	0.285	0.015
	(0.277)	(0.323)	(0.310)	(0.350)
Year2015	−0.252**	−0.221*	−0.253**	−0.219*
	(0.107)	(0.120)	(0.116)	(0.120)
Year2016	0.371***	0.399***	0.333***	0.388***
	(0.093)	(0.108)	(0.103)	(0.109)
Year2017	0.265**	0.303**	0.189	0.280**
	(0.107)	(0.124)	(0.119)	(0.129)
Work Day (work day)	0.612***	−0.614***	−0.677***	−0.724***
	(0.068)	(0.080)	(0.105)	(0.122)
Season (spring)	0.281***	0.294**	0.287***	0.304***
	(0.102)	(0.117)	(0.111)	(0.117)
Season (summer)	0.114	0.120	0.133	0.129
	(0.104)	(0.119)	(0.113)	(0.118)
Season (winter)	−0.178	−0.170	−0.154	−0.160
	(0.115)	(0.131)	(0.125)	(0.131)
Weather (rainy or snowy)	0.149*	0.157	0.132	0.151
	(0.086)	(0.099)	(0.093)	(0.098)
Weather (sunny)	0.176*	0.182	0.193*	0.191*
	(0.099)	(0.115)	(0.108)	(0.114)
Humidity	−0.007**	−0.006*	−0.006*	−0.006*
	(0.003)	(0.004)	(0.003)	(0.004)
PM10	0.002**	0.003**	0.002**	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	X	X	−1.077***	−1.954***
	X	X	(0.225)	(0.831)
Work Day (workday)	X	X	−0.308	−1.918
	X	X	(0.408)	(5.563)
Observations	1280	1280	1280	1280
Log Likelihood	−1413.576	−1393.006	−1394.374	−1390.890
Akaike Inf. Crit.	2851.152	2810.011	2816.747	2811.780

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

Table 5
Four count models for $PM_{2.5}$ impact on daily traffic accidents.

	POISSON	NB	ZIP	ZINB
Constant	0.101	0.039	0.410	0.189
	(0.258)	(0.299)	(0.286)	(0.321)
Year2015	−0.255**	−0.227*	−0.256**	−0.225*
	(0.107)	(0.120)	(0.116)	(0.120)
Year2016	0.387***	0.411***	0.345***	0.397***
	(0.095)	(0.110)	(0.105)	(0.112)
Year2017	0.265**	0.295**	0.183	0.266**
	(0.108)	(0.125)	(0.119)	(0.129)
Work Day (workday)	−0.614***	−0.615***	−0.678***	−0.722***
	(0.068)	(0.080)	(0.105)	(0.122)
Season (spring)	0.281***	0.296**	0.289***	0.306***
	(0.102)	(0.117)	(0.111)	(0.117)
Season (summer)	0.116	0.122	0.135	0.131
	(0.104)	(0.119)	(0.113)	(0.118)
Season (winter)	−0.220*	−0.208	−0.188	−0.195
	(0.121)	(0.137)	(0.131)	(0.136)
Weather (rainy or snowy)	0.149*	0.157	0.133	0.150
	(0.086)	(0.099)	(0.093)	(0.098)
Weather (sunny)	0.185*	0.192*	0.196*	0.197*
	(0.099)	(0.115)	(0.108)	(0.113)
Humidity	−0.008***	−0.008**	−0.008**	−0.008**
	(0.003)	(0.003)	(0.003)	(0.003)
PM2.5	0.003**	0.003**	0.003*	0.003**
	(0.001)	(0.002)	(0.001)	(0.002)
Constant	X	X	−1.068*	−1.894*
	X	X	(0.224)	(0.796)
WorkDay (workday)	X	X	−0.307	−1.561
	X	X	(0.404)	(3.605)
Observations	1280	1280	1280	1280
Log Likelihood	−1414.061	−1393.549	−1394.680	−1391.423
Akaike Inf. Crit.	2852.121	2811.098	2817.369	2812.846

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

differences between significance of coefficient existed. Given that Poisson models are built in ln(y), we usually treat the coefficients with exponential function (exp), then the regression coefficients can be easily interpreted on the initial scale of the dependent variables (the number of daily traffic accidents).

