タバコ規制をめぐる法と政策
目次

58

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装幀／レフ・デザイン工房

III. 受動喫煙(副流煙)の影響

受動喫煙による障害と受動喫煙防止法・条例による効果

大和 浩

Health risks induced by secondhand smoke and declines of risks after comprehensive smoke-free legislation

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Abstract

Secondhand smoke is the major health risk among non-smokers. It is estimated that more than 6,800 non-smokers who are exposed to secondhand smoke die every year in Japan. WHO Framework Convention on Tobacco Control requires all the governments to implement comprehensive smoking ban in order to protect non-smokers' health. Many countries and municipal offices implemented comprehensive smoking ban in workplaces and public spaces including restaurants and bars. The number of patients of acute coronary syndrome and respiratory disease rapidly decreased in those countries. These facts should be announced to the people and policy makers where comprehensive smoking ban has not implemented yet in order to protect non-smokers' health.

Key words: secondhand smoke, smoke-free legislation, acute cardiac syndrome

はじめに

タバコの葉の両面には粘着性のある繊毛が生えている．タバコは水洗いせずに乾燥，醸成，刻まれて製品となるため，繊毛に付着した土壌や肥料に由来する放射性物質(鉛210，ポロニウム210)は，喫煙者の肺に吸引され，内部被曝の原因となっていることをアメリカ環境保護局が示している[1]．また，タバコには防腐剤，保湿剤，溶媒，香料(メンソールなど)をはじめ約600種類の化学物質が添加されており，その燃焼により約4,000種類の化学物質が発生する．そのうち，アルデヒド類，多環芳香族炭化水素類，ダイオキシン類，NiやCdなどの重金属，活性酸素種や一酸化炭素など約200種類は人体に有害であり，発がん物質として64種類の物質が特定されており[2]，毎年13万人の日本人が喫煙により死亡している．

副流煙は600℃前後の低い温度でくすぶるような燃焼によって発生しているため，これらの有害物質が熱分解されず，その濃度は主流煙よりも副流煙の方が数倍〜数十倍も高くなる．非喫煙者が曝露される受動喫煙は，副流煙と吐出煙の混合物である．非喫煙者も受動喫煙に長期間曝露されることによって，動脈硬化性疾患や代謝性疾患，発がんのリスクが高くなる．また，

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肺内でのニコチンの吸収を高めるために添加されているアンモニアの濃度は副流煙の方が40倍以上高いため，眼・鼻の刺激症状や気管支喘息の発作誘発の原因にもなる．

1．受動喫煙による障害

'受動喫煙の方が能動喫煙(喫煙者本人)よりも有害である'と誤解される場合も多いが，'大量の主流煙を吸引し，かつ，タバコ煙が漂う場所に長く滞在する喫煙者の方が多大な影響を受ける．よって，同じ有害物質を含む受動喫煙に曝される非喫煙者にもタバコ関連疾患の発生リスクが上昇する'という説明が妥当であるが，受動喫煙を避ける行動につながることもあり，敢えて誤解を解かない場合もある．

受動喫煙による健康障害に関する研究は数多く行われており，そのメタアナリシスから非喫煙者の肺癌が1.24倍[3]，心筋梗塞が1.25倍に高くなることが確認されている[4]．なお，我が国におけるこれら2疾患による非喫煙者の超過死亡は，少なくとも年間6,800人であることが，国立がん研究センターから報告されている[5]．

2．受動喫煙防止による効果

2005年，喫煙と受動喫煙が及ぼす破壊的な影響から現在と将来の世代を保護することを目的とした'たばこの規制に関する世界保健機関枠組条約'が発効した[6]．第8条'受動喫煙からの保護'では，喫煙室や空気清浄機などの工学的な対策では受動喫煙を防止できないことから，一般の職場だけでなく，飲食店などのサービス産業も含めて全面禁煙とする法律を施行することが求められている[7]．既に多くの国や州，自治体で屋内の喫煙を禁止する受動喫煙防止法・条例が施行されており，喫煙関連疾患が減少したことを証明する報告が相ついでいる．

1）受動喫煙防止法による心筋梗塞の減少

2002年，アメリカ，モンタナ州ヘレナ市で受動喫煙防止条例が施行され，半年後に解除された．条例が有効であった期間のヘレナ市住民の心筋梗塞の入院数は条例の前後5年間の平均入院数よりも4割少なく，条例が適用されなかった郊外の住民の入院数にそのような変化はなかった．受動喫煙防止による効果を検証した最初の論文であるが，対象人口が6万8千人と少ないこと，居住地を郵便番号で判断したこと，喫煙歴は自己申告であったことなどの限界があった[8]．

スコットランドでは，2006年3月にパブなどのサービス産業を含むすべての屋内での喫煙を禁止する法律が施行された．510万人の住民のうち300万人の医療を担当する9病院で，法律の施行前後の急性冠症候群の入院患者数の変化についての研究が，喫煙歴と受動喫煙の状態を問診だけでなく，血中・尿中のニコチン代謝産物で確認しながら行われた．法律が施行される前の10カ月間(2005年6月-2006年3月)の入院患者数3,235人が，施行後の10カ月間(2006年6月-2007年3月)には2,684人と17％減少したことが観察された(**図1**)．喫煙の有無による入院減少率は，喫煙者で14％減(1,176→1,016=160人)，元喫煙者で19％減(953→769=184人)，非喫煙者で21％減(677→537=140人)であった．元＋非喫煙者の入院減少(184+140人)は，全体(160+184+140人)の66.9％を占めており，現在喫煙していない者(元＋非喫煙者)の減少による寄与が大きかった[9]．

