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(Research Article)

Tobacco smoke studies

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Abstract

Smoking has a negative effect on the health of the smoker, and also has a negative effect on surrounding non-smokers as environmental tobacco smoke. According to estimates by Japan's Ministry of Health, Labor and Welfare in 2016, more than 15, 000 people die annually due to environmental tobacco smoke.

The author looked back on research on tobacco smoke conducted over the past 40 years.

Keywords: Environmental tobacco smoke; Cadmium; lead; Mutagenicity; Benzene; Childhood asthma

1. Introduction

Tobacco smoke is composed of more than 9500 chemical substances [1] in gaseous and particulate form, and contains large amounts of harmful chemicals such as carcinogens. In addition, from the perspective of combustion-derived gases and particulates, they fall into the category of PM2.5, which penetrates deep into the respiratory tract and is considered problematic for its negative health effects. Exhaled smoke and second-hand smoke generated by smoking are emitted into the indoor environment and become environmental tobacco smoke (ETS), resulting in exposure to surrounding people (passive smoke) (Figure 1). The unit risk of cancer associated with lifetime ETS exposure in a single-smoker household is approximately 1×10^{-3} [2]. ETS is a highly carcinogenic substance. According to WHO (1997), indoor air pollution causes approximately 2.8 million deaths annually, of which 9% (250,000) occur in urban areas in developed countries. It is speculated that tobacco smoke contamination in highly airtight building spaces is largely associated with these deaths. According to a 2016 press release from the Ministry of Health, Labor and Welfare's research group, at least 15,000 people die annually in Japan due to second-hand smoke, which is far more than the number of deaths from traffic accidents. The effects of second-hand smoke appear to be serious for office workers who spend most of their days in airtight rooms. Even now, when the smoking rate among indoor workers is well below 30%, the problem of environmental tobacco smoke is an issue that cannot be overlooked. On the other hand, recent international developments regarding chemical risks include the United Nations Environment Program (UNEP) proposing a global action plan aimed at minimizing the negative effects of chemical substances on human health and the environment, and efforts to prevent passive smoking. The United Nations Framework Convention on Tobacco Control has come into force, suggesting a direction for reducing the risk of chemical substances, and there is an urgent need for Japan to take action. Regarding the issue of environmental tobacco smoke in the workplace, the Ministry of Health, Labor and Welfare has indicated that workplaces will be completely smoke-free (partially completely segregated smoking areas) by 2020. On this occasion, the author reflect on the research conducted on tobacco smoke over the past 40 years.

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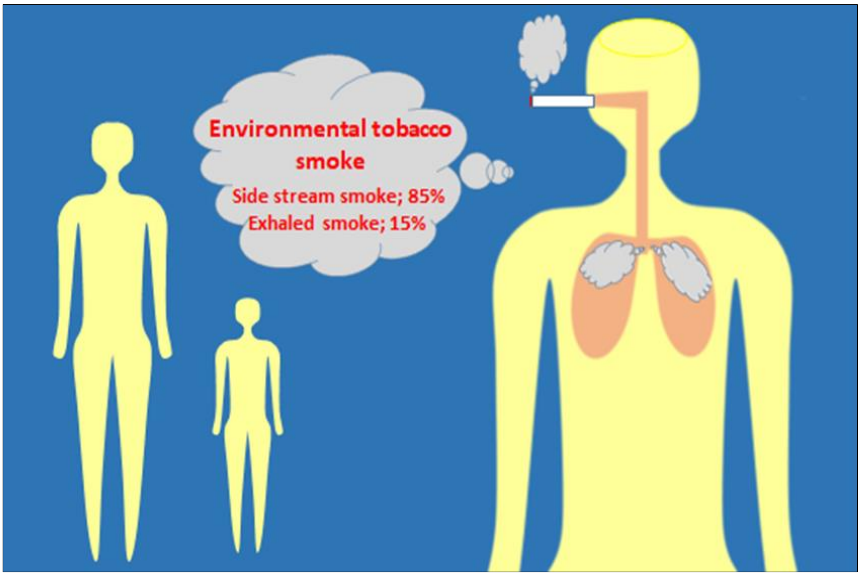


Figure 1 Environmental tobacco smoke

2. Cadmium and lead released from tobacco smoke [5]

A paper published by Hirayama in 1981 first raised the harm of passive smoking [3]. Around this time, the smoking rate among Japanese men exceeded 70%, and smoking was allowed in the office without restriction.

