Environmental monitoring of secondhand smoke exposure

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ABSTRACT

The complex composition of secondhand smoke (SHS) provides a range of constituents that can be measured in environmental samples (air, dust and on surfaces) and therefore used to assess non-smokers' exposure to tobacco smoke. Monitoring SHS exposure (SHSe) in indoor environments provides useful information on the extent and consequences of SHSe, implementing and evaluating tobacco control programmes and behavioural interventions, and estimating overall burden of disease caused by SHSe. The most widely used markers have been vapour-phase nicotine and respirable particulate matter (PM). Numerous other environmental analytes of SHS have been measured in the air including carbon monoxide, 3-ethenylpyridine, polycyclic aromatic hydrocarbons, tobacco-specific nitrosamines, nitrogen oxides, aldehydes and volatile organic compounds, as well as nicotine in dust and on surfaces. The measurement of nicotine in the air has the advantage of reflecting the presence of tobacco smoke. While PM measurements are not as specific, they can be taken continuously, allowing for assessment of exposure and its variation over time. In general, when nicotine and PM are measured in the same setting using a common sampling period, an increase in nicotine concentration of 1 $\mu g/m^3$ corresponds to an average increase of 10 $\mu g/m^3$ of PM. This topic assessment presents a comprehensive summary of SHSe monitoring approaches using environmental markers and discusses the strengths and weaknesses of these methods and approaches.

INTRODUCTION

In this series of articles, three topic assessments summarising current knowledge about measuring secondhand smoke exposure (SHSe) are presented, covering self-reported measures, environmental measurements and biomarkers, and are based on a multidisciplinary expert meeting held in late 2008 at Johns Hopkins University, Baltimore, USA and supported by the Flight Attendant Medical Research Institute (FAMRI). The meeting addressed SHS assessment approaches to provide uniform methods for FAMRI investigators and others, and to set the stage for innovation. The topic assessments reflect the course of discussion at the meeting, along with recommendations developed from meeting participants, who were established researchers in one of the three focus areas. This article describes methods and strategies used to measure SHSe in the environment, strengths and weaknesses, and approaches discussed and recommended at the expert meeting.

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CHARACTERISTICS OF SECONDHAND SMOKE

SHS, a mixture of thousands of components many of which are toxic and carcinogenic[1] is made up of the mainstream smoke exhaled by the smoker and side stream smoke expelled from the end of a lit tobacco product. SHS concentration in the indoor environment depends on the number of cigarettes smoked in a period of time, the volume of the room, the ventilation rate and other processes that eliminate pollutants from the air. These processes vary based on the physical state and properties of the SHS component being measured. In 1986, the National Research Council (NRC), USA, proposed that an environmental marker of SHSe should be 'unique or nearly unique to the tobacco smoke so that other sources are minor in comparison, a constituent of the tobacco present in sufficient quantity such that concentrations of it can be easily detected in air, even at low smoking rates, similar in emission rates for a variety of tobacco products, and in a fairly consistent ratio to the individual contaminant of interest or category of contaminants of interest (eg, suspended particulates) under a range of environmental conditions encountered and for a variety of tobacco products'.[2]

Historically, SHSe has been assessed principally by measuring airborne particulate matter (PM) and gas phase nicotine. In the 1980's it was established that cigarette smoking is a potent source of fine indoor airborne PM,[3 4] and that gas phase nicotine was a sensitive and specific marker of SHSe.[5–7] Some markers are specific to tobacco smoke, while others may arise from a variety of sources. None of the environmental markers in use, however, meet all of the 1986 NRC criteria and no single component will reflect the full disease risk from the complex mixture that comprises SHS.[8 9] The choice of method for measuring environmental SHS concentrations will therefore depend on the study's purpose.[10]

Evaluating sources and microenvironments

Microenvironments are defined as a fixed location in which a person is exposed to SHS or another pollutant. Typical microenvironments include home, work, hospitality venues (eg, restaurants), school, or automobile. Average SHSe of an individual is the sum of airborne concentrations within

each microenvironment (c_{ij}) multiplied by the time spent within each microenvironment (t_{ij}), divided by the total time being considered. The following mass balance equation (adapted from the 2006 Surgeon General's Report (SGR)[8]), is used:

$$E_{avg} = \frac{\sum c_{ij} * t_{ij}}{\sum t_{ij}}$$

where concentration is a function of source strength (number of cigarettes smoked in a given unit of time), room volume, air exchange rates and other removal mechanisms (eg, deposition and chemical reaction).[11–13]

Table 1 lists the major microenvironments and the key factors that govern how exposure occurs within them. Many studies have described the impact of building size, construction, types of tobacco products smoked, forced or natural air movement, and proximity of smokers and non-smokers on concentrations of SHS constituents in common microenvironments.[14 16 18 19 21] In indoor environments, the most influential building characteristics are generally room size and ventilation rate. The effects of forced and natural ventilation, as well as air flow in homes, on pollutant concentrations have been measured and studied theoretically.[16 19] For outdoor settings, proximity to smokers and wind speed and direction are most influential.[14] Outdoor exposure only occurs during active smoking or shortly afterwards, as even low wind speeds will rapidly disperse the smoke.

Validated models can be used to estimate SHS concentrations for typical microenvironments.[3 8 12 23] Models based on mass balance equations can predict peak concentrations or time-weighted averaged (TWA) concentrations of SHS markers, (an extensive overview of the application of modelling to predicting particulate matter from SHS is given in Repace,[23] Ott,[24] and Ott *et al*[25]).

Modelling applications include assessing effectiveness of control measures,[8 12 16 26 27] interpreting results of field studies,[12] and conducting SHS risk assessment.[28] These models can be coupled with pharmacokinetic models to estimate or interpret biomarkers for SHS dose.[8 26]

METHODS FOR SHS ENVIRONMENTAL MONITORING

A wide range of approaches has been used to evaluate SHSe. Assessment methods can be grouped based on the chemical target and the collection method (table 2).

Airborne sampling

Many SHS components can be measured using either active or passive sampling. Active sampling uses a pump to draw air into the sample collection device, usually a filter or adsorbent tube, depending on the constituent of interest. Passive monitoring relies on diffusion to a collection surface. Both approaches allow investigators to measure an integrated time-weighted average (TWA) concentration over the sampling period. Direct reading methods, available for some SHS components, allow for real-time measurement of concentration over a variety of time intervals.

Table 1 Summary of microenvironments and the factors that govern how exposure occurs within them

Microenvironments	Physical factors	Behavioural factors
Outdoors[14 15]	Wind speed, wind direction	Proximity to smokers
Residences (indoors)[16–20]	Room volume, window positions, door positions, HVAC*	Room location of smoker(s), proximity to smoker(s)
Work/office/public building (indoors)[21]	Room volume, HVAC	Room location of smokers, proximity to smoker(s)
Restaurant/tavern[22]	Room volume, HVAC	Proximity to smoker(s)
Automobile cabin[22]	Cabin volume, window position, air conditioning, driving speed	Arm position, seating position

*HVAC, heating, ventilation and air conditioning.

Nicotine

Airborne nicotine has been a widely used indicator for SHS in occupational and non-occupational environments.[8 35 74–76] The measurement of airborne nicotine a tobacco-specific constituent reflects tobacco smoke exposure. Sample collection methods are straightforward, and analytical methods are sensitive at low concentrations.[35 77 78] Methods to measure real-time concentrations of air nicotine are not available.

Nicotine sampling is typically conducted using a passive sampler. The sampling device, first described by Hammond and Leaderer,[5] is a 35 mm polystyrene sampling cassette holding a filter treated with sodium bisulfate and covered by a diffusion screen allowing air to pass at a constant flow rate. Because the effective sampling rate is relatively low (25 ml/min), passive monitors are typically deployed from days to weeks, depending on the expected nicotine concentration. Exposed filters are extracted and nicotine is typically analysed using either gas chromatography (GC) with a nitrogen/phosphorus detector (NPD), or a mass spectrometer (MS). The TWA airborne nicotine concentration is calculated by dividing the amount of nicotine collected on each filter (μg) by sampled volume of air (m^3).

Nicotine can be measured for a shorter period using active sampling with an adsorbent tube or treated filters. Active sampling for nicotine is typically conducted over a span of hours rather than days or weeks. Laboratory analysis methods are similar as those for passive nicotine sampling.

Active and passive nicotine sampling have been used to estimate SHSe in a variety of microenvironments including homes, hospitals, schools, offices, personal and public transportation, and hospitality venues.[74 76 79–86] As passive monitoring often requires integrating longer sampling intervals, including times without occupancy, TWA nicotine concentrations for passive sampling are usually lower than those obtained by active sampling. Both methods are highly effective, however, at discriminating between environments with and without smoking.[37] The 2006 Report of the Surgeon General summarises studies in indoor venues in the USA.[8] In recent years, numerous studies conducted outside the USA have assessed SHSe levels and evaluated the impacts of policies and controls to reduce exposure.[18 74 87–95]

Nicotine is a tracer compound for SHSe that may not always track the mixture of toxic components found in SHS. The relationship between nicotine and other compounds in SHS may vary over time and space (specifically as nicotine is removed from the air through adsorption to surfaces).