上に紹介したスコットランドの報告を含み，2009年までに出版された9論文と3学会発表のメタアナリシスにより，受動喫煙防止法・条例により心筋梗塞は17％減少することが示された(**図2**)[10]．

更に，その長期効果が，職場，レストラン，バーなどすべての建物内を禁煙とする受動喫煙防止条例が2003年7月1日より施行されたコロラド州プエブロ市(人口14万7千人)で確認された．プエブロ市の条例施行前，および，施行後0-18カ月，施行後19-36カ月の3つの期間について，急性心筋梗塞の入院率の変化をプエブロ市内，および，喫煙規制のないプエブロ市郊外，および，45マイル離れたエルパソ郡とで比較する研究がなされた．10万人あたりの心筋梗塞の患者数は，プエブロ市内では施行後0-18カ月の187人から施行後19-36カ月で152

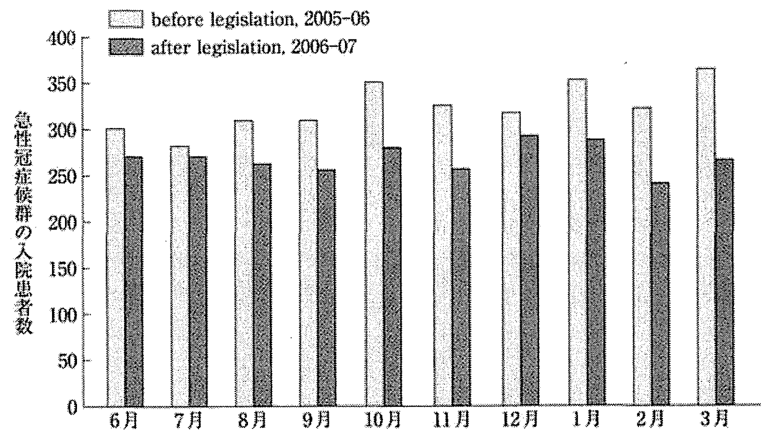

図1 スコットランドの受動喫煙防止法による急性冠症候群の減少

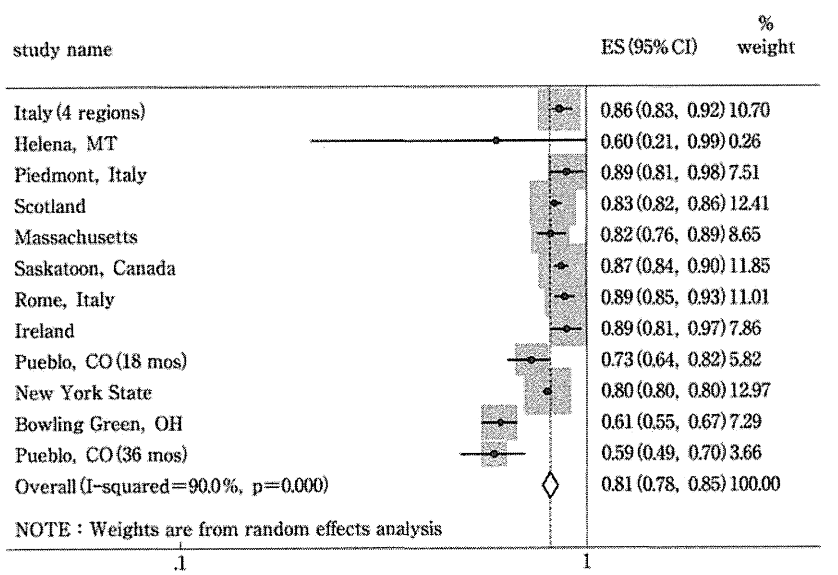

図2 受動喫煙防止法・条例による心筋梗塞の減少

[From Circulation. Lightwood JM, Glantz SA. Declines in acute myocardial infarction after smoke-free laws and individual risk attributable to secondhand smoke. 120, p1373-1379. Reprinted with permission from Wolters Kluwer Health.]

人(リスク比0.81倍, 95%信頼区間=0.67, 0.96)に減少した. 施行前の257人と施行後19-36カ月の間で比較すると(リスク比0.59倍, 95%信頼区間=0.49, 0.70)と更に減少していた. なお, 上記の期間にプエブロ市郊外とエルパソ郡ではこのような変化はなかった(**図3**)[11].

喫煙者が禁煙した場合, 心筋梗塞のリスクの低下は比較的早期に現れることが知られている. 受動喫煙についても同様の現象が確認されたことになる.

2) 受動喫煙防止法による気管支喘息の減少

2004年, 飲食店やパブなどのサービス産業

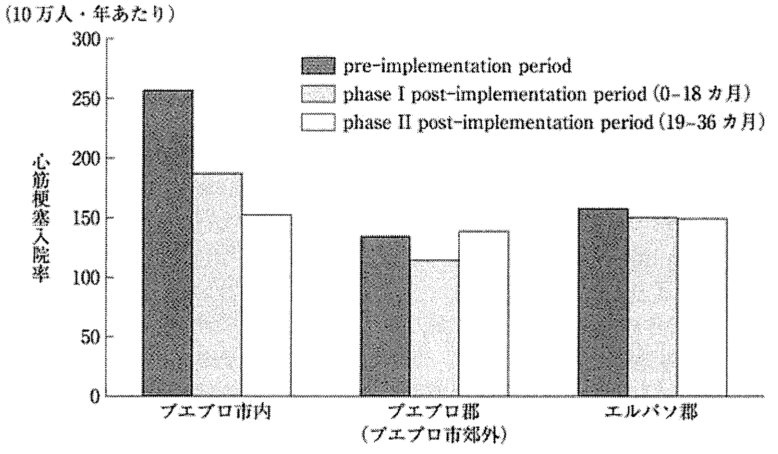

図3 プエブロ市の受動喫煙防止条例による心筋梗塞減少の長期効果

[Reprint from Morbidity and Mortality Weekly Report. Centers for Disease Control and Prevention(CDC). Reduced hospitalizations for acute myocardial infarction after implementation of a smoke-free ordinance—City of Pueblo, Colorado, 2002-2006. 57. p1373-1377. 2009.]