The dust level far exceeded the limits set by the Ordinance on Health Standards in the Office. The authors began their research on environmental tobacco smoke in the late 1980s. First, we focused on cadmium (Cd) and lead (Pb), which are harmful metals contained in cigarette smoke. We established an ultra-sensitive method for measuring Cd/Pb [4] and estimated the amount of Cd/Pb that evaporates when Japanese cigarettes are burned in an artificial smoking device (Figure 2), and measured the amounts of Cd and Pb contained in cigarette smoke. Furthermore, we measured the amounts of Cd and Pb in the blood and urine of male smokers and non-smokers aged 35 to 60 to clarify the actual state of Cd/Pb exposure in active smokers. The authors also investigated the airborne Cd/Pb levels in trains, offices, etc., and revealed Cd/Pb pollution due to smoking [5].

The results are as follows.

- Each of seven Japanese brands of cigarettes contained approximately 1 μg of Cd and Pb. Artificial smoking released approximately 50 ng each of Cd and Pb in mainstream smoke, and 250 ng of Cd and 50 ng of lead in sidestream smoke.
- Blood Cd concentrations in smokers were significantly higher than in non-smokers and were associated with the number of cigarettes smoked daily (Figure 3). Furthermore, blood Cd levels tended to increase with age in smokers and non-smokers (Figure 4). On the other hand, urine Cd concentrations in smokers were slightly higher than in non-smokers (Figure 5).

Blood and urine Pb concentrations did not differ between non-smokers and smokers, but blood Pb concentrations slightly increased with the number of cigarettes smoked daily (Figure 6). .

- In smoky areas such as smoking cars of special express trains, offices, and pachinko parlors, the concentration of Cd in the air was significantly higher than in outdoor air. Airborne Cd concentrations were strongly correlated with environmental cigarette smoke concentrations. On the other hand, in the smoky areas mentioned above, the concentration of lead in the air was slightly higher than outdoors(Figure 7). Airborne Pb concentration was weakly correlated with the environmental tobacco smoke concentration (Figure 6).

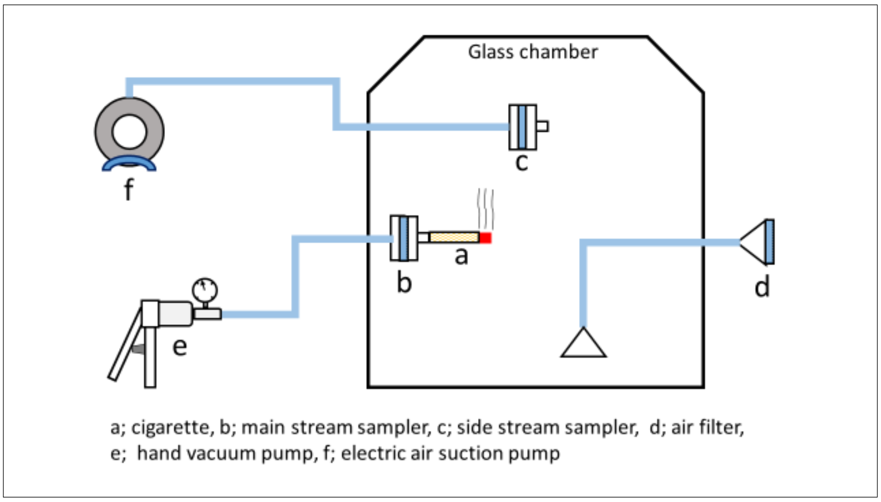


Figure 2 Artificial smoking device

Place a lit cigarette in a glass combustion container. After the first puff was made for 2 seconds using a hand vacuum pump (36 ml/stroke) connected to the main stream sampler, one puff was made every minute. Puffing was performed for 2 seconds each time, and combustion was continued until the combustion length reached 48 mm. The generated mainstream smoke particles are filtered by a glass fiber filter immediately after the cigarette, and side stream smoke particles are filtered by the same type of glass fiber filter at the top of the container. It was collected by suction into a filter using an electric.