Particulate matter

PM, a widely used measure of indoor SHSe, has been assessed in homes, offices, cars and hospitality venues.[22 43 91 93 96–99] table 3 summarises the key advantages and disadvantages of measuring airborne nicotine and PM for estimating SHSe. PM in indoor air can come from many sources including outdoor air. Although there are several potential sources of PM in indoor environments (eg, cooking with solid fuels, burning candles, outdoor air pollution from open windows or ventilation), tobacco smoking

Table 2 Summary of approaches for measuring environmental markers of secondhand smoke by chemical analyte and sampling method

Chemical analyte references of representative studies	Sampling method*	Comments
Airborne markers		
Nicotine (vapour phase)[5 29–33]	Active, adsorbent-based; integrated Passive, filter-based; integrated	Tobacco specific Majority of nicotine in secondhand smoke (SHS) is vapour phase Widely used tracer for SHS mixture of chemicals
Respirable particulate matter[15 31 32 34–37]	Direct reading Active, filter based	Non-specific, many other indoor and outdoor sources Largest component of SHS Most particles in SHS are <1 micron in diameter
Carbon monoxide[22 29 32 36 38–40]	Direct reading	Non-specific, many other sources, particularly outdoor air Used in early SHS studies
3-Ethenlypyridine (3-EP)[30 34 41–50]	Active, adsorbent based Passive, filter based	Tobacco specific, pyrolysis product of nicotine Vapour phase Levels are typically lower than nicotine
Polycyclic aromatic hydrocarbons[22 34 51–59]	Direct reading Active: integrating Passive: integrating	Class of hazardous chemicals, some of which are carcinogens Can be measured in particle and/or vapour phase Non-specific Sampling and wet laboratory analysis is expensive
Tobacco-specific nitrosamines[51 60–62]	Active: integrating	Tobacco specific Potent lung carcinogen Limited data on indoor air in field settings
Other components[31 40 43 51 56 59–61 63–66]	Various active and passive methods	Not tobacco specific, many other indoor and outdoor sources
Nitrogen oxides		
Aldehydes		
Metals		
VOCs		
Surface markers		
Nicotine[67–73]	Dust vacuum samples Surface wipes	Tobacco specific Measure of long-term exposure May be particularly relevant for children's exposure

*'Direct reading' refers to the sampling and measurement of an analyte in real time. 'Integrating' refers to the collection of a sample over some defined period of time, for which a time-weighted average concentration can be estimated. Active sampling refers to the use of a pump to draw air through a collection device. Passive sampling relies on diffusion.

is often the most significant source in venues where smoking is allowed.[101] In some settings, however, high background concentrations of PM from other sources makes difficult to assess the impact of SHSe directly.[35 102]

PM is typically classified by aerodynamic diameter, for example, PM_{10} is comprised of particles less than 10 μm in aerodynamic diameter. Most particles produced through tobacco smoking are smaller than 1 μm in diameter.[103] For this reason,

Table 3 Comparison of air nicotine and particulate matter monitoring

	Airborne nicotine (passive or active sampling)	Particulate matter (PM) (direct reading or active filter sampling)
Timescale	Duration of sampling depends on the amount of nicotine in the air and sampling method (active vs passive). Active sampling generally requires several hours where as passive sampling may need 1–2 days to 1–2 weeks. For instance in a bar or nightclub where smoking is allowed 1 day of sampling is generally sufficient to provide a precise quantification of nicotine in that environment. For any location, a week of sampling has the advantage to provide a good estimate of time-weighted average concentrations.	Measurements are taken continuously and stored in memory as often as once per second for 6–14 h depending on batteries used. Longer sampling would require plugging in and securing the device. Allows for the examination of changes in secondhand smoke exposure (SHSe) over time. Allows for the measurement of peak concentrations that are not seen with integrated methods. Active filter sampling provides the total mass and can be used to identify specific chemical constituents measured over the sample duration.
Sensitivity	A sufficient amount of nicotine must be collected on the filter in order to perform quantification in the laboratory. Current laboratory methods are very sensitive allowing for the quantification of ≥0.0026 μg/ml of nicotine. For instance, 1 h of sampling is sufficient to detect an average concentration of 0.22 $\mu g/m^3$ in an environment where this concentration is constant during the hour of sampling. Nicotine is highly sorbing relative to other SHS compounds.	Highly sensitive to tobacco smoke; the machine detects levels as low as 1 $\mu g/m^3$ of PM while cigarettes emit large quantities of PM, about 14 000 μg per cigarette
Specificity	Highly specific to tobacco smoke. Tobacco is generally the only source of nicotine.	PM is not specific to tobacco smoke and there are many other sources of PM present at all times. Especially at low concentrations it may be difficult to distinguish tobacco smoke PM from other sources. Aerosol-specific calibration required.
Correlation between markers	Both are correlated with other SHS constituents. Especially in places where there is consistent smoking there is a good correlation between nicotine and $PM_{2.5}$ with an increase of about 10 μg of $PM_{2.5}$ for each 1 μg of nicotine.	
Communication	Because there is no safe level of SHSe the concentration of nicotine in the environment should be zero (ie, undetectable). Any level of exposure increases health risk, although the risk is substantially higher with increasing concentrations. Nicotine itself can be of health interest as it may have some cardiovascular effects. Comparisons of air nicotine concentrations in different locations, including smoke-free environments are powerful tools in support of smoke-free initiatives. Difficult to predict health risk associated with levels of nicotine concentrations in the environment.	$PM_{2.5}$ has known direct health effects in terms of morbidity and mortality. There are existing health standards for $PM_{2.5}$ in outdoor air (USEPA and WHO) that can be used to communicate the relative harm of $PM_{2.5}$ levels in places with smoking. The continuous nature of sampling allows for the creation of real-time plots showing levels minute-by-minute, which can be powerful communication tools.
Cost	No expensive equipment to buy up front and minimal operating cost. Per sample laboratory costs including the filter badge are approximately US $40–$100.	High initial investment (approximately US$3000) but minimal operating cost. No per sample costs, that is no laboratory costs or consumables. Potential costs in labour for data reduction and analysis

Modified from Avila-Tang, 2010.[100]
PM, particulate matter; USEPA, United States Environmental Protection Agency.

$PM_{2.5}$, also known as fine PM, is frequently used as an indirect measure of SHS. Fine PM refers to PM with more potential to cause injury than larger PM because it can penetrate to the gas exchange region of the lung.[104] Many studies have shown that ambient fine PM is a risk factor for increased respiratory and cardiovascular morbidity and mortality.[104] As a result, the US Environmental Protection Agency regulates outdoor PM and the WHO has proposed PM guidelines for outdoor and indoor air quality.[105–107] Although these standards may provide useful comparisons for measured indoor air concentrations, it is important to note that they are based on average daily or annual levels of ambient PM and are not specifically applicable to PM from SHS, although there are similarities.[108]

PM in indoor environments can be measured through direct reading or active sampling using a filter to collect the particles. Direct-reading devices use a pump to draw air through a light-scattering sensor measuring the real-time concentration of PM in mg/m^3, which is recorded continuously are widely used.[15 38 91 97 109] Direct reading PM monitors, which measure exposure in real time, may be based on other methods of analysis such as a piezobalance technique.[15 22 32 37 110] Regardless of the detection principle, direct reading PM instruments must be calibrated against gravimetric methods to be used to assess SHSe directly. This is a significant limitation as gravimetric calibration factors can be very different for different aerosol sources and mixtures. If used to evaluate the relative (not absolute) contribution of smoking-related PM to different environments, calibration is less important. A calibration may be an over or under estimate and may differ based on the type of monitoring and machines used. Also, the degree of bias in light-scattering instruments increases at high relative humidity (>60%)[111] and, as a result, readings of these instruments must be corrected for humidity effects.[112]

PM can also be measured directly using active, filter-based sampling followed by gravimetric analysis. PM collected on filters can also be speciated in a laboratory to identify the concentrations of chemical constituents, such as Polycyclic aromatic hydrocarbons (PAHs) or metals. Other types of PM measurements less widely used include ultraviolet PM, fluorescing PM and solanesol PM.

Carbon monoxide (CO)

Carbon monoxide is a gaseous byproduct of incomplete combustion,[25] and has historically served as a marker for SHS.[29 32 36 39 40 113–115] While CO is not tobacco specific and levels may increase due to ambient air pollution and indoor sources, studies have demonstrated its usefulness in discriminating between outdoor and non-smoking and smoking environments, especially if cigars are being smoked.[22 38 115 116] CO can easily be measured using direct reading instruments containing a CO specific electronic sensor. The use of direct reading monitors makes measuring CO relatively simple.[15 31 32 113]

3-Ethenylpyridine (3-EP)

The decomposition of nicotine through pyrolysis yields vapour phase 3-EP, and 3-EP is more stable than nicotine in indoor air.[50 117] The surface absorption rate of 3-EP is also lower than that of nicotine.[50] Since 1998, a number of studies have used 3-EP as a SHS marker, mostly tobacco-industry funded,[41 42 46 47 118] and have shown elevated levels of 3-EP in smoking versus non-smoking areas and high correlations with nicotine and other markers.[30 41 47] Concentrations of 3-EP in the air are typically lower than those of nicotine, resulting from a greater number of non-detectable samples.[8 118] Sampling methods for detecting 3-EP include active and passive sampling approaches. Laboratory analysis uses GC-MS or NPD.