3.1. Air pollution

The Poisson and ZIP estimates on PM_{10} were smaller in magnitude than the NB and ZINB estimates, although the four estimates were positive and statistically significant in this case. Meanwhile, the coefficient estimates on the $PM_{2.5}$ on each count regressions were the same and significant at 0.01 level. After other variables were controlled, if PM2.5 increased from the Chinese Ambient Air Quality Standards-Grade I (35 μg/m3) to the Grade II(75 μg/m3), then the traffic accidents increased by 11.1%. The regression coefficient of PM10 was 0.003, there were a nearly 35% increase in traffic accident when the Air Quality Standards-Grade I (50 μg/m3) increased to Grade II (150 μg/m3).

We randomly sampled the dataset of PM (PM2.5 and PM10) 200 times. Than sampling results compared with Air Quality Standards-Grade I according to the results of the model, while controlling other variables unchanged, to obtain the probability multiple of the risk of traffic accidents. Fig. 3 was the histogram of the sampling results.

3.2. Time factor

The three rows below the year variable showed the regression coefficient of season, which had four level factors. The regression coefficient of spring was positive and significant at the 5% level. However, the main effect of summer and winter on traffic accident was negative and statistically insignificant. The coefficients of spring were between 1.4 and 1.6, which indicated that the risk of traffic accident in spring was approximately 1.5 times that in autumn after other variables were controlled.

The correlation coefficients of work day were significant at the 1% level, and the discrepancy across all models was small, that is, between −0.6 and −0.73. When other variables were controlled, the expected value of traffic accidents on the work day was 0.5 times that on the off day (holiday and weekend).

3.3. Weather condition and humidity

In weather factor, rain or snow day only had passed the significant test at 0.1 levels in Poisson model. The coefficient of bad weather was positive and indicated that the day on rain or snow day was much more likely to have traffic accident than cloudy day. On the contrary, sunny day had a positive effect on risk of traffic accident and had passed the significant test at 0.1 levels in all models, except the NB regression of PM_{10}.

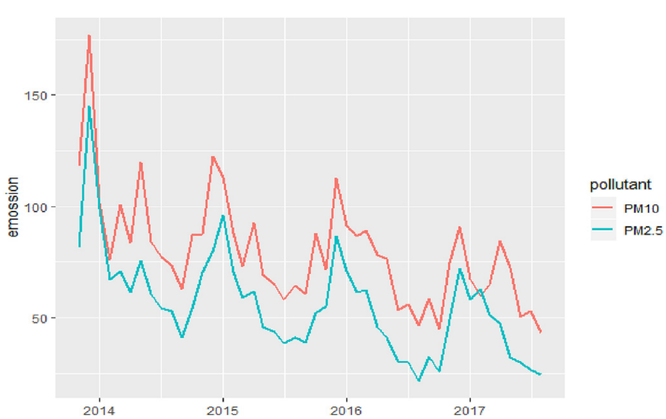

Fig. 2. Monthly emissions of PM_{10} and $PM_{2.5}$ from November 2014 to August 201.