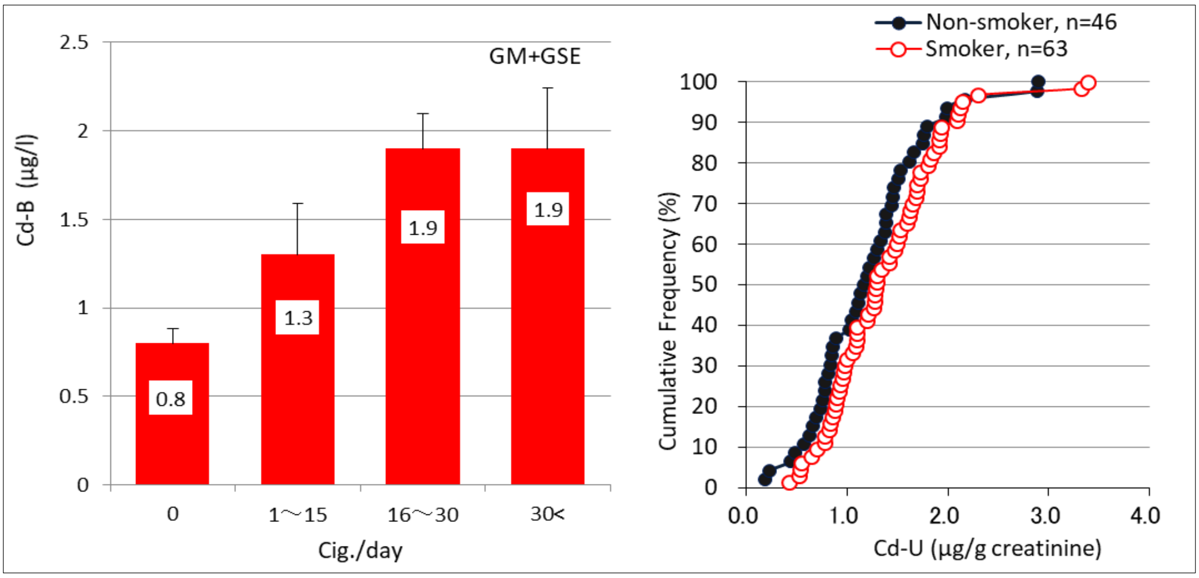


Figure 3 Blood and urine Cd concentrations in smokers and non-smokers

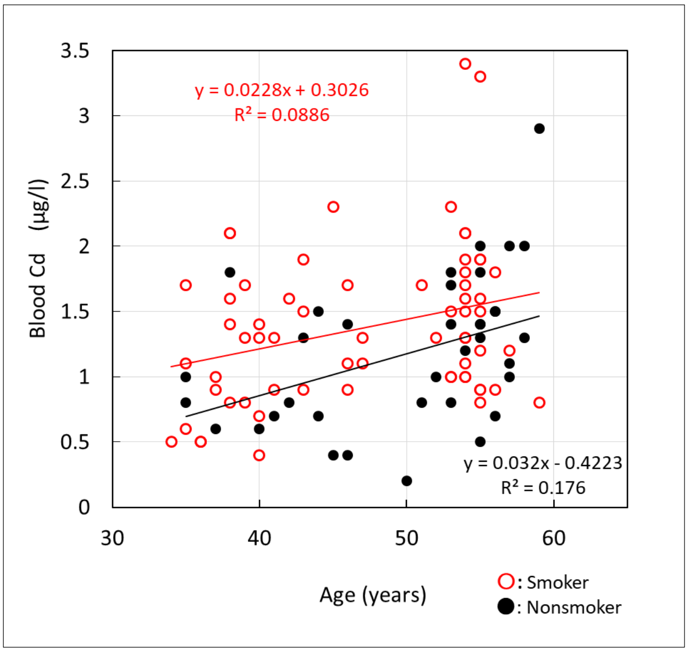


Figure 4 Relation between blood Cd concentrations and age in smokers and non-smokers