Polycyclic aromatic hydrocarbons (PAHs)

PAHs are produced during the incomplete combustion of organic materials.[25 119] There are over 100 different PAHs, and typical human exposure occurs to mixtures of these compounds. In addition to cigarette smoke, airborne sources of PAHs include automobile exhaust, coal combustion, wood burning and wildfires; dietary sources of PAH include grilling or charring meat. Because PAHs are not specific to tobacco, they are not routinely used as SHS markers. Some studies have shown increased concentrations of PAHs in association with greater SHSe,[51 56] while others have demonstrated no association.[57] This may be due in part to the contribution of other sources of PAHs.[51 56 57] Recent studies, however, have shown that cigarettes emit of the order of 14 ng/cigarette, and they report strong correlations between PM and PAH in smoking environments.[12 120]

Although there are more than 100 PAHs, only 10–16 are routinely measured, primarily because of the analytical techniques available.[121] Further, PAHs can be found in the particle phase and the vapour phase. As a result, comparisons across studies can be highly dependent on the sampling method, specific analytes measured, their physical phase and the level of background exposure. Depending on the phase of PAHs (particle or vapour), these compounds can be measured through direct reading[22] or active integrated sampling, and also with real-time monitors.[120 122 123] Laboratory analysis is conducted using GC-MS.

Tobacco-specific nitrosamines (TSNAs)

TSNAs such as NNK are potent carcinogens found in tobacco smoke. TSNAs metabolites, such as NNAL (4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol) have been used as SHSe biomarkers and indicators of risk of cancer and respiratory disease.[124 125] Limited data exist to date on concentrations of NNK or other TSNAs in indoor air following tobacco smoking.[61 62] The studies that have been published were conducted in controlled environments, rather than in field settings.[51 62] Given the specificity to tobacco and the health risk implications of TSNAs, further research is needed to characterise the feasibility and utility of measuring this class of compounds in indoor air as SHSe markers.

Other constituents

Many other constituents of tobacco smoke have been evaluated as SHSe markers.[31 40 42 51 63] These include nitrogen oxides, aldehydes, metals and volatile organic compounds; all are non-specific to tobacco smoke but are present in it. Because of their non-specificity to SHS, these analytes are often measured in conjunction with others.

Dust/surface sampling

Dust or surface nicotine concentration can be a surrogate for long-term SHSe and may reflect the potential for indirect exposure. Dust and surface samples have been collected using a handheld vacuum cleaner containing a filter and cotton wipes treated with ascorbic acid.[67–70 72 73 109 126 127] Carpets tend to accumulate more contaminants than hard surfaces and are more likely to represent long-term reservoirs of tobacco smoke constituents. Nicotine has been measured in dust samples using GC-MS[67] with findings reported as concentration in ng/mg dust or in units of $\mu g/m^2$ (dust loading). Wipe samples are analysed with HPLC-tandem mass spectrometry. Nicotine concentrations

are typically reported as the mass of nicotine per wipe or per square metre of surface area.

Correlations between house dust nicotine levels and urinary cotinine concentrations and between self-reported smoking in the home have been reported.[67 70 71] In particular, long-term smoking behaviour was predictive of dust nicotine concentrations, suggesting that dust nicotine concentration reflects long-term, cumulative smoking habits, rather than just current smoking behaviour. Studies have suggested that it may be easier to eliminate tobacco-related compounds from air, and that surfaces and dust are long-term reservoirs of tobacco smoke contamination.[67 70–73 126 128 129] Contaminated microenvironments have been described as a source of third-hand smoke (THS) exposure.[130] This concept appears useful because it discriminates differences in toxic agents due to ageing of chemicals from cigarettes and because it offers distinct sources of exposure through physical contact. More research is needed on the dynamics of THS exposure.

CORRELATIONS BETWEEN AIRBORNE NICOTINE, PARTICULATE MATTER AND SMOKING INTENSITY

Nicotine and PM have been among the most widely used environmental SHSe markers. These components have most often been measured separately, so that their relationship to each other has received little attention. In this section, the relationship between airborne nicotine concentrations, PM concentrations, and reported smoking intensity in indoor environments is addressed. Knowledge of relationships among these quantities is useful for retrospective exposure assessment, litigation, or to predict likely exposures and risks.

Nicotine and particulate matter (PM)

Several studies have characterised the relationship between nicotine and PM concentrations in indoor environments (table 4). In all, 17 published articles were identified using PubMed in late 2008 that reported 20 correlations. Correlations between air nicotine and PM concentrations ranged from 0.41 to 0.98.[5 32 34 35 46 79 82 91 131–139] One tobacco industry-funded study conducted in several countries throughout Asia, Europe and North America reported widely disparate findings and was excluded from the summary described here.[41]

These correlations were used to generate a regression slope of the relationship between nicotine and PM concentrations, weighted by the number of samples in the study. The slopes for respirable suspended particles (RSP) and $PM_{2.5}$ were analysed separately and found to be similar. This is not surprising since in environments where SHS is the dominant source of PM, RSP and $PM_{2.5}$ samples will provide similar exposure estimates. A weighted slope of 10.3 $\mu g/m^3$ PM per $\mu g/m^3$ of airborne nicotine was estimated, which is in agreement with the slope reported in the 2006 SGR[8] which concludes, 'for each microgram of atmospheric nicotine in the various environments where people spend time, there is an estimated increase of about 10 μg in second-hand smoke particle concentrations'.[8]

Although the findings from most studies were generally consistent, variability between nicotine and PM has been reported and could be due to several factors. First, PM can be generated from other non-smoking sources in the indoor environment. Second, several size cut-offs have been used to measure PM in relation to SHS. For example, Rumchev *et al*[138] measured PM_{10}, Bolte *et al*[34] measured $PM_{2.5}$, and Ellingsen *et al*[132] reported measuring airborne dust collected on filters with a pore size=1.0 μm. In addition, the collection sampling times between and among studies varied dramatically, from several hours to more than 2 weeks. For example, Bolte *et al*[34] sampled air nicotine and PM actively for 4 h, Rumchev *et al*[138] collected PM actively and nicotine passively for 24 h, and Agbenyikey *et al*[91] collected PM actively for 30 min and nicotine passively for 7 days. It is expected that correlations between samples collected over different timeframes would be lower than for samples collected for the same period.

Variability in the relationship between nicotine and PM may also depend on the smoking history of the environment and the characteristics of the indoor space, including wall and floor composition.[140] Although nicotine can be measured in the particle phase, it is found mostly in the vapour phase in SHS. Vapour phase nicotine has different removal processes than particles (eg, adsorption to surfaces and re-emission into the environment).[131 140] Despite variation across studies, a moderate to strong correlation was most often found between concentrations of these two SHS tracers.

Nicotine and smoking intensity in field settings

Few studies describe the slope of the relationship between nicotine concentration and cigarettes smoked. Leaderer and Hammond[35] report that for each cigarette smoked, week-long air nicotine concentrations measured in the main living area of residences increased by 0.026 $\mu g/m^3$, on average. Among 12 studies identified using PubMed in late 2008, the correlations ranged from 0.25 to 0.88. One limitation to comparing the associations is the differing characterisations of smoking intensity. For example, Berman *et al*[141] used 'cigarettes per day smoked in the home', while O'Connor *et al*[142] used 'total number of smokers to whom the subject was exposed'.[143] Varying SHSe indices have been used, including hours of SHSe, number of smokers and proximity. The majority of measures for cigarettes smoked are questionnaire based, while some studies employed more detailed information including daily records of

Table 4 Studies reporting the particulate matter to airborne nicotine relationship (ratio) in indoor environments

Location	Sampling method and time frame	N	Slope	Reference
16 US cities, personal exposure	PM (RSP) and nicotine: active; collected together	1498	10.9	131
New York State, USA, homes	PM (RSP): activeNicotine: passive, colocated: 1 week	47	9.8*	35
USA, railroads	PM (RSP): activeNicotine: active, collected together, 2 days	306	8.6	84
Norway, hospitality venues	PM (airborne dust) and nicotine: active, stationary, sampled in parallel	48	7.1	132
Metro Boston, USA	$PM_{2.5}$: activeNicotine: passive, collected together, 2 days, only during public access	57	9.1†	82
USA, truck cabs	$PM_{2.5}$ and nicotine: active; sampling times comparable	16	5.2‡	133
Weighted slope		**1972**	**10.3**	

All PM and air nicotine measurements were reported in units of $\mu m/m^3$. Studies that used log transformed data or differing time frames for PM and nicotine were excluded.
*Reported slope represents only residences with reported cigarette consumption. All residence (N=96) slope=10.8.
†Reported slope excludes two largest points. Authors also present slope representing all data points, slope=14.8.
‡Nicotine collected using stand alone filter. Authors also collected nicotine inline after PM collection, slope using inline =5.5.
PM, particulate matter; RSP, respirable suspended particles.

