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Pollutants and climatic conditions related to the smoking rate

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Abstract

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

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.

Keywords: Smoking rate; Photochemical oxidants; Ambient temperature; Relative humidity

1. Introduction

Smoking is considered a coping behavior for stress [1-4]. On the other hand, pollutants and climatic conditions are environmental stressors that can have a negative impact on health [5-7]. 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 [8]. Therefore, there are significant differences in weather depending on the region. Also, climatic differences may affect the formation of photochemical oxidants [9].

This study shows the relationship between smoking rate in Japanese prefectures and photochemical oxidants concentrations and climatic conditions.

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2. Methods

2.1. Smoking rate

The smoking rate in prefectures 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). The smoking rate is the ratio of the total number of people (men and women over 20 years old) who answered "smoking daily" or "sometimes smoked" as a numerator and the "total number of respondents" as a denominator.

2.2. Air pollutants

Annual average photochemical oxidants concentrations in prefectures were obtained from the National Institute for Environmental Studies.

(https://tenbou.nies.go.jp/gis/monitor/?map_mode=jpn_env_atmosphere)

2.3. Climatic conditions

The annual average values of ambient temperature and relative humidity in prefectures were from Social Indicators by Prefecture. The values were downloaded from e-Stat (https://www.e-stat.go.jp/dbview?sid=0000010102). e-Stat is a portal site for Japanese Government Statistics.

2.4. Statistical analysis

Multiple linear regression analysis was performed to determine the relationship between smoking rate and environmental conditions. $p < 0.05$ was considered as statistically significant.

3. Results

3.1. Smoking rate

Table 1 shows the smoking rates of prefectures according to the 2010, 2013, and 2016 comprehensive living conditions surveys.

Table 1 Smoking rate of prefectures according to the 2010, 2013, and 2016 comprehensive living conditions surveys

Prefecture	Smoking (%)			Prefecture	Smoking (%)		
	2010	2013	2016		2010	2013	2016
Hokkaido	24.8	27.6	24.7	Shiga	19.1	19.8	18.7
Aomori	24.7	25.9	23.8	Kyoto	19.1	18.5	17.5
Iwate	22.4	23.4	22.6	Osaka	22.3	22.3	19.9
Miyagi	22.9	24.1	21.0	Hyogo	19.0	19.2	18.9
Akita	22.5	23.5	20.3	Nara	18.2	17.0	17.1
Yamagata	20.6	20.9	19.3	Wakayama	19.3	19.8	18.9
Fukushima	23.0	25.1	22.4	Tottori	19.1	19.7	18.2
Ibaraki	21.4	23.3	21.6	Shimane	17.3	19.7	18.0
Tochigi	22.8	22.7	21.8	Okayama	19.6	19.7	18.8
Gunma	22.8	23.3	22.0	Hiroshima	19.5	20.5	18.1
Saitama	22.7	23.1	20.8	Yamaguchi	18.5	19.8	19.1
Chiba	22.8	21.8	21.1	Tokushima	18.4	18.0	17.4

Tokyo	20.3	20.9	18.3	Kagawa	20.2	19.4	17.4
Kanagawa	22.1	19.8	20.0	Ehime	18.9	18.2	18.0
Niigata	21.0	21.7	20.0	Kochi	19.9	21.9	19.3
Toyama	20.4	19.7	19.5	Fukuoka	22.7	23.6	20.4
Ishikawa	19.8	21.3	19.7	Saga	21.3	23.1	21.7
Fukui	18.7	20.5	19.8	Nagasaki	20.6	22.3	18.9
Yamanashi	21.7	23.3	20.5	Kumamoto	19.7	20.9	-
Nagano	19.7	20.0	19.5	Oita	19.7	21.7	19.1
Gifu	19.5	20.5	17.7	Miyazaki	21.1	21.3	20.0
Shizuoka	20.9	21.7	19.9	Kagoshima	18.4	19.7	17.4
Aichi	21.7	21.2	18.8	Okinawa	20.4	20.6	18.2
Mie	20.3	19.4	17.7	mean (SD)	20.6 (2.0)		

3.2. Air pollutants and climatic conditions

Table 2, 3 and 4 show the ambient temperature, relative humidity and photochemical oxidants of the prefectures in 2010, 2013 and 2016.