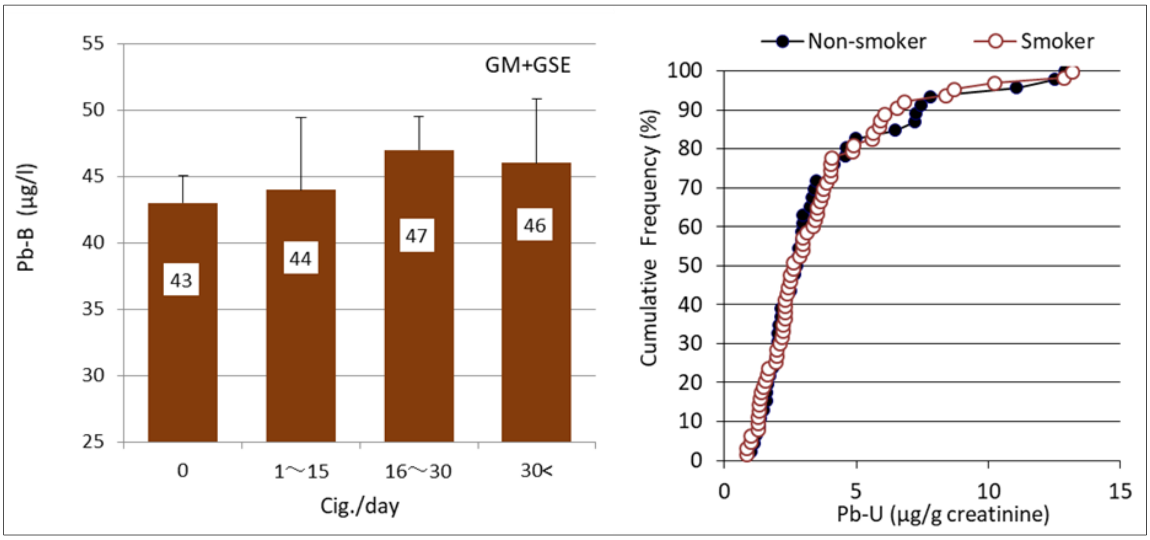


Figure 5 Blood and urine Pb concentrations in smokers and non-smokers

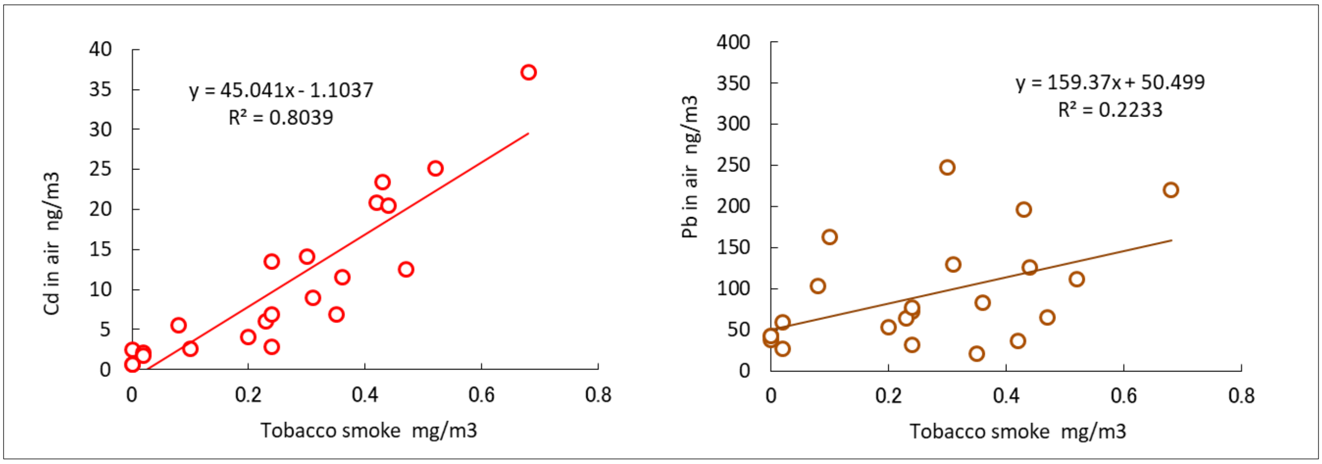


Figure 6 Relation between airborne Cd/Pb and tobacco smoke concentrations in smoky areas