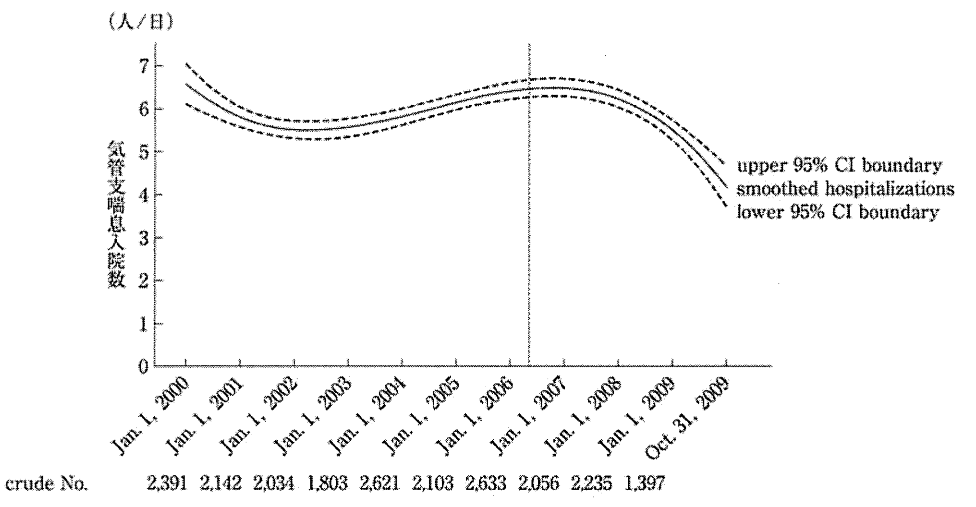

図4 受動喫煙防止法による小児喘息の減少

[From The New England Journal of Medicine. Mackay D, et al. Smoke-free legislation and hospitalizations for childhood asthma. 363. p1139-1145. Copyright© (2010) Massachusetts Medical Society. Reprinted with permission from Massachusetts Medical Society.]

を含むすべての屋内を全面禁煙とする法律が世界で初めて施行されたアイルランドでは，その直後からパブで働く従業員の上気道症状が軽減したことが報告されている[12]。

2006年に禁煙化されたスコットランドでは，飲食店などでの喫煙が禁止されると自宅での喫煙が増え，小児喘息の症状が悪化することが懸念されたが，2000年以降，毎年5.2%上昇していた小児喘息(15歳以下)による入院が，**図4**に示すように法律の施行後には毎年18.2%減少

した[13]．法律で自宅外の喫煙が禁止されたことで，自主的に自宅内での受動喫煙も防止する配慮が働いたものと考察されている．

おわりに

受動喫煙に曝露されることで喫煙関連疾患のリスクが上昇し，法律・条例で屋内が禁煙化された国・自治体では，国民・住民の心疾患や呼吸器疾患が減少することが明らかとなった．

我が国では，2003年の健康増進法第25条で'多数の者が利用する施設を管理する者は，受動喫煙を防止するために必要な措置を講ずるように努めなければならない'という努力義務にとどまっている．ようやく，違反者への罰則を定めた条例として'神奈川県公共的施設における受動喫煙防止条例'(2010年施行)，および，2012年3月に兵庫県で成立した'受動喫煙の防止等に関する条例'により先鞭がつけられた．しかし，いずれも飲食店などのサービス産業からの'営業利益が低下する恐れがある'という強い反対により，一定の措置(分煙)のもとで営業区域にも喫煙区域を認めたこと，小規模店舗やパチンコ店などについては努力義務であること，更に，規制のない自治体と隣接していることから，海外のように条例によって喫煙関連疾患が減少する効果は期待できない．

これまで，喫煙する利用者の利便性から論じられてきた我が国の受動喫煙防止対策であるが，今後，その施設で働く人々の健康を守る(特に，サービス産業)という観点，および，飲食店を禁煙化しても営業利益は低下しなかった，という内外のデータに基づく議論が必要である[14,15]．

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Designated Smoking Areas in Streets Where Outdoor Smoking is Banned

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Key Words: Outdoor smoking bans, Designated smoking areas, Tobacco control, Second-hand smoke exposure

ABSTRACT

Although Japan has been a signatory to the Framework Convention on Tobacco Control since 2004, progress in translating the recommendations into national policy has been limited. Globally, outdoor smoking bans cover outdoor dining areas, beaches, public parks, schools, etc. In Japan, most of existing outdoor smoking bans allow designated smoking areas (DSAs) in the no-smoking zones, thus limiting protection from second-hand smoke (SHS). We examined the impact of DSAs on air quality in the areas of Kobe City where such ordinance is in force. Air quality measurements were conducted near two DSAs in August 2012 by using personal aerosol monitors. Three measurements were performed, each for 15 minutes, by four investigators: a line-up measurement, a vertical and horizontal measurement, and a circle measurement. In the line-up measurement, over 150 $\mu g/m^3$ of $PM_{2.5}$ was detected by the monitor four metres from the ashtray, gradually reducing as the distance increased. In the vertical and horizontal measurement, 80–110 $\mu g/m^3$ of $PM_{2.5}$ was detected at 4, 11, 18 and 25 metres. In the circle measurement, similar concentrations of $PM_{2.5}$ were detected at all testing points (mean concentration 94 $\mu g/m^3$). The study indicates that DSAs are sources of SHS in zones where a street smoking ban is in force, since SHS spreads widely, both vertically and horizontally. Street smoking bans that permit DSAs strongly limit protection from SHS and should be eliminated if protection against SHS is to be effective where such bans are in force.