Table 5 Hierarchy of secondhand smoke exposure assessment using environmental markers for epidemiological studies

Feasibility	Approach
Most feasible Less ideal	Modeled concentrations of relevant environments combined with survey data on typical time-activity-location.
	Modeled concentrations in relevant environments combined with individual questionnaires;
	Personal sampling of other individuals to establish typical exposures, combined with individual data on how the experience of subjects may vary from those of the people sampled ;
	Area sampling in the microenvironments of each individual at a later time period and adjusted for temporal changes (e.g., prevalence of smoking) combined with questionnaire data for the relevant time period;
	Area sampling in the microenvironments of each individual during the relevant time period combined with time activity diary data for that time period;
	Personal sampling to establish typical exposures, which are then combined with knowledge of historical changes and time activity to estimate current or historical exposures during the relevant time period;
Least feasible Ideal	Personal sampling during the entire time period relevant to the health effect under study;

children's exposure kept by parents[144] or observation during the sampling time.[139] Overall, the expected positive association between cigarettes smoked and air nicotine concentration in real-world field settings has been established.

Particulate matter and smoking intensity in field settings

The literature generally suggests an increase of 1 $\mu g/m^3$ of PM for each cigarette over an extended period of time.[69 145 146] Across studies reviewed, correlations in field locations ranged from 0.44 to 0.82.[12 34 35 69 135 147–151] The descriptors used for cigarettes smoked in these studies are even more varied than those used in the nicotine studies. For example, Hyland *et al* use active smoker density (eg, average number of burning cigarettes per 100 cubic metres),[147] Bolte *et al* use number of smokers in the location,[34] Brauer *et al* use the average number of burning cigarettes counted,[148] while Leaderer and Hammond *et al* use the number of self-reported cigarettes smoked during the sampling period.[35] These were also collected through self-reported questionnaires or observation. Even though PM can be produced by sources other than cigarette smoking, it is clear that there is a positive relationship in field settings between the amount of smoking taking place and PM concentrations.

Environmental SHS monitoring has numerous applications in research and policy development, including studies on the adverse health effects of SHSe, research supporting development and evaluation of smoke-free legislation, and evaluations of the impact of interventions and control measures to reduce SHSe (table 5).

CONCLUSIONS

This topic assessment summarises the most widely used methods and applications for SHS environmental monitoring, including vapour-phase nicotine and respirable PM. Air nicotine measurement has the advantage of being tobacco specific. Additionally, sample collection methods are relatively straightforward, and analytical methods are sensitivity at low concentrations. However, to date, methods to measure real-time concentrations of air nicotine are not available, and therefore laboratory analysis is necessary. Airborne PM in indoor environments can be measured through direct reading or active gravimetric sampling. Direct reading instruments generate real-time concentrations; however, although tobacco smoking remains a significant source of PM in venues where smoking is allowed, in some settings, high background concentrations may make it difficult to assess small increases or changes in SHSe directly. In general, when nicotine and PM are measured in the same setting using a common sampling period, an increase in nicotine concentration of 1 $\mu g/m^3$ corresponds to an average increase of 10 $\mu g/m^3$ of PM. TSNAs, which are potent human carcinogens, may prove to be particularly useful SHS markers. However, to date, limited field studies have been undertaken to validate their use. In more recent years, environmental SHS monitoring has included nicotine measurement in dust and on surfaces in homes and other indoor environments to assess long-term SHSe and the potential for indirect exposure. Future studies should focus on validating dust measures as surrogates for long-term SHSe and as a possible route for indirect exposure, particularly for children. Environmental SHS monitoring should continue to provide important evidence needed to develop and implement tobacco control policies around the world.

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There is No Risk-Free Level of Exposure to Secondhand Smoke

The U.S. Surgeon General has concluded that breathing even a little secondhand smoke poses a risk to your health.

- Scientific evidence indicates that there is no risk-free level of exposure to secondhand smoke. Breathing even a little secondhand smoke can be harmful to your health.

Secondhand smoke causes lung cancer.

- Secondhand smoke is a known human carcinogen and contains more than 50 chemicals that can cause cancer.
- Concentrations of many cancer-causing and toxic chemicals are potentially higher in secondhand smoke than in the smoke inhaled by smokers.

Secondhand smoke causes heart disease.

- Breathing secondhand smoke for even a short time can have immediate adverse effects on the cardiovascular system, interfering with the normal functioning of the heart, blood, and vascular systems in ways that increase the risk of heart attack.
- Even a short time in a smoky room can cause your blood platelets to become stickier, damage the lining of blood vessels, decrease coronary flow velocity reserves, and reduce heart rate variability.
- Persons who already have heart disease are at especially high risk of suffering adverse affects from breathing secondhand smoke, and should take special precautions to avoid even brief exposure.

Secondhand smoke causes acute respiratory effects.

- Secondhand smoke contains many chemicals that can quickly irritate and damage the lining of the airways.
- Even brief exposure can trigger respiratory symptoms, including cough, phlegm, wheezing, and breathlessness.
- Brief exposure to secondhand smoke can trigger an asthma attack in children with asthma.
- Persons who already have asthma or other respiratory conditions are at especially high risk for being affected by secondhand smoke, and should take special precautions to avoid secondhand smoke exposure.

Secondhand smoke can cause sudden infant death syndrome and other health consequences in infants and children.

- Smoking by women during pregnancy has been known for some time to cause SIDS.
- Infants who are exposed to secondhand smoke after birth are also at greater risk of SIDS.
- Children exposed to secondhand smoke are also at an increased risk for acute respiratory infections, ear problems, and more severe asthma. Smoking by parents causes respiratory symptoms and slows lung growth in their children.

Separating smokers from nonsmokers, cleaning the air, and ventilating buildings cannot eliminate secondhand smoke exposure.

- The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the preeminent U.S. standard-setting body on ventilation issues, has concluded that ventilation technology cannot be relied on to completely control health risks from secondhand smoke exposure.
- Conventional air cleaning systems can remove large particles, but not the smaller particles or the gases found in secondhand smoke.
- Operation of a heating, ventilating, and air conditioning system can distribute secondhand smoke throughout a building.

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COMMISSION STAFF WORKING DOCUMENT

Report on the implementation of the Council Recommendation of 30 November 2009 on Smoke-free Environments (2009/C 296/02)

Report on the implementation of the Council Recommendation of 30 November 2009 on Smoke-free Environments (2009/C 296/02)

According to conservative estimates, over 79000 adults, including 19000 non-smokers, died in the EU-25 in 2002 due to the exposure to tobacco smoke at home (72 000) and at their workplace (7 300).[1] In this light, in November 2009 the Council adopted a Recommendation on Smoke-free Environments[2] (hereafter 'Recommendation'). The Recommendation calls on Member States to *"provide effective protection from exposure to tobacco smoke in indoor workplaces, indoor public places, public transport and, as appropriate, other public places"*. The Recommendation has taken inspiration from Article 8 of the WHO Framework Convention on Tobacco Control (FCTC)[3] and the corresponding guidelines on protection from exposure to tobacco smoke, as adopted by the Second Conference of the Parties to the FCTC[4] in 2007.

The Recommendation invites Member States to introduce smoke-free environments no later than November 2012 and invites the Commission to report on the implementation, functioning and impact of the measures. To prepare this report the Commission analysed responses to two questionnaires sent to Member States in 2012. Information was also received by Turkey, Serbia, Former Yugoslav Republic of Macedonia, Iceland, Croatia and Norway[5]. Information from the 2012 Eurobarometer Special Report[6] and relevant scientific studies were also used. The focal points appointed by the Member States were consulted on the draft report.

While the Recommendation is not legally binding, it reflects Member States political commitment to protect their citizens against second hand smoke and constitutes an important tool to benchmark Member States against best practices developed in the EU.

1. MAIN COMMITMENTS UNDER THE RECOMMENDATION

The Recommendation calls on Member States to introduce smoke-free environments by November 2012. Smoke-free environments should be created in particular for "indoor workplaces", "indoor public places", "public transport" and "other public places". Special emphasis is placed on measures to protect children and adolescents.

The Recommendation also calls for the adoption of complementary tobacco control policies, in particular in the areas of cessation and treatment of tobacco dependence, as well as for the adoption of comprehensive multi-sectorial strategies. To facilitate implementation and monitoring the Recommendation calls for the appointment of national focal points, which can also serve for the exchange of information and best practices.

The main objective of smoke-free environments is to protect EU citizens against the exposure to second hand tobacco smoke. Smoke-free environments might also have the potential to incentivise established smokers to quit smoking.

2. RESULTS

Progress made by Member States to implement the Recommendation is summarised below under the headers (1) legislation on smoke-free environments, (2) enforcement of the legislation, (3) protection of children and adolescents including complementary measures, (4) measures for cessation, (5) multi-sectorial approach.