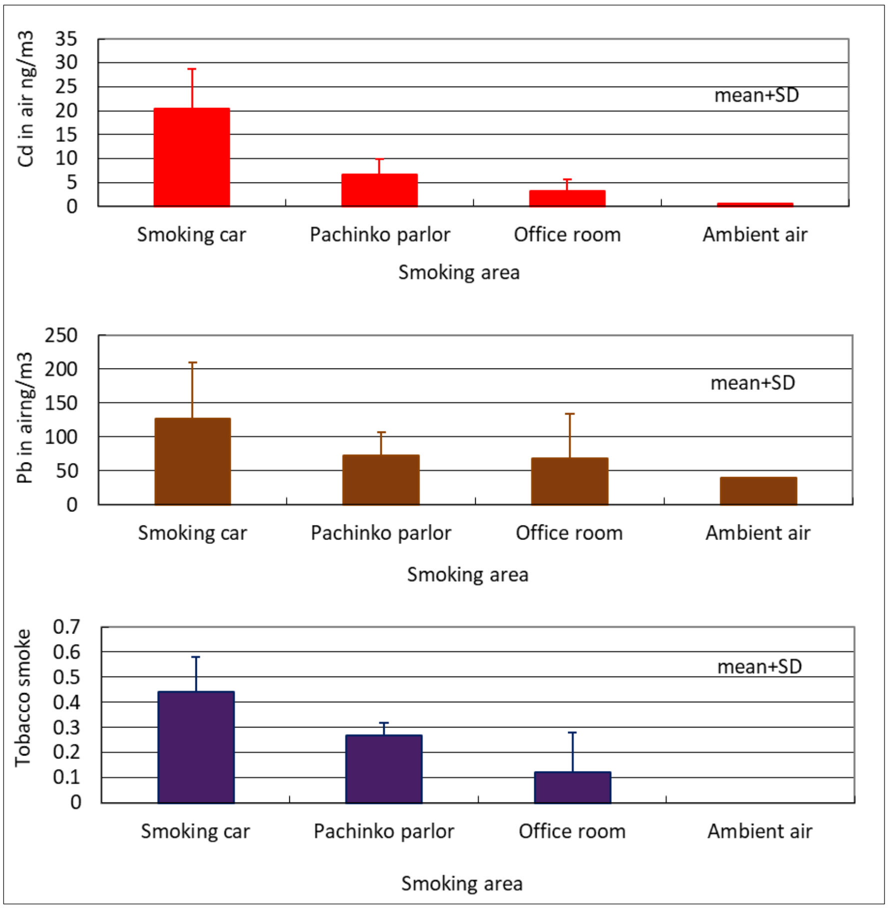


Figure 7 Airborne Cd/Pb and tobaccosmoke concentrations in smoky areas

Tobacco smoke concentrations were measured by Roken filter paper dust sampler with dual-wavelength spectrophotometer [6]

3. Mutagenic activity of tobacco smoke [9]

We also measured the mutagenicity of mainstream and sidestream smoke generated when cigarettes were burned in an artificial smoking device (Figure 2) [7-9]; the mutagenicity of cigarette smoke was significantly enhanced after treatment with liver microsomes; When tobacco is burned in an artificial smoking device, side stream smoke has higher mutagenicity per cigarette than mainstream smoke, and low-tar cigarettes have higher mutagenicity per unit amount of tar (Figure 8, 9).