INTRODUCTION

The Framework Convention on Tobacco Control (FCTC) became a key landmark in protecting people from the damage of tobacco when it entered into force in 2005. Japan has been a signatory to the FCTC since 2004, and as of December 2012 there were 176 Parties to the Convention. [1] However, progress in translating the FCTC recommendations into comprehensive regulations and laws has been slow. Protection against second-hand smoke (SHS) has wide public and political support in an increasing number of countries and has

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paved the way for the adoption of indoor smoking bans as major tools of tobacco control [2]. In order fully to protect people against SHS, the scope of a smoking ban must widen to include not only indoor spaces but also outdoor areas, following the clear recommendation of the World Health Organization (WHO) that "under some circumstances, the principle of universal, effective protection may require specific quasi-outdoor and outdoor workplaces to be smoke-free" [3]. Increasing numbers of cities worldwide have enacted regulations and legislation banning smoking in outdoor areas, often for reasons not explicitly related to health – such as ensuring safety (to limit the risk of fire), and maintaining a clean and attractive environment (to control littering) [4].

Although completely smoke-free cities remain an exception (like the city of Calabasas in the USA which enacted an ordinance banning smoking in the entire city in 2006), outdoor smoking bans cover outdoor dining and drinking areas (e.g. in Canada and the USA), beaches (e.g. in Hong Kong), public parks (e.g. in Australia, Bhutan, India, Italy and Thailand), schools and playgrounds (e.g. in Finland, the Republic of Korea, Singapore and the Philippines), sports facilities (e.g. in South Africa), and hospital grounds (e.g. in the United Kingdom)[5]. However, streets have seldom been covered although outdoor smoking bans are becoming increasingly common.

In Japan, streets adjacent to shopping areas have been the focus of outdoor smoking bans [6]. However, these bans remain very limited in scope and, more importantly, in their protection of health. As such, they are weak policy instruments for restricting exposure to SHS as they are usually implemented for environmental reasons.

Ueda et al (2011) reported that 6% of all municipalities in Japan implement ordinances that ban street smoking, the reasons for which were "unrelated to consideration of the smoking issue as a health matter". Street smoking bans by themselves are very limited as tobacco control measures. Moreover, since these bans allow designated smoking areas (DSAs) to be located within the non-smoking streets, the protection from SHS is very limited.

DSAs are a common feature of street smoking bans in municipalities of Japan. For instance, although the Kobe City ordinance indicates that smoking is prohibited, smoking areas are in fact designated within the zone that has street smoking bans [7]. The DSAs are either constructed with public money [8] or provided by the tobacco industry [9]. For example, Japan Tobacco Inc. (JT) reported that they often give both financial and technical assistance to local governments for the installation of DSAs [9], and Kobe is no exception [7]. As of April 2011, JT stated that it had provided 943 DSAs in collaboration with 212 different municipalities in Japan [9]. In the case of the special wards of Tokyo, each ward consults with JT to identify a suitable location, taking into account the accessibility, visibility and negative health impacts of the installation of a DSA [10].

In some cases, community complaints about DSAs have been reported. For instance, Shibuya ward of Tokyo implemented an ordinance banning street smoking in 1998 in order to prevent littering or to "keep the city beautiful" and, as a part of this ordinance, the littering of cigarette butts is prohibited. In this same ward, a total of 21 DSAs were provided in the past; however, two of them have now been removed due to the large number of complaints from the public [11]. In anticipation of such public discontent with SHS generated by DSAs, a new approach has been introduced by a private Japanese company named General Fundex. In this new approach, the designated smoking rooms are installed in former shops, namely ippuku, to which passers-by can gain admission for a fee of ¥500 per week [12]. The officially declared purpose of this kind of smoking room is to provide an opportunity for smokers to smoke in a relaxed environment [13]. General Fundex raised concerns that, as a result of widely implemented street smoking bans, the numbers of places where people are allowed to smoke has been reduced [13]. As of October 2012, there were three designated smoking rooms (DSRs) in the streets of metropolitan Tokyo [12].

BACKGROUND

The impact of DSRs in indoor areas on exposure to SHS has been extensively documented.

Since the early 1990s, where DSRs were encouraged as an alternative to reduce exposure to SHS, it was already documented that, owing to several factors, the smoke leaked to areas where a ban was in force [14], and spillovers were inevitable – specifically particulate matters of less than 2.5 μm, which are "a major source of respirable suspended particles (in) cigarette smoke" [15].

As early as 1993, nicotine vapor measurement showed that, in the hospitality industry, nicotine concentrations were as high in nonsmoking sections as in the DSR [16]. In response to such clear evidence of the ineffectiveness of partial bans, the tobacco industry promoted heavily the use of ventilation and filtration systems as a way to clean the air and protect nonsmokers from SHS while at the same time allowing smokers to smoke in as many facilities as possible.

Further studies conducted since 2000 showed that, comparatively, restaurants with a DSR had poorer air quality than restaurants applying a complete smoking ban, despite all technical advances in ventilation, pressurization and filtration systems [17][18]. Indeed, unless the DSR is completely sealed off from the outside world, leakage will always happen, even simply when the access or exit door is opened [19]. All types of facilities have been the subject of similar studies (restaurants, airports, office buildings, medical facilities, and games rooms, to cite a few) with similar findings.

