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Results of a Prospective Study of Acute Coronary Syndrome Hospitalization After Enactment of a Smoking Ban in Public Places in Hyogo Prefecture

– Comparison With Gifu, a Prefecture Without a Public Smoking Ban –

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Background: Hyogo Prefecture is the 2nd prefecture in Japan, after Kanagawa, to enact a ban with penal code on smoking in public places, although the restriction is partial.

Methods and Results: This study included consecutive patients with acute coronary syndrome (ACS) who were admitted to 33 major hospitals in the Hyogo District during the 12 months before implementation of the legislation and during the 24 months thereafter. Consecutive patients with ACS from Gifu Prefecture who were admitted to 20 major hospitals were enrolled as geographical controls. The number of ACS admissions did not change from the years 2012–2015 in both Hyogo District (1,774 in the pre-year, 1,784 in the 1st year, and 1,720 in the 2nd year) and Gifu Prefecture (1,226 in the pre-year, 1,174 in the 1st year, and 1,206 in the 2nd year). However, a clear reduction was observed in the subanalysis for Kobe City (895 in the preceding year, 830 (–7.3%) in the 1st year, and 792 (–11.5%) in the 2nd year), where adherence to the smoking ban was higher than in other Hyogo districts.

Conclusions: The primary endpoint did not show a significant change. However, the subanalysis showed a significant decrease in ACS admissions in Kobe City. These results suggest that ACS reduction may depend on the degree of adherence to a smoking ban. (*Circ J* 2016; **80:** 2528–2532)

Key Words: Acute coronary syndrome; Coronary artery disease; Epidemiology; Smoking

According to the World Health Organization (WHO) and the Japanese Ministry of Health, Labour and Welfare, secondhand smoke (SHS) kills 0.6 million people annually worldwide (15 thousand people in Japan) while active smoking kills 5.4 million people (130 thousand people in Japan).[1,2] Epidemiological studies have shown that exposure to secondhand smoke has adverse effects on cardiovascular health. In 2002, a legislative ban with a penal code on smoking in public places was enacted in the city of Helena (Montana State) in the USA. The mean number of patients with acute coronary syndrome (ACS) admitted to St. Peter's Community Hospital decreased by 40%.[3] Since then, evidence has emerged and meta-analyses have shown that the enactment of legislation that imposes a smoking ban in public places reduces the incidence of coronary events by 8–17%.[4–6] Smoke-free legislation ranges from partial bans, where smoking is allowed in some public places (eg, bars and/or restaurants), to comprehensive smoking bans, where smoking is banned in all public

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Members of the Smoking ban in public places in HYOgo prefecture: comparison to GIfu (SHYOGI) study are listed in the Appendix.

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Table 1. Patients Demographics

	Hyogo			Gifu		
	Pre (n=1,774)	1 st year (n=1,784)	2nd year (n=1,720)	Pre (n=1,226)	1 st year (n=1,174)	2nd year (n=1,206)
Age (years)	70.3±12.3	70.6±12.1	70.5±11.8	69.1±11.8	70.0±12.2	69.1±12.6
Male (%)	1,313 (74.0)	1,292 (72.4)	1,271* (73.9)	903 (73.7)	853 (72.7)	897 (74.4)
Female (%)	461 (26.0)	492 (27.6)	448 (26.0)	323 (26.3)	321 (27.3)	309 (25.6)
Current smoker (%)	578 (32.6)	552 (30.9)	550 (32.0)	406 (33.1)	389 (33.1)	411 (34.1)
HT (%)	1,202 (67.8)	1,247 (69.9)	1,181 (68.7)	844 (68.8)	792 (67.5)	812 (67.3)
DM (%)	629 (35.5)	643 (36.0)	633 (36.8)	446 (36.4)	396 (33.7)	440 (36.5)
ACS history (%)	266 (15.0)	282 (15.8)	248 (14.4)	179 (14.6)	166 (14.1)	158 (13.1)

*Missing information on sex of 1 subject. ACS, acute coronary syndrome; DM, diabetic mellitus; HT, hypertension.

places and workplaces. The reduction in ACS admissions is less or absent in locations with only partial restrictions compared with those that implemented comprehensive legislation.[4–6] However, data from Japan are lacking.

Editorial p2432

Hyogo Prefecture, with a population of approximately 5.58 million was the 7th most populous prefecture in Japan as of October 2011. The Kobe-Hanshin-Awaji (Kobe: Kobe City; Hanshin: Nishinomiya City, Ashiya City, Takarazuka City, Itami City, Kawanishi City and Amagasaki City; Awaji: Awaji City, Sumoto City, and Minamiawaji City) (Hyogo District) is populated by approximately 3.27 million people, accounting for 58% of the population of Hyogo Prefecture. Gifu Prefecture, where smoking ban legislation was not enacted, is the 17th most populous prefecture in Japan with approximately 2.07 million people. Hyogo is the second prefecture in Japan, after Kanagawa, to ban and penalize smoking in public places, although the smoking ban is partial in the restricted areas and separation smoking is permitted (incomplete ban). The aim of this study was to evaluate the changes in the numbers of ACS cases treated in major hospitals in Hyogo District of Hyogo Prefecture from before to after enactment of the smoking ban.