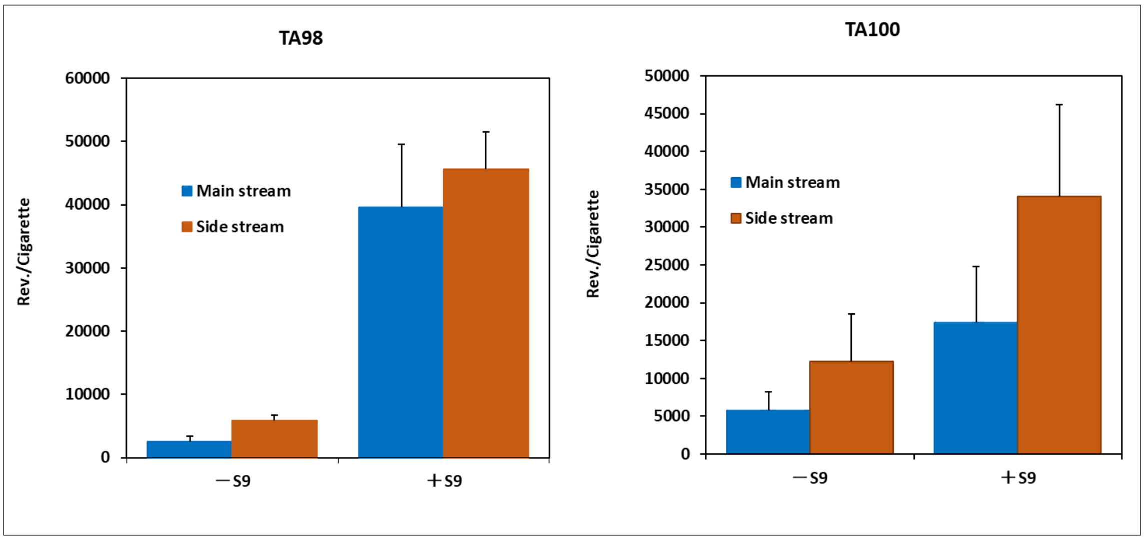


Figure 8 Mutagenicity of smoke from eight Japanese cigarette brands

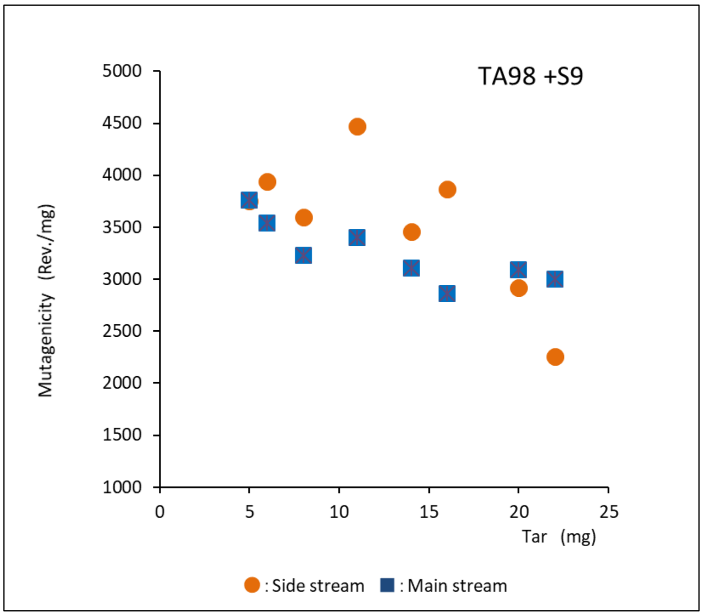
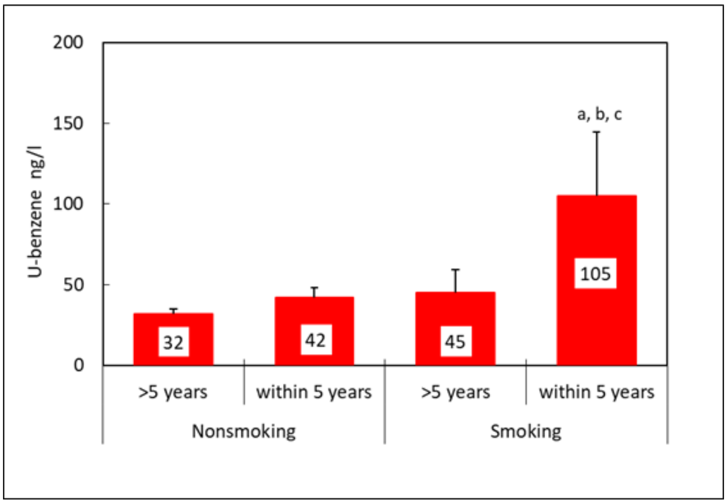


Figure 9 Relation between mutagenicity per unit amount of tar and cigarette tar content

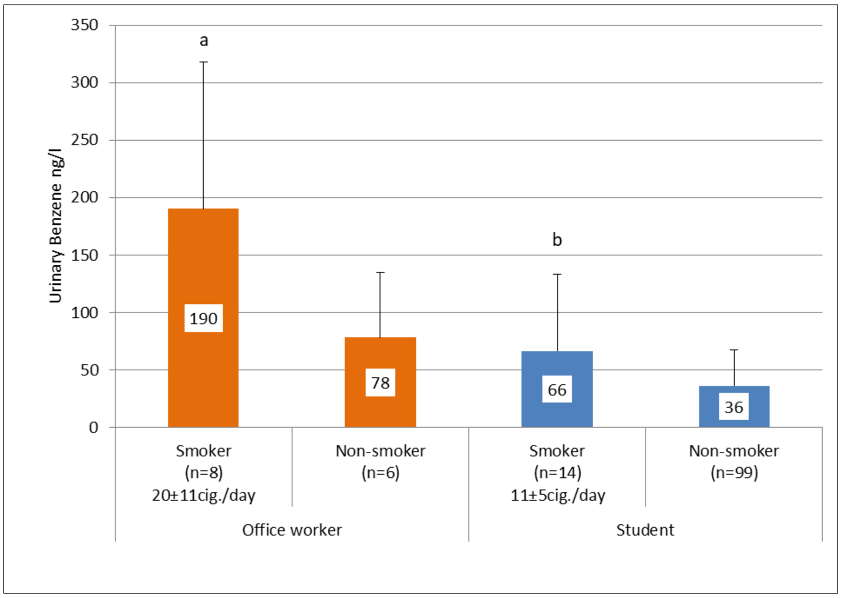
4. Urinary benzene concentration in smokers and non-smokers [10, 11]

With the enforcement of the Health Promotion Act in 2003, prevention of passive smoking in public places was mandated, and standards such as complete smoking ban and separate smoking areas (complete and incomplete) were proposed, and environmental tobacco smoke countermeasures in the workplace began. Around this time, we established an ultra-sensitive method for measuring urinary benzene [10] and measured the urinary benzene levels of university students [11] and office workers [10] at a certain company where no smoking measures had been taken. As a result, urinary benzene levels were higher in smokers than in non-smokers in both groups, suggesting exposure from smoking. In addition, urinary Benzene levels in office workers and non-smokers were as high as those in university student smokers (average number of cigarettes smoked: 11±5 cigarettes), suggesting the possibility of passive smoking in airtight rooms (Figure 11). Furthermore, as a result of examining factors related to Benzene exposure among university students, urinary Benzene levels were significantly higher among smokers living in residences that were built or renovated within five years (Figure 10) , suggesting that factors such as the airtightness of the housing may be related to urinary Benzene levels.



[a] P < 0.05 as compared to smoking-old house group, [b] P < 0.01 as compared to nonsmoking-new house group, [c] P < 0.001 as compared to nonsmoking-old house group, one-way ANOVA followed by Scheffe's test..