Table 2 Annual average values of ambient temperature by prefecture

Prefecture	**Ambient temperature (°C)**			**Prefecture**	**Ambient temperature (°C)**		
	2010	**2013**	**2016**		**2010**	**2013**	**2016**
Hokkaido	9.8	9.2	9.3	Shiga	15.3	15.1	15.8
Aomori	11.1	10.5	11.0	Kyoto	16.4	16.2	17.1
Iwate	11.0	10.6	11.2	Osaka	17.3	17.1	17.7
Miyagi	13.2	12.7	13.5	Hyogo	17.2	17.0	17.8
Akita	12.3	11.9	12.5	Nara	15.4	15.3	16.0
Yamagata	12.5	11.9	12.7	Wakayama	17.1	17.0	17.7
Fukushima	13.8	13.4	14.2	Tottori	15.6	15.5	16.0
Ibaraki	14.5	14.3	14.8	Shimane	15.5	15.4	15.9
Tochigi	14.8	14.4	14.8	Okayama	16.7	16.4	16.6
Gunma	15.5	15.2	15.6	Hiroshima	16.6	16.6	17.2
Saitama	15.8	15.6	15.9	Yamaguchi	16.0	15.8	16.5
Chiba	16.6	16.6	16.8	Tokushima	17.0	16.8	17.6
Tokyo	16.9	17.1	16.4	Kagawa	17.0	16.8	17.5
Kanagawa	16.5	16.6	16.9	Ehime	16.9	16.8	17.6
Niigata	14.4	13.8	14.5	Kochi	17.6	17.3	18.1
Toyama	14.9	14.5	15.2	Fukuoka	17.5	17.7	18.1
Ishikawa	15.1	15.0	15.7	Saga	17.0	17.1	17.9
Fukui	15.0	14.9	15.6	Nagasaki	17.5	17.5	18.1

Yamanashi	15.2	15.4	15.7	Kumamoto	17.4	17.2	18.0
Nagano	12.6	12.3	13.1	Oita	17.0	16.9	17.6
Gifu	16.4	16.3	16.9	Miyazaki	17.7	17.9	18.6
Shizuoka	17.2	17.2	17.6	Kagoshima	18.9	18.9	19.6
Aichi	16.6	16.4	17.0	Okinawa	23.1	23.3	24.1
Mie	16.6	16.5	16.9	mean (SD)	15.9 (2.4)		

Table 3 Annual average values of relative humidity by prefecture

Prefecture	Relative humidity (%)			Prefecture	Relative humidity (%)		
	2010	2013	2016		2010	2013	2016
Hokkaido	69	71	66	Shiga	74	72	73
Aomori	75	-	76	Kyoto	64	64	66
Iwate	74	77	74	Osaka	62	61	65
Miyagi	72	71	68	Hyogo	68	63	65
Akita	74	74	74	Nara	73	72	76
Yamagata	73	74	71	Wakayama	64	66	68
Fukushima	69	69	69	Tottori	72	72	75
Ibaraki	73	72	74	Shimane	74	75	78
Tochigi	71	67	68	Okayama	65	65	72
Gunma	61	60	63	Hiroshima	64	67	65
Saitama	66	63	63	Yamaguchi	70	74	78
Chiba	68	64	67	Tokushima	66	67	71
Tokyo	61	61	69	Kagawa	65	65	69
Kanagawa	67	-	70	Ehime	62	67	70
Niigata	72	73	74	Kochi	70	68	71
Toyama	80	75	72	Fukuoka	65	66	73
Ishikawa	69	70	70	Saga	67	71	73
Fukui	77	74	72	Nagasaki	70	71	75
Yamanashi	65	60	63	Kumamoto	70	70	75
Nagano	73	72	73	Oita	66	69	72
Gifu	64	64	65	Miyazaki	75	73	77
Shizuoka	70	65	69	Kagoshima	71	70	75
Aichi	64	64	65	Okinawa	74	73	74
Mie	67	66	66	mean (SD)	69 (4)		

Table 4 Annual average concentration of photochemical oxidants by prefecture

Prefecture	Photochemical oxidants (ppm)			Prefecture	Photochemical oxidants (ppm)		
	2010	**2013**	**2016**		**2010**	**2013**	**2016**
Hokkaido	0.032	0.029	0.031	Shiga	0.038	0.037	0.036
Aomori	0.032	0.032	0.033	Kyoto	0.036	0.035	0.034
Iwate	0.029	0.030	0.031	Osaka	0.033	0.033	0.033
Miyagi	0.032	0.030	0.033	Hyogo	0.032	0.033	0.033
Akita	0.036	0.036	0.035	Nara	0.032	0.032	0.033
Yamagata	0.032	0.032	0.035	Wakayama	0.033	0.036	0.035
Fukushima	0.034	0.032	0.033	Tottori	0.033	0.035	0.037
Ibaraki	0.035	0.032	0.032	Shimane	0.038	0.040	0.038
Tochigi	0.035	0.032	0.032	Okayama	0.033	0.032	0.032
Gunma	0.036	0.036	0.038	Hiroshima	0.032	0.033	0.034
Saitama	0.034	0.033	0.032	Yamaguchi	0.034	0.035	0.035
Chiba	0.031	0.032	0.032	Tokushima	0.032	0.033	0.038
Tokyo	0.032	0.032	0.031	Kagawa	0.030	0.033	0.036
Kanagawa	0.029	0.032	0.031	Ehime	0.032	0.033	0.033
Niigata	0.037	0.036	0.037	Kochi	0.033	0.033	0.036
Toyama	0.037	0.036	0.038	Fukuoka	0.031	0.032	0.035
Ishikawa	0.037	0.036	0.039	Saga	0.035	0.036	0.036
Fukui	0.035	0.037	0.037	Nagasaki	0.036	0.035	0.036
Yamanashi	0.033	0.032	0.033	Kumamoto	0.034	0.033	0.035
Nagano	0.035	0.034	0.035	Oita	0.032	0.031	0.035
Gifu	0.031	0.033	0.035	Miyazaki	0.029	0.030	0.028
Shizuoka	0.034	0.034	0.034	Kagoshima	0.030	0.031	0.032
Aichi	0.031	0.032	0.033	Okinawa	0.029	0.028	0.031
Mie	0.034	0.035	0.035	mean (SD)	0.034 (0.002)		