The leakage of environmental tobacco smoke (ETS) has been widely studied [20] [21] and it has been confirmed that DSRs, whether ventilated or nor and whether equipped with filtration systems or not, do not protect from exposure to SHS.

In addition to air quality considerations, partial bans could legitimize smoking and may prevent people from quitting, as has been shown in Canada where smoking areas were permitted in some schools [22]. Moreover, as Winickoff et al. point out [23] [24], even when absolute no-smoking policies are implemented, nonsmokers may still be exposed to harmful levels of toxins from "off-gasing from smoker's clothing, through open windows and doors and from exhaled toxins for several minutes after the cigarette is extinguished".

Whereas, as illustrated above, ample evidence has been provided on the ineffectiveness of DSRs to fully protect people from the negative effects of SHS in indoor areas, little vetted data is available on DSAs in outdoor areas. Thus there is a need to document the impact of DSAs where partial bans are implemented. This study aims to assess the impact of DSAs where a street smoking ban is enforced using data from one of the cities where such a regulation has been implemented.

Kobe City, the capital of Hyogo Prefecture, has a total population of 1.5 million (estimated as of November 2011) and is the fifth most populous city in Japan. In Kobe, *Kobe-shi poiste oyobi rojo-kitsuen no boshi ni kansuru jorei* (the Kobe City ordinance on prevention of littering and street smoking), which prohibits smoking in certain streets, came into force on 1 April 2008. The ordinance was intended to make the city cleaner and to prevent brush-by burns resulting from street smoking. The Bureau of the Environment is in charge of the ordinance, not the Bureau of Health. Articles 4, 8, and 9 of the ordinance focus on smoking, stating that people must try not to smoke in any street of the city and prohibiting smoking within the area designated by the mayor. However, the reality is that four DSAs are provided within the no-smoking areas.

A characteristic of urban areas in Japan is the presence of pedestrian walkways called "pedways". These are common structures that can be seen connecting urban high-rise buildings to each other, particularly around the public transport hubs where many people pass every day. Pedways provide quick and comfortable movement from building to building, away from the traffic and sheltered from inclement weather. In Kobe, two of the DSAs are in fact installed under the stairs attached to a pedway. The DSAs are delineated by physical partitions and are equipped with ashtrays; some have a roof over the ashtrays as a means of keeping people smoking inside the DSA. The sign indicating "Smoking Area" can be seen clearly just outside the train station, directing smokers to the place where they are authorized to smoke while in the no-smoking zone.

Since 2008, soon after the implementation of the ordinance, a fine of ¥ 1000 was applied to illegal smokers in the red-shaded area in Figure 1. The total area of the street smoking ban zone is 500 metres from north to south and 800 metres from east to west, and only public streets are covered by the ordinance [25].

OBJECTIVE

The objective of this study was to determine the impact of DSAs on air quality in the areas of Kobe City where the municipal ordinance banning street smoking is in force. The study was carried out as part of a broader study to assess compliance with the street smoking ban in Kobe.

MATERIALS AND METHODS

In order to measure the air quality, we selected two different DSAs (out of four), DSA1 and DSA2, located near the central train station in Kobe where the street smoking ban is enforced, as shown in Figure 1a and 1b. DSA1 (N34 41.587 – E135 11.693) is located under an overpass linking several shopping Centres to a nearby street. It is also a resting area nearby the taxi station located at the South entrance of the main train station in the centre of Kobe City. The overpass which is above DSA1 provides passengers, a connection between two public transportation systems (a train station and an automated shuttle to Kobe airport) and a pathway to the major shopping street on the South side of the station. There is important pedestrian traffic as it is a central nod in Kobe for public transportation and shopping (a bus station is located nearby, as well as the three main train companies and the subway). DSA2 (N34 41.569 – E135 11.652) is located West of DSA1, on the opposite side of a main road linking the North and South ends of the city. DSA2 sits under the stairs of an overpass that connects the exits of two main train stations to the shopping street below (arrows in the maps of DSA1 in Figure 2a and DSA2 in Figure 2b indicate 20 m). The two locations were selected as a result of an earlier pilot study. Air quality measurements of the two DSAs were conducted in August 2012 (August 7^{th} and August 9^{th}) by means of a SIDEPAK™ AM510 Personal Aerosol Monitor manufactured by TSI Inc. [1] The concentrations of fine particulate matter of $PM_{2.5}$ were measured. $PM_{2.5}$ particles pose the greatest health risks because they have the ability to penetrate deeply into the lungs, where they may reach the peripheral regions of the lungs [24]. The monitor determines the mass concentration by the intensity of scattered laser light. As the light-scattering properties of

[1] See: http://www.tsi.com/sidepak-personal-aerosol-monitor-am510/.

particles differ according to their size and composition, it is necessary to calibrate the measurement results of the monitor [18]. The monitor was set to record $PM_{2.5}$ concentration every 10 seconds. An impactor for 2.5 μm particles attached to the inlet of the monitor removed particles greater than 2.5 μm at a flow rate of 1.7 litres [26]. We used 0.295 as a correlation factor for measurements following the method described by Lee [26].