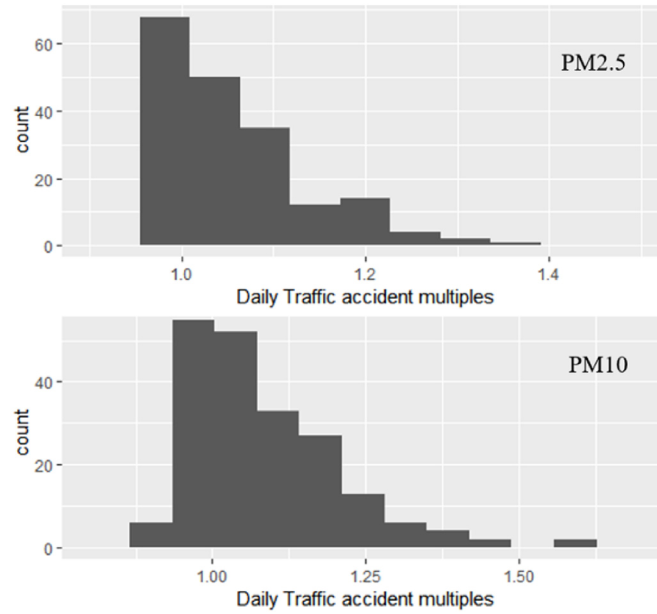

Fig. 3. The risk of traffic accident compared with the Chinese Ambient Air Quality Standards-Grade I.

The coefficient of humidity was negative and significant at 0.05 level in all models of $PM_{2.5}$ but negative and significant at 0.1 level in models of PM_{10}. After other variables were controlled, the risk of traffic accident would be reduced to 0.85 times if humidity increased by 20% according to the coefficient.

4. Discussion

In this exploratory study, all independent variables and traffic accidents were daily data. This study excluded detailed information on traffic accident, such as time and place, collision type, and severity. Meanwhile, the dataset did not provide accurate data about air pollution before and after the accident. Thus, the results could only be interpreted as observable associations; they did not establish causation.

4.1. Air pollution

Our result indicated that daily traffic accidents was positively related to air pollutants (PM_{10} and $PM_{2.5}$) in short term. We briefly discussed the possible negative effects of air pollution on drivers and pedestrian.

A number of epidemiologic studies have reported associations of exposures to outdoor air pollution with increased risk of a wide variety of adverse health effects (Künzli et al., 2000; Pope and Dockery, 2006; Kan et al., 2012), such as cardiopulmonary disease (Pope et al., 2002), respiratory disease (Yao et al., 2019), and mortality (Sarkodie et al., 2019). Heart rate variability, which is a marker of cardiac autonomic function, has been associated with short-term exposures to particulate air pollution in patients (Laumbach et al., 2010), even in young healthy adults (Wu et al., 2010).

Increasingly literature suggest that air pollution may be associated with mental health problems. A number of studies reporting an association between air pollution and increased risk of Attention Deficit Hyperactivity Disorder (ADHD) which involves problems with concentration and impulse control (Aghaei et al., 2019). Drivers with ADHD have a higher risk of being involved in accidents (Barkley et al., 1993) and reckless driving (Vaa, 2014) compared to drivers without

ADHD among young adults.

A transient increase ambient PM is associated with the increased risks of suicide (Kim et al., 2010) and emergency department visits for depression in Korea (Zijlema et al., 2016). Cho et al. (2014) found inconsistent evidence for the association between ambient air pollution and depressed mood from four European general population cohorts. Another US study among women has reported that short-term exposure to fine PM particulate matter (PM2.5) is related to high symptoms of anxiety (Power et al., 2015). Anger and anxiety have been found to linked to unsafe driving behaviors (Bernstein and Calamia, 2019). Driver with emotional distress (e.g., suicidality, ill temper) have higher incidence of aberrant driving behaviors, especially in the elderly (Bernstein et al., 2019).

Recent studies on animals have shown that air pollution can induce neuroinflammation and neurotoxicity, which is linked to cognitive delay and central nervous system disease (Calderón-Garcidueñas et al., 2008; Levesque et al., 2011; Araújo et al., 2019). So far, Considerable research has reported that air pollution adversely effects cognitive function (Power et al., 2011; Gatto et al., 2014), such as delaying neurodevelopment in children (Perera et al., 2006; Freire et al., 2010) and aggravating neurological diseases in the elderly (Chen et al., 2017; Lee et al., 2019). A study on elderly women has demonstrated that exposure to PM is associated with cognitive impairment in the visuospatial domain (Schikowski et al., 2015). Gatto et al. (2014) suggested that increasing exposure to $PM_{2.5}$ is associated with low verbal learning in middle-aged and older adults.