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[1] Cf. recital 4 of Council Recommendation of 30 November 2009 on smoke-free enviroments (OJ C296, 5.12.2009, p. 4.).
[2] Council Recommendation of 30 November 2009 on smoke-free enviroments (OJ C296, 5.12.2009, p. 4.).
[3] http://whqlibdoc.who.int/publications/2003/9241591013.pdf
[4] http://www.who.int/fctc/cop/art%208%20guidelines_english.pdf
[5] The questionnaire was also sent to Montenegro who did not reply.
[6] http://ec.europa.eu/health/tobacco/docs/eurobaro_attitudes_towards_tobacco_2012_en.pdf

2.1. LEGISLATION ON SMOKE-FREE ENVIRONMENTS

All Member States have reported that they have legislation in place with the aim to protect their citizens from exposure to tobacco smoke at indoor workplaces, indoor public places, public transport and other public places[7]. However, the scope of this legislation varies considerably from one Member State to another. In certain Member States where the protection of public health falls into the competence of regional bodies there are even significant differences within one and the same Member State. Smoking bans are the most comprehensive in educational establishments, facilities providing services for children, public transport and in the healthcare sector. An overview of national legislation is contained in figure 1 below.

Educational establishments

With regard to educational establishments the vast majority of Member States have banned smoking altogether, even if a few accept some exceptions such as smoking rooms, e.g. for teaching personal. In some Member States smoking is completely banned in institutions of lower education, whereas smoking is allowed, or restricted to smoking rooms in the higher education system/institutions.

Public transport

Legislation against exposure to tobacco smoke in public transport is also well developed. A large majority of Member States report a total ban on smoking. The Member States that do not have a total ban, often have reported limited exemptions, such as Finland, Latvia and Denmark who allow smoking in areas or designated rooms on long distance passenger ships.

Health care facilities

In health care facilities, about half of the Member States have banned smoking completely. The others have introduced partial bans or restrictions that allow some exceptions or smoking rooms or designated smoking areas for either patients and/or employees.

Hotels

The large majority of Member States allow smoking in some hotel rooms or smoking is allowed in the rooms at the owners' discretion. Some Member States allow that a certain percentage of hotel rooms are reserved for smokers (e.g. Finland 10%). In other Member States smoking is not allowed in hotel bedrooms (Cyprus, Austria and Bulgaria).

Residential care facilities[8]

Regarding residential care units, some Member States (Greece, Hungary, Bulgaria and Malta) have reported that smoking is forbidden in these facilities. In Spain smoking is forbidden for staff and visitors in residential care, but allowed for residents under certain conditions.

Prisons

Smoking in prison cells is not allowed in Spain, Malta, Sweden, Bulgaria or Wales.

In most Member States that allow smoking in the "private" rooms (e.g. bedroom of a hotel), smoking in the communal areas/areas open to the public is restricted to designated smoking rooms, or banned altogether in line with the general smoke-free legislation concerning enclosed public places and workplaces.

[7] Some Member States (Belgium, Malta and Slovakia) do not only act against tobacco smoke, but extend their ban to the consumption of electronic cigarettes in enclosed public places, bars and restaurants and other workplaces. Finland reports that several owners/proprietors have banned the consumption of these products on their own accord.

[8] A generic term for a group home, specialized apartment complex or other institution that provides care services (medical, social or other) where individuals live.

Indoor workplaces, enclosed public places, including hospitality sector[9]

The scope of smoke-free legislation in indoor workplaces and public places, in particular in bars and restaurants varies widely between the Member States. The most far-reaching legislation is provided in Hungary, Bulgaria, Spain, Ireland, the United Kingdom, Malta, Greece, Former Yugoslav Republic of Macedonia and Turkey where smoking is completely banned in enclosed workplaces and public places, including bars and restaurants. There are some very limited exemptions in these Member States. 10 other Member States (Belgium, Cyprus, Finland, France, Italy, Latvia, Lithuania, Sweden, Poland, and Slovenia) and Norway and Iceland have a general ban on smoking in workplaces and enclosed public places, but allow separate, enclosed smoking rooms under specific conditions. Some of these countries have stricter legislation in the hospitality sector. In the remaining Member States (Denmark, the Netherlands, Luxembourg, Romania, Portugal, Austria, Germany[10], the Czech Republic, Estonia and Slovakia) and the Republic of Serbia and Croatia smoke-free laws give exemptions for certain public places such as bars and/or restaurants in general, or certain categories of bars and restaurants. In some Member States the legislation differs between the hospitality industry and other workplaces and enclosed public places. Legislation is often less strict in the hospitality sector.

[9] Hospitality sector: a broad category of fields within the service industry that includes restaurants, bars, clubs, cafes, brasseries etc. For the purpose of this report regulation concerning bedrooms and communal areas of hotels and accommodation are not included in the definition as they are dealt with separately in the report.

[10] Smokefree environments are regional competence. Legislation in Germany therefore varies on this point.

Figure 1 - Overview of smoke-free legislation

Legend:

● - Total ban on indoor smoking

◌ - Partial ban on indoor smoking, e.g. smoking zones or exemptions for certain categories of venues

◉ - Ban on indoor smoking, while providing for separate enclosed smoking rooms / Obligation for employer to protect employees

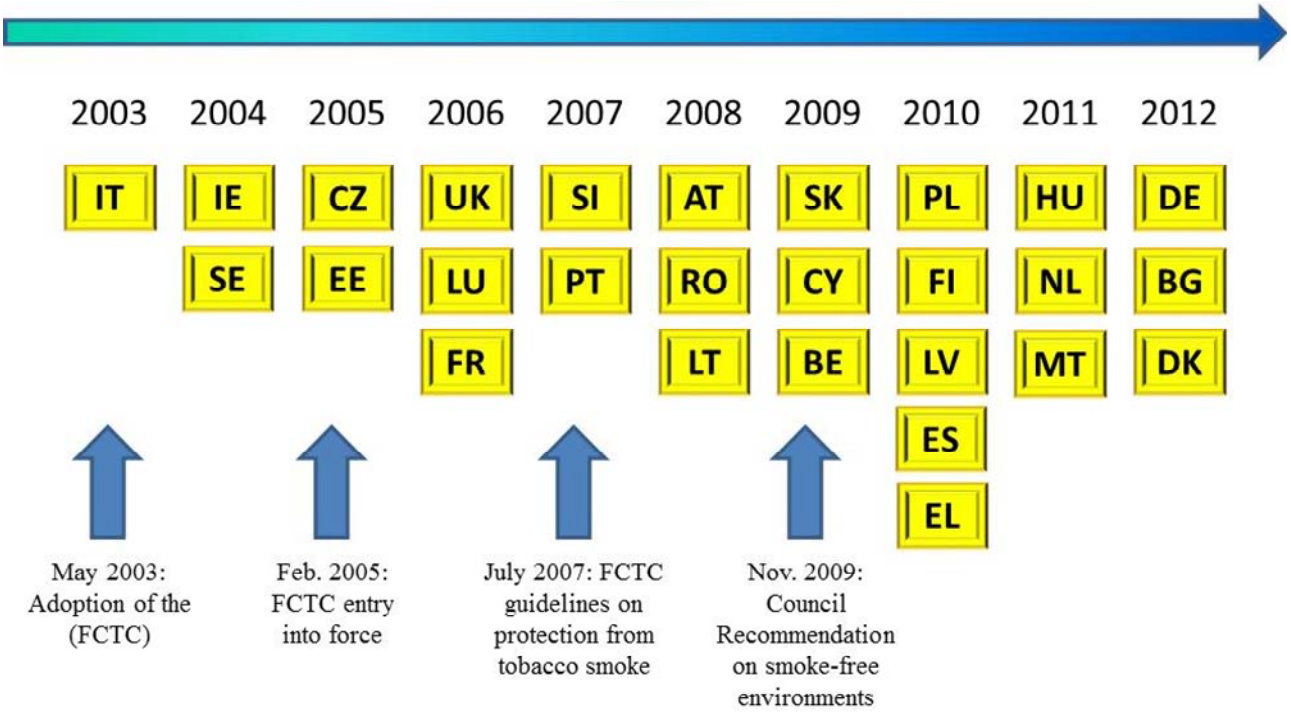
X - Recommendations, suggestions, or no ban