Methods

Study Design

The protocol used in the study has been reported previously.[7] The "Hyogo Prefectural Ordinance on Prevention of Exposure to Secondhand Smoke," adopted in March 2012 and enforced in April 2013 aims to "prevent negative health impacts due to secondhand smoke by promoting smoke-free environments." This smoking ban is briefly summarized as follows.

- Target facilities: All facilities in public spaces used by the public and a large number of people.
- Restriction by enforcing the penal code. Schools: Completely nonsmoking within the premises including the building; Hospitals, governments, and municipal offices: Completely nonsmoking in the building; Other public facilities such as restaurants, drug stores, banks, buildings in parks, hotels, cinemas, and public transport facilities: separate areas for smokers and nonsmokers such as smoking rooms.
- Restriction via work obligation but not the penal code: Bars, taverns, pachinko parlors, etc.

This study included consecutive patients with ACS from Hyogo Prefecture who were admitted to cardiology units in the 33 major hospitals (all major hospitals of the Japanese Circulation Society: http://www.j-circ.or.jp/cgi-bin/senmoni/sisetu_ken.cgi) in Hyogo District (listed in Appendix S1) during the 12 months before the implementation of the legislation (April 2012 through March 2013) and during the subsequent 24 months (April 2013 through March 2015). Consecutive patients with ACS from Gifu Prefecture who were treated in the cardiology units of the major hospitals in Gifu Prefecture (listed in Appendix S1) were enrolled as geographical controls. The primary endpoint of the study was the change in the

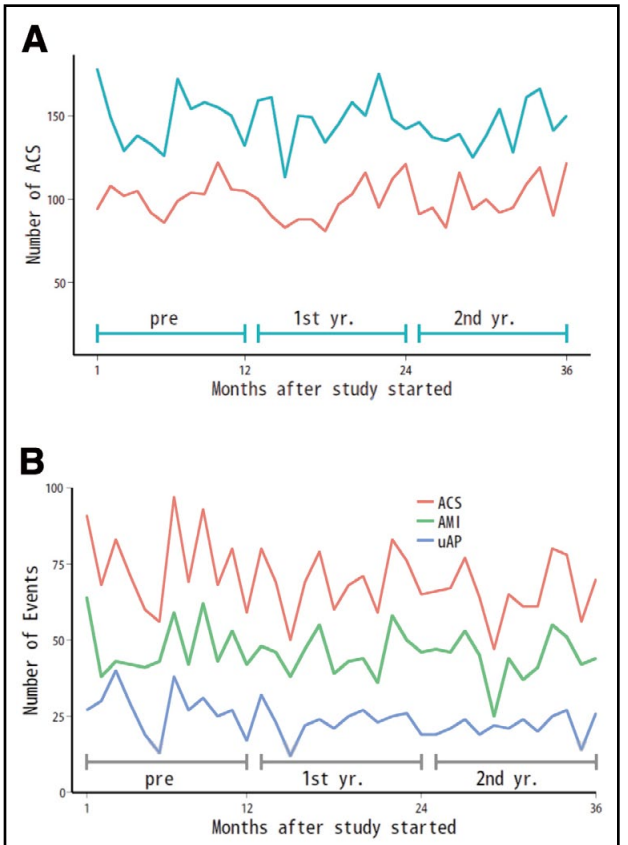

Figure 1. (A) Change in the number of ACS cases in Kobe-Hanshin-Awaji district (blue line) and Gifu Prefecture (red line). The decrease in ACS cases was not seen in either district from April 2012 to March 2015. (B) Change in the number of ACS cases in Kobe City. The decrease in ACS (both acute myocardial infarction (AMI) and unstable angina (uAP)) was seen from April 2012 to March 2015.

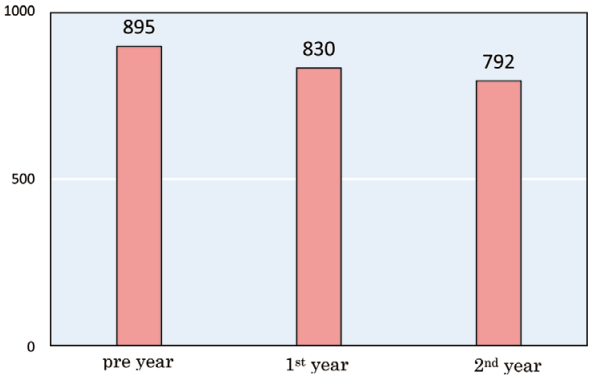

Figure 2. Change in the number of ACS cases in Kobe City.

number of ACS admissions in Hyogo District from April 2012 through March 2015, considering the periods before and after the implementation of the smoking ban legislation in Hyogo Prefecture. The monthly numbers of ACS hospitalizations before and after the implementation of the legislation in the Hyogo District and Gifu area were evaluated using a generalized linear model based on the Poisson distribution.