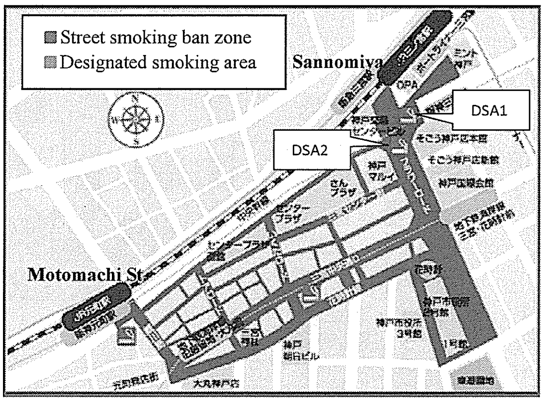


Fig. 1a. Street smoking ban zone and DSAs

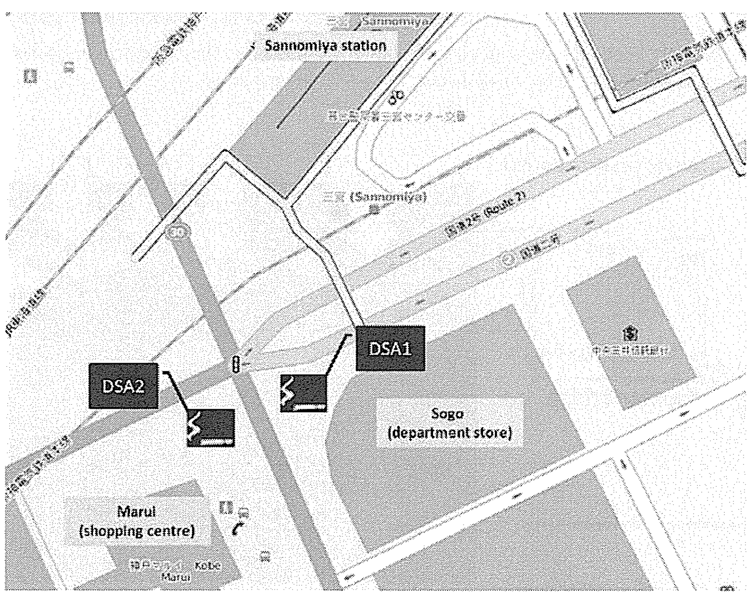


Fig. 1b. Magnified view of DSA1 and DSA2

Three different measurements were collected on two different days in August 2012. The three different measurements were: 1) line-up (horizontal) measurement; 2) vertical and horizontal measurement of DSA1; and 3) circle measurement of DSA2. Each measurement lasted approximately 15 minutes. The monitoring was conducted from 8 to 9 a.m. to monitor people smoking in the DSAs on their way to work. The data were downloaded to a computer for calibration.

1) Line-up (horizontal) measurement

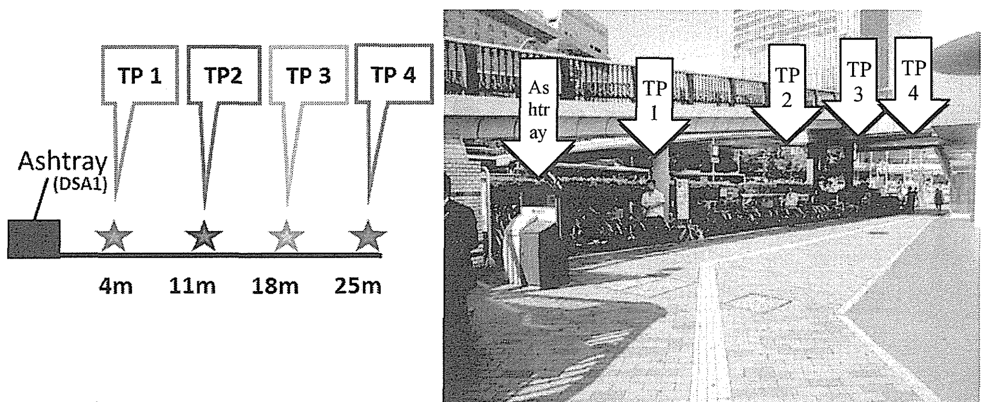


Fig. 2a. Line-up measurement
Each of the four investigators lined up with a monitor as shown in Figure 2a. The closest testing point (TP) was 4 metres away from DSA1 and the most distant TP was 25 metres away.

2) Vertical and horizontal measurement

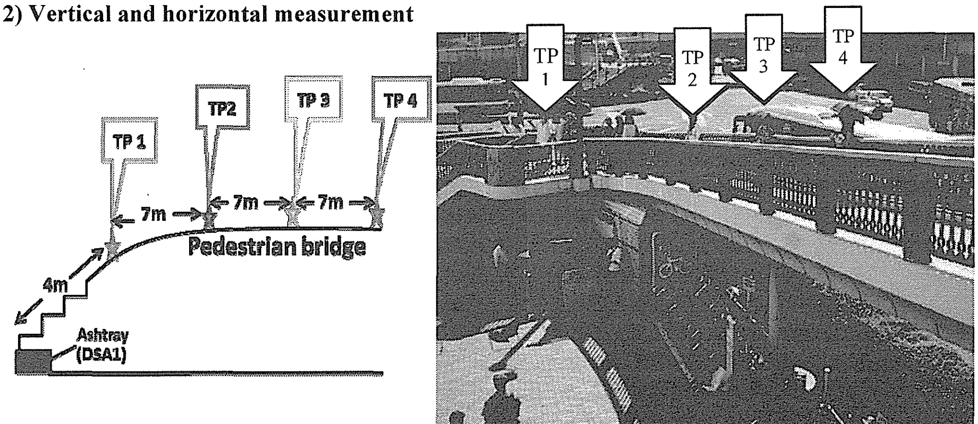


Fig. 2b. Vertical and horizontal measurement
The four investigators lined up horizontally on the pedway above the DSA1 with a monitor, as shown in Figure 2b. The concentration of SHS was measured both vertically and horizontally with this method.

3) Circle measurement

E98

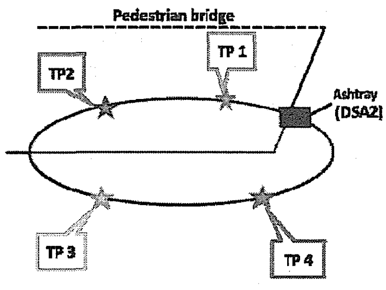


Fig. 2c. Circle measurement
The four investigators formed a circle with a monitor in hand, as shown in Figure 2c. There was a pedestrian walkway located just above the DSA2.