	General Workplace	Enclosed Public Places	Restaurants	Bars	Health Care Facilities	Education Facilities	Public Transport	Hotels & Accommodation	Residential Care	Prisons
Austria[i]	◉	◉	◌	◌	◉	◉	◉	◉	◉	◉
Belgium[ii]	◉	◉	◉	◉	◉	●	●	◉	◉	◉
Bulgaria[iii]	●	●	●	●	●	●	◉	●	●	●
Cyprus[iv]	◉	●	●	●	●	●	●	●	X	◌
Czech Republic[v]	◌	◌	X	X	◉	●	◉	◌	◉	◌
Denmark[vi]	◉	◉	◉	◌	◉	◉	◉	◌	◉	◉
Estonia[vii]	◌	◌	◉	◉	◌	◌	◌	◌	◌	◌
Finland[viii]	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉
France[ix]	◉	◉	◉	◉	●	●	●	◉	◉	◉
Germany[x]	◉	◉	◌	◌	◉	◉	◉	◉	◉	◉
Greece[xi]	●	●	●	◌	●	●	●	◉	●	●
Hungary[xii]	●	●	●	●	◉	●	●	◉	●	◉
Ireland[xiii]	●	●	●	●	●	●	●	◉	◉	◉
Italy[xiv]	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉
Latvia[xv]	◉	●	●	●	◉	●	◉	◉	◉	◉
Lithuania[xvi]	◉	●	●	●	●	●	◌	◌	◉	◉
Luxembourg[xvii]	◉	●	◉	◌	◉	●	◉	◉	◉	◉
Malta[xviii]	●	●	●	●	●	●	●	◉	●	●
Netherlands[xix]	◉	◉	◉	◌	◉	◉	◉	◉	◉	◉
Poland[xx]	◉	●	◉	◉	●	◉	◉	◉	◉	◉
Portugal[xxi]	◌	◌	◌	◌	◌	◉	●	◌	◌	◉
Romania[xxii]	◉	◉	◌	◌	●	◉	●	◌	◉	◉
Slovakia[xxiii]	◉	●	◉	X	●	●	◉	◉	◉	◉
Slovenia[xxiv]	◉	◉	◉	◉	●	●	◉	◉	◌	◉
Spain[xxv]	●	●	●	●	●	●	●	◉	◉	◉
Sweden[xxvi]	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉
Unit. Kingdom[xxvii]	●	●	●	●	●	●	●	◉	◉	◉
Turkey[xxviii]	●	●	●	●	●	●	●	◉	●	◉
FormerYugoslav Republic of Macedonia	●	●	●	●	●	●	●	●	●	●
Norway[xxix]	◉	◉	●	●	◉	●	◉	◉	◉	◉
Serbia[xxx]	●	●	◌	◌	●	●	●	◉	◉	◉
Iceland	◉	●	●	●	●	●	●	◉	◉	◌
Croatia	X	◉	◉	●	●	◉	◉	◌	◌	◌

This overview is based on the analysis of the relevant legal provisions in each Member State as of January 2013, but does not take into account their enforcement nor does it reflect forthcoming legislative changes or plans in Bulgaria, the Czech Republic, Denmark, Estonia, Finland, Hungary, Latvia, Luxembourg, Portugal, Romania, Sweden and Norway.

In terms of timing many Member States started introducing comprehensive smoke-free legislation, including bans in the hospitality sector very early, with Ireland being the first European country to do so in a comprehensive manner in 2004. Other Member States for example, the United Kingdom, Slovakia, Greece, Hungary, the Czech Republic, Estonia and Poland followed in the years thereafter. However, many Member States did not adopt national legislation until after the adoption the FCTC guidelines (2007) and after the Council Recommendation (2009) as shown in figure 2. The Commission was in close contact with a number of Member States following the adoption of the Recommendation and assisted them in developing their legislation, e.g. by pointing to best practices (Poland (2010), Luxemburg (2011), Hungary (2011), Bulgaria (2012)).

Figure 2 - Adoption of most recent smoke – free legislation in the EU 2003-2012



2.2. ENFORCEMENT OF NATIONAL LEGISLATION

Legal framework for the enforcement

All Member States reported that measures are in place for effective enforcement of their policy. In most cases health authorities are responsible, but responsibilities are often shared with other bodies/agencies such as labour authorities, police, and food safety agencies.

All Member States have introduced sanctions for non-compliance, the most common being fines. In cases of repeated violations, the establishment may lose its license (Romania, Portugal, Ireland, Malta and Austria). Fines for individuals are generally at a lower level than those that can be imposed on the business. Typically the level depends on factors such as gravity of the offence, whether it is a repeated act, or the firm's turnover. The sanctions range from EUR 14 (individual) in Latvia to EUR 10 000 for repeated business violations in Austria and Greece.

All Member States have reported about actual enforcement activities and several cases have been decided in the courts. Lack of resources is most often reported to be the main difficulty in enforcement efforts. Several Member States have reported that enforcement in the hospitality sector is most challenging. A specific enforcement difficulty is measuring the size of venues in Member States where there are exemptions for certain venues and these exemptions are based on the size of the venue.. Other difficulties are "covered outdoor areas" in colder months (e.g. covered terraces) or the designation of certain rooms as “private” in order to allow smoking indoors. It is reported that

exemptions relating to outdoor areas in licensed premises is challenging and that there have been several court cases concerning this issue. It is also reported that enforcement is difficult in prisons, psychiatric hospitals, nursing homes and outdoor areas of health and educational facilities.

A German survey[11] has concluded that the multitude and complexity of the exemptions in the individual German states have made it virtually impossible to monitor compliance with the ban on smoking in bars and restaurants, and legal violations are an everyday occurrence. This suggests that complicated legislation is more difficult to enforce and leads to lower compliance.

The information provided by Member States and studies show that complex legislation with many exemptions is more likely to lead to diverging interpretation, problems with enforcement and compliance and therefore appears to lead to inferior protection[12]. A study reported by Finland[13] showed that the exposure to tobacco smoke of employees in workplaces with designated smoking rooms is significantly higher than the exposure of employees who work in totally smoke-free workplaces. The report calls for legal amendments. A Spanish study[14] shows that best protection is achieved by a comprehensive ban.

Actual exposure to second hand tobacco smoke in the EU

The Eurobarometer survey of 2012[15] on exposure to tobacco smoke shows that - despite a significant reduction in EU citizens' exposure since the last survey in 2009 - a significant number are still exposed to second hand smoke. More specifically, the exposure was 28% of EU citizens who visited[16] a **drinking establishment** in the preceding six months[17] and 14% of citizens who visited eating places. At work places the exposure rate to second hand smoke was still 6%. The subsequent figures (3a, 3b and 3c) provide an overview per sector and Member State.

According to the Eurobarometer results of 2009 and 2012, exposure in work places remained at the same level or dropped in all but four Member States (Cyprus, the Netherlands, Slovakia and Czech Republic). Over the same period, exposure in restaurants dropped in all but 4 Member States (Estonia, Ireland, Greece and Portugal). Results are less positive as regards bars, where exposure increased in this period in at least 7 Member States (Czech Republic, Denmark, Estonia, Ireland, Greece, Luxembourg and Portugal).

[11] Evaluations from Germany: http://www.dkfz.de/de/tabakkontrolle/download/Publikationen/AdWfP/AdWfP_Ineffectiveness_of_smoking_bans_in_Germany.pdf

[12] Evaluations from Germany: http://www.dkfz.de/de/tabakkontrolle/download/Publikationen/AdWfP/AdWfP_Ineffectiveness_of_smoking_bans_in_Germany.pdf

[13] Heloma A. et al. Exposure to secondhand smoke in Finnish workplaces and compliance with national smoke-free workplace legislation. Scandinavian Journal of Public Health. 2011

[14] Lopez MJ, Nebot M, Schiaffino A, Perez-Rios M, Fu M, Ariza C, Munoz G, Fernandez E. Two-year impact of the Spanish smoking law on exposure to secondhand smoke: evidence of the failure of the 'Spanish model.' *Tob Control 2012;*. 21: 407-11.

[15] http://ec.europa.eu/health/tobacco/docs/eurobaro_attitudes_towards_tobacco_2012_en.pdf

[16] For the purpose of this report the data on exposure in figures 3a & b is only for those patrons who actually visited an eating or drinking establishment.

[17] The figure was established by deducting those persons that did not visit a drinking place.