The study protocol was approved by the human research ethics committees of the Hyogo Prefectural Amagasaki Hospital and each institution concerned. This study was conducted in concordance with the guidelines of the Japanese Ministry of Health, Labour and Welfare.

Results

We identified 8,884 patients in Hyogo District (5,278 patients) and Gifu Prefecture (3,606 patients) who were hospitalized with a principal diagnosis of ACS during the study period. The demographic characteristics of the ACS patients are shown in Table 1. The number of ACS admissions, pre- and post-legislation implementation, which was the primary endpoint of this study, did not show a constant change from 2012 to 2015 in either Hyogo District (1,774 in the preceding year, 1,784 in the 1st year [+0.6%], and 1,720 in the 2nd year [−3.0%]) or Gifu Prefecture (1,226 in the preceding year, 1,174 in the 1st year [−4.2%], and 1,206 in the 2nd year [−1.6%]; Figure 1A).

However, a constant reduction was observed in the subanalysis for Kobe City (895 in the preceding year, 830 in the 1st year, and 792 in the 2nd year). The risk reduction was −7.3 (95% confidence interval [CI], −9.0 to −5.6) in the preceding and 1st years and −11.5 (95% CI, −13.6 to −9.4) in the 2nd year (Figures 1B,2). This constant reduction was observed irrespective of ACS type (acute myocardial infarction or unstable angina; Table 2), sex and age (Table 3).

Discussion

Prevention and cessation of smoking are standard measures for cardiovascular risk reduction.[8–10] The main mechanisms whereby acute and chronic smoking cause cardiovascular injury are considered to be nicotine-induced dysfunction and damage to vascular endothelial cells caused by increased oxidative stress, and impairment of vessel dilatation. In addition, smoking increases the release of norepinephrine and epinephrine. The subsequent vasoconstrictive effects and endothelial damage are considered to play important roles in the pathogenesis of smoking-dependent arteriosclerosis and/or plaque rupture with thrombi. SHS is also considered to predispose individuals to ACS. The aim of smoking legislation is to protect nonsmokers from SHS.

Compared with developed countries in the West, Japan is still a developing country with respect to programs that ban smoking. Internationally, as indicated by the WHO, smoke-free

Table 2. Numbers of ACS (AMI and uAP) Cases Before and After Enactment of Smoke-Free Legislation in Kobe City

	Pre	1 st year	Risk reduction	2nd year	Risk reduction
Total ACS					
Kobe City	895	830	−7.3 (−9.0~−5.6)	792	−11.5 (−13.6~−9.4)
Other Hyogo districts	879	954	7.9 (6.2~9.6)	928	5.3 (3.8~6.7)
AMI and uAP					
Kobe City	572	550*	−3.8 (−5.4~−2.3)	530	−7.3 (−9.5~−5.2)
	323	279*	−13.6 (−17.4~−9.9)	262	−18.9 (−23.2~−14.6)
Other Hyogo districts	579	589*	1.7 (0.7~2.7)	566	−2.2 (−3.5~−1.0)
	300	365*	17.8 (13.9~21.7)	362	17.1 (13.2~21.0)

*Missing information on the final diagnosis for 1 subject in Kobe City. ACS, acute coronary syndrome; AMI, acute myocardial infarction; uAP, unstable angina pectoris.

Table 3. Subgroup of ACS Cases Before and After Enactment of Smoke-Free Legislation in Kobe City

	Pre	1 st year	Risk reduction	2nd year	Risk reduction
Sex					
Male	652	591	−9.4 (−11.6~−7.1)	584**	−10.4 (−12.8~−8.1)
Female	243	239	−1.6 (−3.2~−0.0)	207**	−14.8 (−19.3~−10.3)
Age					
<65 years	269	228*	−15.2 (−19.5~−10.9)	226***	−16.0 (−20.4~−11.6)
≥65 years	626	599*	−4.3 (−5.9~−2.7)	565***	−9.7 (−12.1~−7.4)

ACS, acute coronary syndrome. *Missing information about age (3)*, sex (1)**, and missing data on age (1)***.

legislation with a penal code that completely bans smoking in every indoor facility, including those related to the service industry such as restaurant and bars, is standard. In Japan, the Health Promotion Act, passed in 2003, states, "facility managers shall make efforts to prevent secondhand smoke." However, a mere obligation to make efforts may allow unrestricted smoking in most service industry establishments such as restaurants. The smoking ban with a penal code in public places was enacted in Kanagawa Prefecture in 2010 and in Hyogo Prefecture in 2013. The bans, however, exclude bars, small restaurants, taverns, etc from their ambit (partial ban), and separation smoking, such as a smoking room, is permitted in most areas (incomplete ban).