RESULTS

Line-up measurement

In the line-up measurement, the monitor at testing point 1 (TP1), which was nearest to the ashtray point, detected more than 150 μg/m³ (Figure 3-1) and 120 μg/m³ (Figure 3-2) which represent higher concentrations of $PM_{2.5}$ than the other testing points. The concentration of $PM_{2.5}$ gradually decreased with the distance. However, at the end of the line-up measurement in Figure 2, TP4, which was 25 metres from the ashtrays, recorded the lowest concentration of $PM_{2.5}$.

Figure 3.1 Line-up Measurement 07 Aug 2012

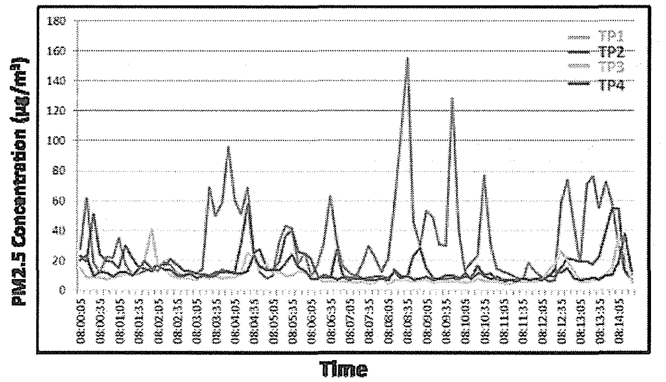
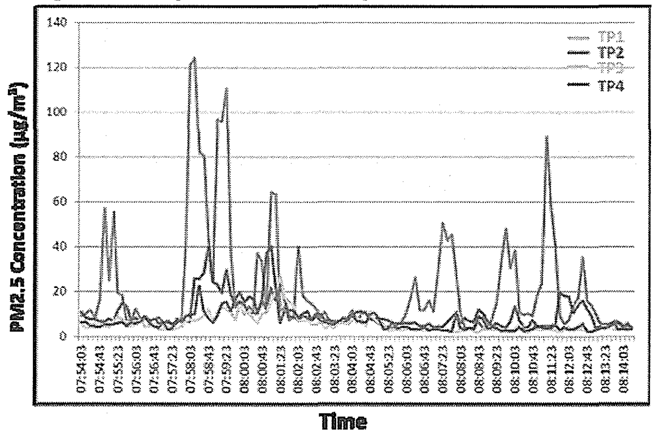


Figure 3.2 Line-up Measurement 09 Aug 2012



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Vertical and horizontal measurements (Pedestrian Bridge with a DSA below)

On day 1, the monitors closest to the ashtrays, TP1 and TP2, recorded around 120 μg/m³ and 94 μg/m³ respectively. That represents more concentration of $PM_{2.5}$ than at TP3 and TP4 (Figure 4-1). However, at the end of measurement period, a high level of $PM_{2.5}$ was recorded at each of the four testing points (Figure 4-1). On day 2, under the same measurement conditions (Figure 4-2), the concentration of $PM_{2.5}$ detected was higher at TP2 than at the other testing points.

Figure 4.1 Vertical and horizontal measurement 07 Aug 2012

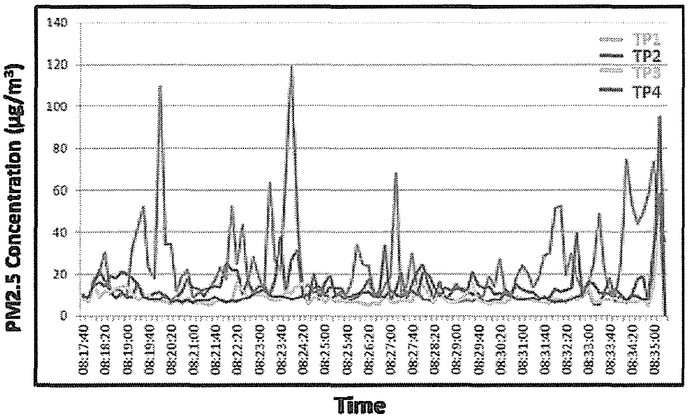
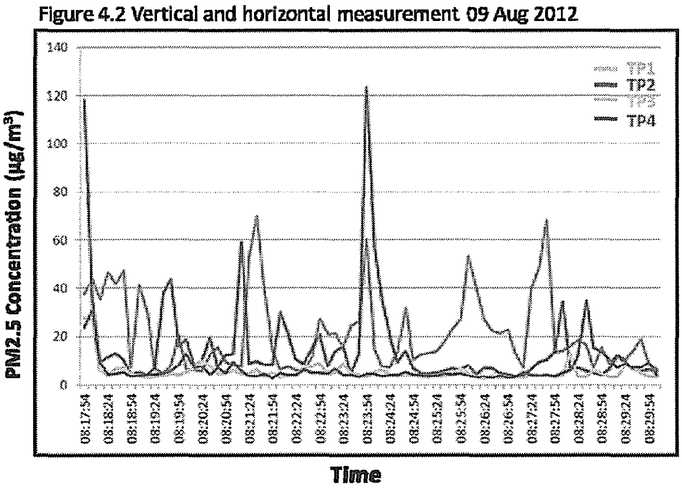


Figure 4.2 Vertical and horizontal measurement 09 Aug 2012



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Circle measurement

On day 1, a high-level concentration of $PM_{2.5}$ was detected at TP1, TP3 and TP4, with approximately 80–110 μg/m³ (Figure 5-1). On day 2, under the same measurement conditions, at the beginning of the measurement period, $PM_{2.5}$ concentration peaks were detected at all testing points (Figure 5-2).