Figure 3a - Exposure to second hand tobacco smoke in EU-27 in 2009 and 2012

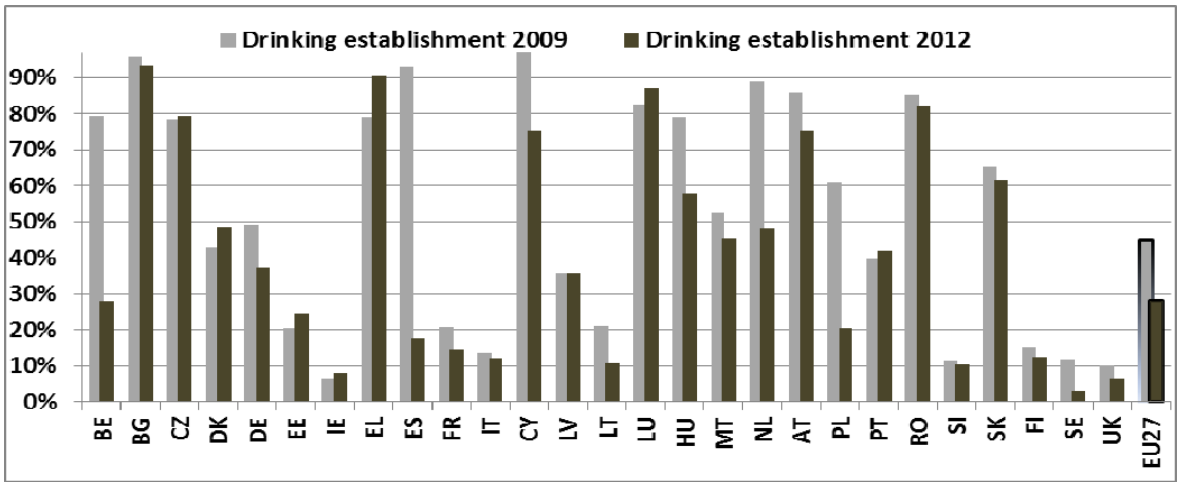


Figure 3b - Exposure to second hand tobacco smoke in EU-27 in 2009 and 2012

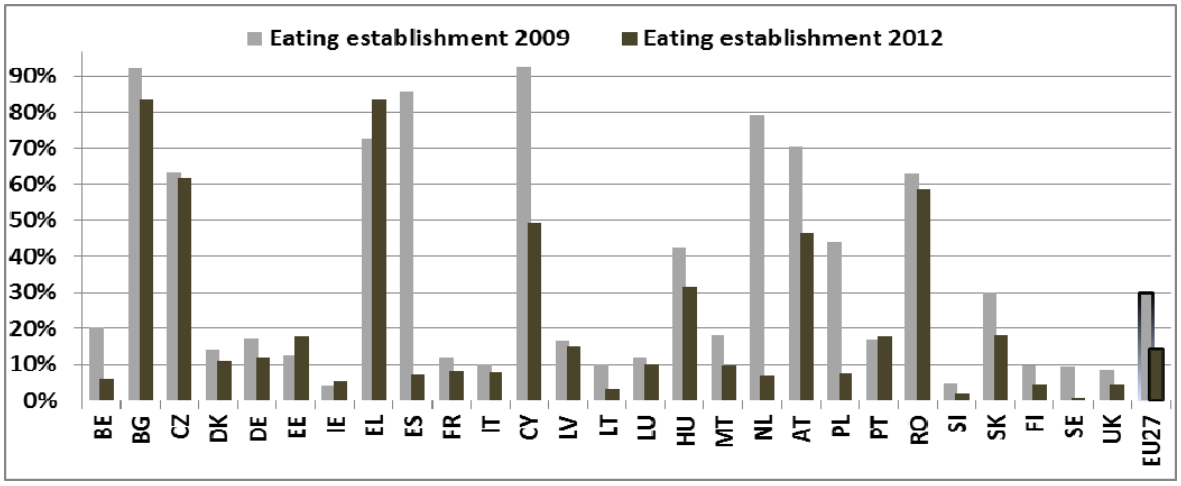
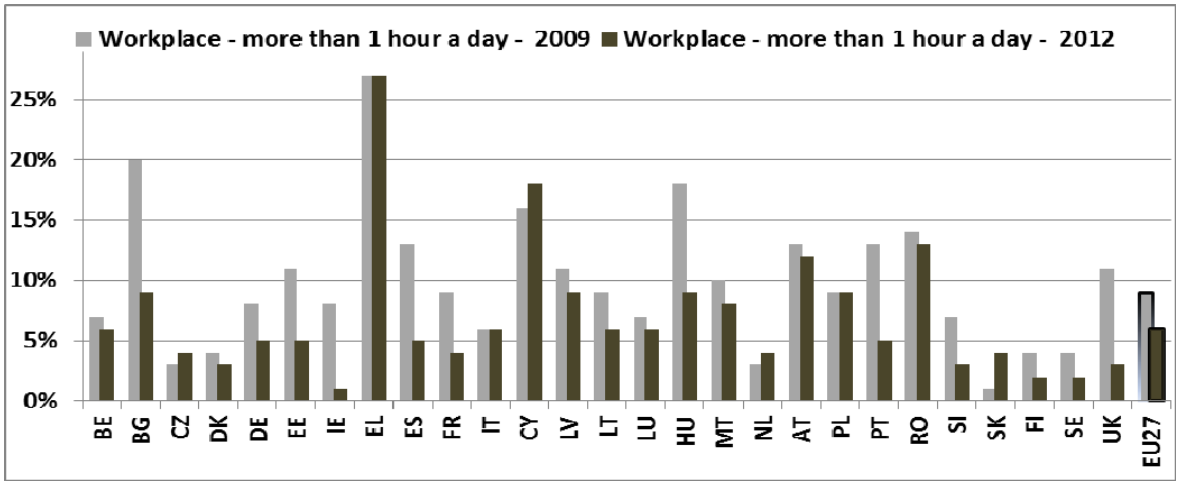


Figure 3c - Exposure to second hand tobacco smoke in EU-27 in 2009 & 2012

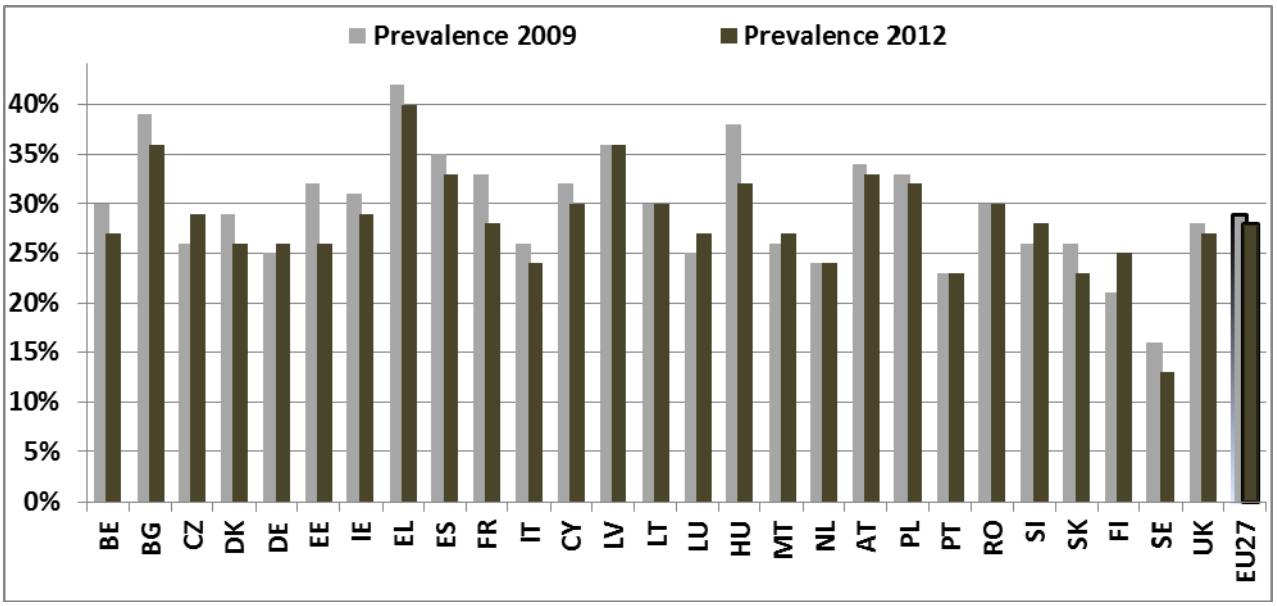


Some Member States[18] reported national exposure data. In a number of cases the information deviates from the Eurobarometer data. Different sample sizes and other methodological issues may account for these differences.

Respondents in Greece (71%), Bulgaria (69%)[19] and Luxembourg (68%) are the most likely to say that - when they visited a drinking establishment within the last 6 months – they were exposed to tobacco smoke. In contrast, very few respondents in Sweden (3%), the United Kingdom (6%), Lithuania (8%), Ireland (8%) and Finland (9%) have recently been to a drinking establishment where people smoked inside. The largest decrease is observed in Spain (-70 points). Large drops are also observed in Belgium, the Netherlands and Poland. It is apparent that the drops in Spain, Belgium and Poland followed the entry into force of amendments to their smoke-free legislation underlying the impact of such measures.

When comparing the actual level of exposure with the legislation on smoke-free environments formally in place, it is clear that some Member States do quite well in terms of enforcement. This is for example the case in Sweden and the United Kingdom. In Sweden very few eating and drinking establishments have enclosed smoking rooms, despite the fact that the legislation allows it. In other Member States the high exposure rates are either the result of a lack of enforcement or of a lack of ambition in terms of legislation or both. In some cases stricter legislation only came into effect after the Eurobarometer survey (e.g Bulgaria). The national prevalence level for smoking can also play an important role when it comes to enforcement (see figure 4). In Member States with high prevalence levels effective enforcement might be more challenging taking into account that smoking is perceived as more acceptable. However even Member States with a prevalence level exceeding 30% have managed to reduce exposure to second hand smoke very significantly (e.g. Spain, Poland).

Figure 4 – Prevalence in EU 27 2009 -2012



[18] National data: Denmark reported that 41 % were exposed to tobacco smoke in bars in 2012, 15 % in restaurants and 16 % in other workplaces. Hungary reported that 47 % were exposed to tobacco smoke in bars,, 19 % in restaurants and 33 % in other workplaces. Latvia contests Eurobarometer data, but does not have national data on exposure. Romania reported that 94 % were exposed to tobacco smoke in bars, 86 % in restaurants and 34 % in workplaces. France reported that 5 % were exposed in bars, 3 % in restaurants and 21 % in workplaces. Italy reported that 12 % were exposed in restaurants and 10 % in workplaces in 2011. Slovenia reported that 9 % were exposed in bars, 9 % in restaurants and 14 % in workplaces. Estonia reported that 22 % were exposed in the workplace.