For the primary endpoint of this study, we did not observe a significant change from before to after the implementation of the partial smoking ban. This confirms previous studies in which inadequate implementation of smoking ban legislation, such as in workplaces only, showed a lesser or no decrease in ACS cases than the comprehensive implementation of the smoking ban legislation.[5] However, our subanalysis showed a clear, constant decrease in ACS admissions from the baseline to the 2nd year in Kobe City (−7.3% in the 1st year and −11.5% in the 2nd year). These results were consistent with those obtained for acute myocardial infarction and unstable angina, in both sexes and all age subgroups. In Kobe City, the entire population was 1.541 million in 2012, 1.538 million in 2013 and 1.536 million in 2014 (the rate of decrease being 0.3%) (http://www.city.kobe.lg.jp/information/data/statistics/toukei/jinkou/suikeijinkou.html). Therefore, this reduction does not seem to be related to a decrease in population. Moreover, according to the Hyogo Prefectural Government Health & Welfare Department, Public Health Bureau Medical Affairs Division and the Kobe Fire Department, no new cardiovascular healthcare program other than this legislation was conducted and there was no change in the emergency systems in Kobe City during this period (personal communication). The reason why only Kobe City showed a significant decrease in the number of ACS admissions irrespective of subgroups is unclear. One possible reason is that the Hyogo Prefectural Capital Office is located in Kobe City, and social understanding of smoking legislation might have been accepted more widely. Indeed, questionnaires by Hyogo Prefectural Government Health & Welfare Department, distributed in the bars and restaurants larger than 100 m^2 in 2015, showed that the adherence rate to the smoking ban legislation was 97% in Kobe City and 88% in other Hyogo districts included in the present study.[11] Therefore, compared with the other districts in Hyogo, the adherence rate to the smoking ban legislation was higher in Kobe City.

Contrary to that, ACS admissions, especially for unstable angina, showed a tendency to increase in other Hyogo districts (Table 2), although the rate of increase ACS was low and the sample size of unstable angina patients was small. In Spain, smoking is banned in all indoor workplaces, public places, and public transport facilities, including enclosed stations, hospitals and other healthcare facilities, schools and universities, as well as in retail stores and shopping centers. However, hospitality venues are subject to a partial ban only. Fernández et al reported that, at venues in Spain where smoking was completely prohibited, a significant reduction in salivary cotinine (an alkaloid found in tobacco and a predominant metabolite of nicotine) concentration was observed in workers, whereas no changes were observed in workers at venues where smoking was only partially restricted or permitted).[12] López et al[13] reported that after 2 years of implementation of the anti-smoking law in Spain, the vapor-phase nicotine concentration decreased by 60% in public administration, university, and private-sector offices, as well as in venues where smoking was totally banned. However, nicotine levels significantly increased by 40% in hospitality venues that allowed smoking. That is, the partial smoking ban does not always provide protection against SHS for employees working in such venues. It is well-known that ACS, especially unstable angina, can be attributed to coronary flow reserve reduction and endothelial dysfunction caused by SHS.[14] Thus, we speculate that the increased tendency of ACS may be associated with worsening of SHS in the other districts in Hyogo, where adherence to the smoking ban legislation was lower, with the partial and incomplete smoking ban, although we have no direct evidence. Therefore, further investigations are warranted.

Study Limitations

Clinical background details of the ACS patients were not considered. Direct observation to measure the reduction in exposure to SHS was not performed. However, a review article showed that many other studies of ACS before and after smoking-ban legislation also did not adjust for geographic background, disregarded clinical background details, and did not measure the change in smoking prevalence or exposure to SHS.[4]

Conclusion

This is the first large-scale Japanese study using major hospitals in Hyogo District that was based on an ACS registry and was conducted during the implementation of smoking ban legislation. The primary endpoint did not show a significant change. However, the subanalysis showed a significant constant decrease in the number of ACS admissions in Kobe City where, when compared with other districts in Hyogo, adherence to the smoking ban legislation was higher. These results suggest that ACS reduction, with a partial and incomplete smoking ban, may depend on the degree of adherence to the smoking ban in the area and, therefore, the implementation of comprehensive smoking ban with a penal code would be needed to reduce ACS admissions in Japan.

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Supplementary Files

Supplementary File 1

Appendix S1. Members of the Smoking ban in public places in HYOgo prefecture: comparison to GIfu (SHYOGI) study

Please find supplementary file(s);
http://dx.doi.org/10.1253/circj.CJ-16-0492