Figure 5.1 Circle measurement 07 Aug 2012

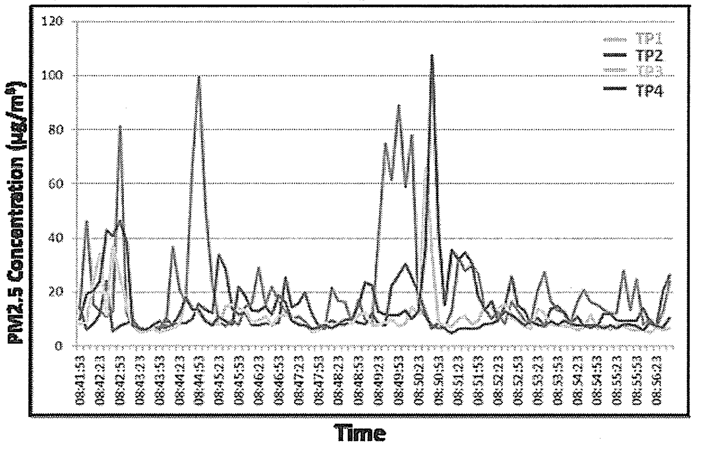
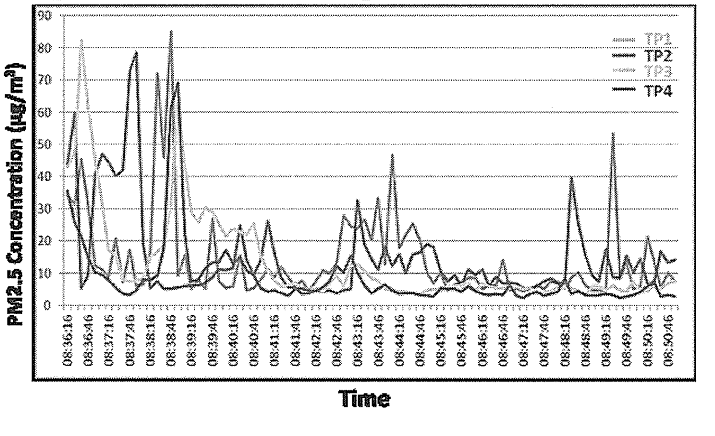


Figure 5.2 Circle measurement 09 Aug 2012



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DISCUSSION

The results point towards the existence of release of SHS from the DSAs into the street where a smoking ban is in force. Although the concentration of SHS gradually decreases as the distance from the ashtray of the line-up and vertical and horizontal measurements increases, the furthest testing points (TP4) still detected concentrations of particulate matter as high as 30 $\mu g/m^3$. As shown in the figures, there is a gradual delay in detecting SHS by both line-up and vertical and horizontal measurements as one moves away from the ashtrays from TP1 towards TP4. The weather of the measurement was typical mid-summer pattern, mild wind coming from south or south west (sea-side) to north or north west (mountain-side). The flow of SHS is highly dependent on the direction and velocity of the wind; it can reach further than 25 metres or it may remain with a high concentration for a longer period of time in certain areas [27]. However, it should be emphasized that all the pedestrians were exposed to high concentration of SHS at the TP1 and TP2 in the vertical and horizontal measurements because those points are located just above the ashtray.

The circle measurement, on the other hand, constantly shows a high level of SHS concentration at each of the four testing points. In this case, the situation is made worse by the fact that the DSA is installed under the stairs attached to a pedway which serves as a roof for the DSA.

The presence of a DSA can weaken the strength of an ordinance banning smoking in the street as the DSA is a source of SHS. The dispersion of the smoke indicates that there are no safe levels of exposure to SHS in the presence of DSAs. Moreover, there are additional health concerns, such as occupational health issues for cleaners of the DSA who will be exposed to SHS; and also that DSA contribute to the social acceptability of smoking in areas where there is a street smoking ban, as shown in Canada [22].

LIMITATIONS

A first potential limitation is that since we did not measure the wind speed and direction on the day of the measurements, variations in the dissemination of the SHS due to weather conditions could not be reported. However, the measurements were done in relatively stable weather conditions. In those mid-summer days, the wind is not strong and relatively constant seasonal south wind (from seaside to mountain side) is observed because of the difference of the temperature between the seawater and heated land. It has been reported that, in the absence of wind, the cigarette plume will rise if the temperature of the smoke plume is hotter than the surrounding air and will rapidly cool and lose its upward momentum. If there is wind, the amount of rise of the thermally-induced plume is inversely proportional to the wind velocity. A strong wind will create a more horizontal but wider cone. Therefore as the wind direction changes, SHS pollution will be spread in various directions, affecting downwind nonsmokers [28]. Secondly, Personal Aerosol Monitor also detects combustible diesel exhaust of vehicles as its particulate matter is smaller than 2.5 µm. Since two of the DSAs are located beside a busy main road, or near bus terminals, it is possible that the monitor has detected diesel exhaust. In October 2004, Hyogo prefecture implemented the ordinance called "Creation of the preservation of the environment", and this ordinance limits vehicles with diesel engines in certain areas of Hyogo [29]. However, the ordinance does not include the area in which the study was carried out. Therefore, the contamination of $PM_{2.5}$ cannot be ruled out. The baseline standard of the collected data was nevertheless clean as it was lower than the air quality standard set by the Ministry of the Environment [30] and lower than the WHO standard. Third, the concentration of the SHS is highly dependent on the number, distribution, and density of the smokers. Although we targeted the time when smokers were