Figure 10 Urinary benzene levels in smokers and non-smokers of students live in new house (built or renovated within five years) and old house



[a] P < 0.05 as compared to office non-smoker, [b] P < 0.05 as compared to non-smoke student

Figure 11 Urinary benzene in office worker and university student

5. Tobacco smoke separation in office [12]

Around 2005, corporate offices in Japan began considering completely shielding smoking areas (Figure 12). From 2005 to 2006, the authors investigated the actual state of environmental pollution caused by tobacco smoke in offices with incomplete smoking separation (Figures 13, 14 and 15), and investigated the environmental pollution reduction effect after complete separation of smoking areas. With complete smoke separation (closed ventilation), cigarette smoke particles no longer flow directly into the office and the airborne dust level has been significantly improved and is well below the criteria for determining smoke separation effectiveness (Figure 16). However, elevated airborne dust levels were frequently observed due to the leakage of cigarette smoke particles when entering and exiting the smoking room.

Theoretically, it is possible to prevent cigarette smoke from escaping by significantly increasing ventilation capacity. However, new problems arose, such as the cost of maintaining performance and noise, and it was not considered a realistic solution. This result suggests that there are limits to preventing passive smoking through complete separation of smoking areas.

Figure 12 Incomplete separation of smoking area (a) and completely separating smoking area (b)

Figure 13 Digital dust meters for measuring tobacco smoke

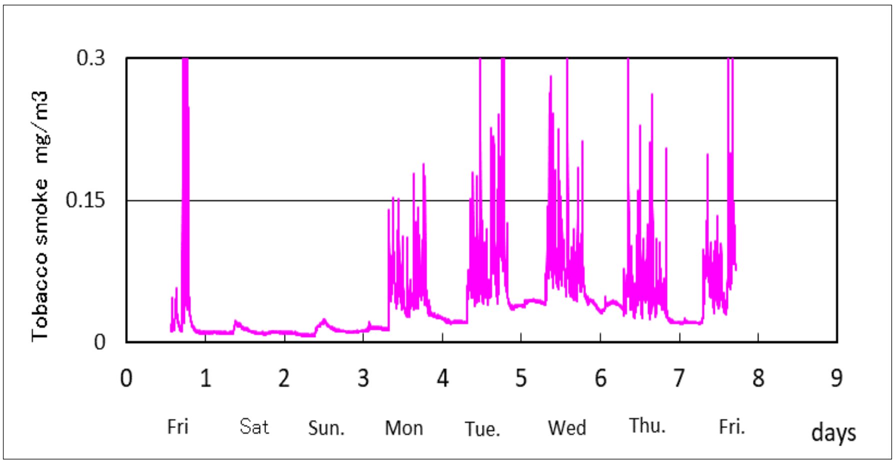


Figure 14 One week trends in tobacco smoke concentration on smoking area boundaries

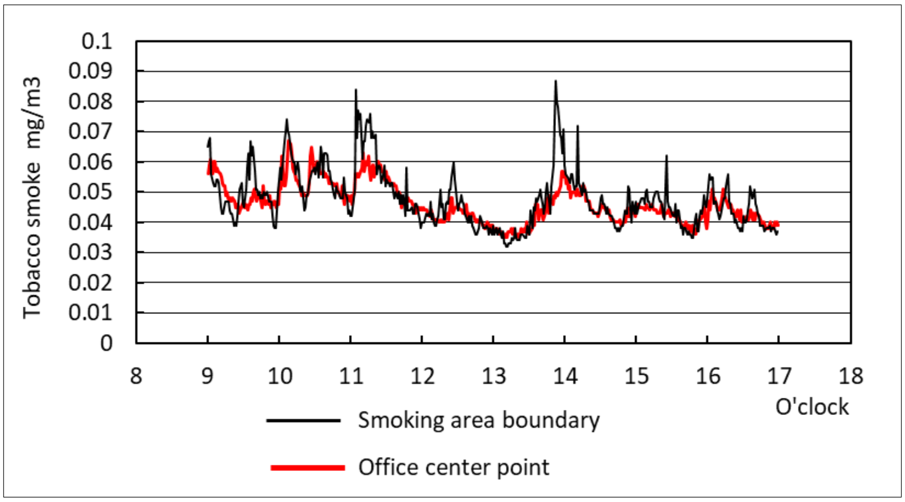


Figure 15 Changes in tobacco smoke concentration at the boundary of the smoking area and in the center of the office room during working hours