3.3. Multiple linear regression analysis

Correlation analysis showed that ambient temperature, relative humidity, and photochemical oxidants were negatively correlated with smoking rate. As shown in Table 5, ambient temperature and relative humidity and photochemical oxidants are significant independent variables by stepwise multiple regression analysis using smoking rate as objective variables, ambient temperature, relative humidity and photochemical oxidants as explanatory variables.

Table 5 Stepwise multiple regression analysis using smoking rate as objective variables, ambient temperature, relative humidity and photochemical oxidants as explanatory variables

Independent variables	Estimated regression coefficient B	95% confidence interval		Partial regression coefficient β	Cumulative R^2	*P*-value
		Lower bound	Upper bound			
Intercept	40.817	34.965	46.668	-	-	0.000
Ambient Temperature	-0.464	-0.580	-0.349	-0.555	0.247	0.000
Photochemical oxidants	-245.696	-356.713	-134.680	-0.304	0.352	0.000
Relative Humidity	-0.067	-0.129	-0.006	-0.154	0.375	0.031

4. Discussion

Colder weather and fewer sunlight hours increase alcohol consumption [10]. This suggests that smoking may also be induced in cold and depressing environments. In addition, the author found that country latitudes significantly correlated with country smoking rates (unpublished, Figure 1) [11, 12]. Climatic conditions such as cold and dry air are environmental stressors that can adversely affect human skin function [13-17]. In contrast, smoking temporarily relieves the stress of the cold. Nicotine administered through tobacco smoke and other delivery systems (eg, patch, nasal spray) produced acute analgesic effects that may be characterized as small to medium in magnitude [18-21]. Low humidity stimulates epidermal DNA synthesis and amplifies the hyperproliferative response to barrier disruption [22]. Smoking stimulates dopaminergic activity in the brain by inducing its release and inhibiting its degradation [23]. Dopamine D2-like receptor agonists accelerate barrier repair and inhibit the epidermal hyperplasia induced by barrier disruption [24]. On the other hand, photochemical oxidants and tobacco smoke are strong oxidative stressors [5, 25]. Combined oxidative stress can have serious adverse effects on smokers [26].

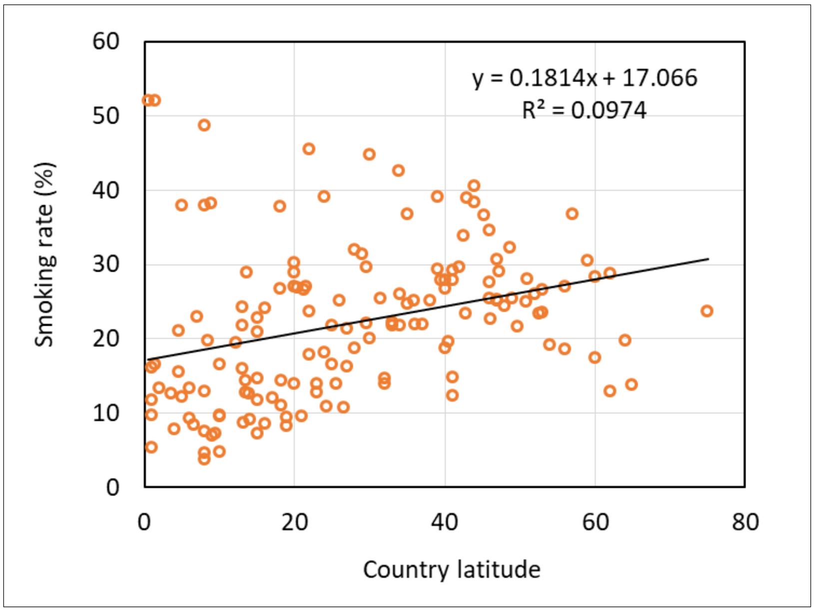

Figure 1 Correlation between latitude and smoking rate of countries in the world in 2018

5. Conclusion

This result suggests that ambient temperature, relative humidity, and photochemical oxidants in the area may be related to smoking rate in the area. However, there is a limitation that the results of regression analysis cannot prove a causal relationship.

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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