In a short word, air pollution was likely to be an initial factor that negatively affects the physiological, psychological, and cognitive functioning of the driver and might influence the driving behavior and thus leading to traffic accidents. However, this finding did not suffice for a causal conclusion that air pollution induced the daily traffic accidents, further studies exploring possible psychological and physiological pathways are needed.

Ambient fine particulate matter (PM2.5) is considered a major risk factor to the global burden of disease (Butt et al., 2017). PM2.5 exposure is estimated to be associated with 4.2 million deaths and 103 million Disability Adjusted Life Years (DALYs) in 2015 , 59% of these in east and south Asia (Cohen et al., 2017). Our study explores the potential burden of air pollution in addition to the health burden, the result suggests that air pollution may increase road injuries and deaths to some extent. Air pollution can also lead to other potential burdens that increase social management costs, such as crime.

4.2. Other variables

We lacked the data about traffic flow. Thus, we took the time variables of different frames into the models to offset the loss of flow factor. The research site is a tourist island in Suzhou, in which the tourist flow is high in spring, summer, and holidays. Our results showed that the number of traffic accidents on work day was approximately half of that on off day, while the number of traffic accidents in spring and summer were higher than that in autumn and winter. The result was consistent with the study results of Ceder and Livneh (1978), which suggested that the total accident density increased with the increase in ADT.

The simple statistical showed that the frequency of traffic accidents varies from high to low: spring (0.891 ± 1.152)、summer (0.669 ± 1.002)、autumn (0.669 ± 1.002)、winter (0.669 ± 1.002). This is consistent with the results of the models. In China, PM2.5 and PM10 are seasonal, with peak in winter and spring, low in summer (Fig. 2). The seasonality of PM (PM2.5 and PM) is different from that of traffic accidents. The impact of seasons on traffic accidents may be related to traffic volume, as the study site is located at a tourist attraction.

Many studies have suggested that the overall accident risk under rainfall conditions is higher than normal (Theofilatos et al., 2014). Our study showed the same result about the rainfall conditions. However, humidity was negatively correlated with traffic accidents, although the coefficient was small. The reason was that humidity was affected not only by rainfall but also by season and island environment.

4.3. Model robustness and comparison

Considering zero inflation and overdispersion, Poisson and NB regression and zero-inflated versions of each were executed to fit the data. The coefficients and significance of the four counting models are basically the same, which shows the robustness and low sensitivity of the Poisson model, clear the positive correlation between PM (PM2.5 and PM10) with traffic accidents.

We briefly discussed their performance with respective maximum likelihood estimate (MLE) and Akaike information criterion (AIC). The overall goodness of fit of NB regression was better than those of Poisson regression and so do their zero-inflated version. ZINB was the best model to fit the data but had minimal adv antage over NB in terms of MLE. However, ZINB regression might be slightly overfitted compared with NB regression because the AIC value of ZINB regression was slightly larger than that of NB regression. Overall, for the traffic accident dataset of this study, NB regression had a great correction effect on side effects caused by excessive dispersion. Meanwhile, zero inflation model had small correction effect on side effects caused by zero inflation.

5. Conclusions

This study provided evidence for the associations between exposure to PM_{10} and $PM_{2.5}$ and daily traffic accidents while year, holiday, season, humidity, and weather condition were controlled. Increased exposure to air pollutants was associated with increased daily traffic accidents. Further studies are needed to collect accurate information on the severity of the accident and the number of casualties and focus comprehensively on the multiple components of air pollution in consideration of traffic characteristics for adjusting the model. Our study also shows that the adverse impact of air pollution on human is not only a health burden, but also a potential additional burden that needs to be explored in future studies.

Credit author statement

Zhongqiu Li: Conceptualization, Methodology, Investigation, Supervision. **Yue Wan:** Methodology, Software, Writing - Original Draft, Writing - Review & Editing. **Yuhang Li:** Data Curation. **Chunhong Liu:** Data Curation.

Declaration of competing interest

The authors declare no competing financial interests.

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