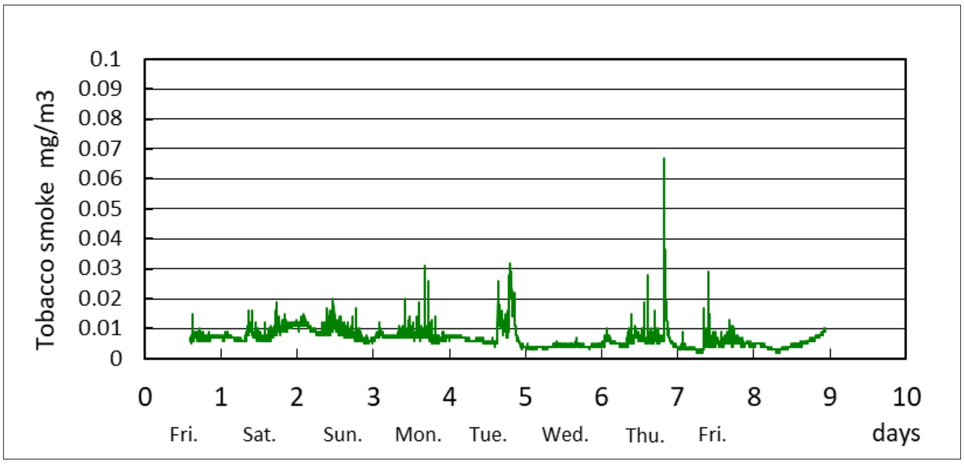


Figure 16 One week trends in tobacco smoke concentration at the exit of the smoking room

6. Pollutants and climatic conditions related to smoking rate [22]

Smoking is considered a coping behavior for stress [13-16]. On the other hand, pollutants and climatic conditions are environmental stressors that can have a negative impact on health [17-19]. Therefore, there may be a link between regional smoking rate and air pollution and climatic conditions.

Since the Japanese archipelago is long from north to south, it belongs to various climate categories, from the subarctic zone in the north to the subtropical zone in the south. In addition, because the Japanese archipelago has mountain ranges with high mountains, there are many cloudy, snowy or rainy days on the Sea of Japan side in winter, while there are many sunny days on the Pacific side [20]. Therefore, there are significant differences in weather depending on the region. Also, climatic differences may affect the formation of photochemical oxidants [21]. To clarify the relationship between the regional smoking rate in Japan and the environmental conditions such as photochemical oxidants concentration, ambient temperature and relative humidity, multiple regression analysis was performed. Correlation analysis showed that the ambient temperature and relative humidity and photochemical oxidants are negatively correlated with smoking rate. Stepwise multiple regression analysis with smoking rate as the objective variable, the ambient temperature and relative humidity and photochemical oxidants as explanatory variables, revealed that the ambient temperature and relative humidity and photochemical oxidants are significant independent variables. The above results suggest that ambient temperature, relative humidity and photochemical oxidants in the region may be related to smoking rate in the region.

7. Pollutants and climatic conditions related to childhood asthma and atopic dermatitis [29]

Indoor, outdoor pollutants and climatic conditions in the growing environment can develop childhood asthma and atopic dermatitis [22-28]. Therefore, it is important to identify the environmental burden of the community on the risk of childhood asthma and atopic dermatitis.

To clarify the relationship between regional prevalence rate of childhood asthma and atopic dermatitis among the first grade elementary school students and preschool indoor and outdoor conditions such as smoking rate, photochemical oxidants concentration, ambient temperature and relative humidity, multiple linear regression analysis was performed.

Stepwise multiple regression analysis with asthma rate as the objective variable, atopic dermatitis rate, smoking rate, photochemical oxidants, ambient temperature and relative humidity as explanatory variables, revealed that atopic dermatitis rate and smoking rate were significant independent variables. This result suggests that tobacco smoke is a risk factor for non-atopic asthma rather than atopic asthma

Stepwise multiple regression analysis with atopic dermatitis rate among first grade elementary school students as the objective variable, smoking rate, photochemical oxidants, ambient temperature and relative humidity as explanatory variables, revealed that photochemical oxidants and ambient temperature were significant independent variable [29].

Present study suggests that preschool indoor and outdoor conditions such as environmental tobacco smoke, photochemical oxidants, and ambient temperature may be associated with the development of childhood asthma and atopic dermatitis.

8. Conclusion

The author looked back on research on tobacco smoke conducted over the past 40 years. Tobacco smoke is one of the substances that humans enjoy most, but it is also the substance that has the most negative impact on human health. Now that 2020 has passed, the smoking rate among Japanese people has fallen well below 30%, and we are moving closer to becoming a smoke-free society. It is the duty of modern people to aim for a society free of tobacco smoke.

The smoking rate in Japan is based on the comprehensive living conditions surveys by the Ministry of Health, Labour and Welfare. The survey is conducted every 3 years. The values were downloaded from the Cancer Information Service of the National Cancer Center. (https://ganjoho.jp/reg_stat/statistics/dl/index.html#smoking).

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest in this work.

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