[19] In Bulgaria the total smoking ban did not enter into force until 1 June 2012. Before this time smoking was allowed in bars and restaurants under 50 m2, in all-night premises in designated smoking rooms during the day, and everywhere after 22:00 in night bars. This may account for the high exposure reported in this country.

2.3 EXPOSURE TO TOBACCO SMOKE IN PRIVATE PLACES

While the exposure to tobacco smoke in private places (homes, cars) is not covered by the Recommendation, a number of Member States have nonetheless provided information. The underlying reason is that the Recommendation invites Member States to pay particular attention to the protection of children and adolescents. In Member States with comprehensive smoke-free legislation in public places and high enforcement levels, smoking in private places is the most likely risk for children and adolescents to be exposed to second hand smoking.

Most Member States have not introduced legislative measures to protect children against tobacco smoke in homes and cars. Cyprus has banned smoking in cars if children under 16 are present. Similar legislation has been proposed by the Irish Ministry of Health. The National Public Health Institute in Sweden has been tasked to prepare a report on exposure to tobacco smoke as a basis for potential new legislation, which would include regulation of smoking in outdoor areas, particularly those that are frequented by children and adolescents. In Norway the government has proposed a ban on exposing children to tobacco smoke. Icelandic legislation imposes a duty of care to protect children from tobacco smoke in all areas.

Figure 5 summarises the information concerning exposure in private settings. Results are not directly comparable as they are from different years, use different samples and age groups.

Figure 5 – Exposure to tobacco smoke in homes and cars

Country	Exposure to tobacco smoke in homes and cars
Denmark	69 % never exposed in homes. 15 % are exposed daily or weekly.
Estonia	23,5% are exposed in homes.
Finland	16 % are exposed in homes.
Hungary	44 % are exposed in homes.
Italy	14,4 % exposed in cars.
Latvia	44,6 % are exposed in homes.
Portugal	33 % are exposed homes.
Romania	35,4 % are exposed in homes
Slovenia	19 % are exposed in homes. 6,6 % are exposed in cars.
Poland	44.2 % are exposed in homes
Ireland	14.9% of children are exposed in cars.
Sweden	76 % are exposed in homes.
Serbia	45 % are exposed everywhere, 37 % are exposed in some areas at home.
Norway	88 % are never or almost never exposed in homes.
Former Yugoslav Rep. of Macedonia	67,5 % are exposed in homes.

2.4. Protection of children and adolescents

The Recommendation places a special emphasis on the need to develop or strengthen measures to reduce exposure to tobacco smoke for children and adolescents and to adopt complementary/supporting measures. Almost all Member States reported that strategies to protect children and adolescents were introduced. They also reported about complementary measures, most of which are contained in the recent Commission proposal for the revision of the Tobacco Products Directive.

In Denmark, the Czech Republic, Germany, Portugal, Hungary, Italy, Romania, Luxembourg, the United Kingdom, Sweden, Portugal, Poland and Croatia there are specific programs and/or projects to raise awareness in schools - sometimes involving parents. Mass media campaigns are also in place in some Member States to raise awareness. In Belgium, Denmark, Czech Republic, Estonia, Hungary, Latvia, Portugal, Spain, Bulgaria, France, Slovenia, Malta, Poland Cyprus, Finland, Lithuania, the Netherlands, and Greece, various smoking bans are in place in establishments used by children and adolescents such as indoor and outdoor school premises, playgrounds, and childcare institutions..

In the majority of Member States, a number of complementary measures are taken to protect young people against the risks associated with tobacco consumption. Most of them aim at reducing the initiation of tobacco use. All Member States have advertising bans or limitations in place (in line with the Advertising Directive 2003/33/EC), but significant differences prevail for advertising and promotion activities, in particular at points of sale. Currently, three Member States (Finland, Ireland and the UK) and two EEA countries (Iceland and Norway) have laws to prohibit the visible display of tobacco products at the point of sale. Fourteen Member States (Austria, Denmark, France, Greece, Hungary, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Sweden, and Spain) have put in place restrictions or bans on promotion at point of sale.

As of 2009, about half the Member States ban sales of sweets and toys which resemble tobacco products. In some Member States the prohibition is based on the fact that these products constitute indirect tobacco advertising.

All EU Member States have age limits in place as regards purchasing of tobacco. The legal buying age is 18 years in 22 Member States and 16 years in the remaining five.

Thirteen Member States have banned the sale of tobacco from tobacco vending machines completely and Finland will introduce it as of 2015. In the Member States that allow vending machines provisions are in place to limit uncontrolled access to tobacco products. Restrictions range from ID control systems to the need of adequate supervision. Some Member States also regulate where the machines can be installed (e.g. Portugal and Spain). Ireland and Denmark permit the use of vending machines only in licensed premises or retail stores.

Member States have different rules in place as regards the minimum number of cigarettes per package (to limit the use of "kiddy packs"). 14 Member States (Austria, Czech Republic, Estonia, Finland, France, Greece, Ireland, Luxembourg, Lithuania, Poland, Portugal, Denmark, Romania and Spain) specify a minimum pack size of 20 cigarettes. In four Member States (Hungary, Germany, the Netherlands and Sweden) the minimum pack size is 19 cigarettes. Italy specifies that cigarettes must be sold in either packets of 10 or 20. In the UK the minimum pack size is 10 cigarettes. Slovenia, Sweden, Romania, Spain and Lithuania expressly ban the sale of single cigarettes.

14 Member States regulate ingredients. Poland bans the use of ingredients, which enhance the addictive properties of tobacco. Four Member States (Belgium, France, Romania, and the UK) have introduced different varieties of positive lists of ingredients allowed to be used in tobacco products. Lithuania has introduced a negative list which restricts specific additives (e.g. vanilla root and clove) from being included in tobacco products and the Czech Republic, Germany, Hungary, Bulgaria and Slovakia have a combination of positive and negative lists. In 2009, France adopted a

legislation focusing on the attractiveness of certain tobacco products. The French law allows setting up maximum levels for ingredients that impart a sweet or fruity/acid taste to cigarettes. In Sweden, there is no positive or negative list, but it is possible to regulate ingredients on an ad-hoc basis.

10 Member States have adopted legislation on combined health warnings as defined by Article 2(4) of Commission Decision 2003/641/EC: Belgium, Denmark, Hungary (in force from 1st January 2013), Latvia, Romania, Spain, the United Kingdom, France, Malta and Ireland (in force from February 2013). Seven of these countries include information on services supporting cessation on the packaging. In Bulgaria, the process of adoption is underway. Outside the EU, Norway, Iceland and the Former Yugoslav Republic of Macedonia and Turkey have introduced picture warnings.

2.5. CESSATION MEASURES

The Recommendation calls on Member States to introduce tobacco cessation policies. This is in line with Art. 14 FCTC and the implementation guidelines adopted in 2010[20]. All Member States have reported about cessation measures. The large majority of Member States have developed comprehensive cessation guidelines based on scientific evidence and best practice, media campaigns to promote cessation, cessation programs for certain target groups, telephone quitlines and local events (e.g No Tobacco Day). Almost all Member States report about cessation programs in educational institutions, health care facilities or workplaces. Diagnosis and treatment of tobacco dependence and counselling services for cessation are in place in the large majority of Member States. 20 Member States have specialized centres for cessation and treatment of tobacco dependence, and 11 have these programs in rehabilitation centres. Eight Member States have low cost dispense of NRT or reimbursement schemes for NRT (Nicotine Replacement Therapy). Figure 6 summarises the main measures taken by Member States.

Figure 6 – tobacco cessation and tobacco dependence treatment measures

	Cessation Guidelines	Media campaigns	Targeted cessation programs	Quitlines	Specialized centres for cessation services	Low cost dispense of NRT
Austria	x	x	x	x		
Belgium		x	x	x	x	
Bulgaria	x	x	x	x		x
Cyprus		x	x	x	x	
Czech Republic	x	x	x	x	x	
Denmark	x	x	x	x	x	
Estonia	x		x	x	x	
Finland	x	x	x	x		
France	x	x	x	x	x	x
Germany	x	x	x	x	x	
Greece	x	x	x	x	x	
Hungary	x	x	x	x		
Ireland	x	x	x	x		x
Italy	x	x		x	x	
Latvia				x		
Lithuania	x	x		x	x	
Luxembourg	x	x	x	x	x	x
Malta	x	x	x	x		
Netherlands	x			x	x	x
Poland	x	x	x	x	x	
Portugal	x		x	x	x	
Romania	x		x	x	x	x

	Cessation Guidelines	Media campaigns	Targeted cessation programs	Quitlines	Specialized centres for cessation services	Low cost dispense of NRT
Slovakia	x	x	x	x	x	x
Slovenia	x	x	x	x		
Spain	x	x	x	x	x	
Sweden	x		x	x	x	
United Kingdom	x	x	x	x	x	x
Turkey	x	x	x	x	x	x
Former Yugoslav Republic of Macedonia		x	x		x	
Norway	x	x		x		
Serbia	x	x	x			
Iceland		x		x		
Croatia		x	x			

2.6 MULTI-SECTORIAL TOBACCO CONTROL STRATEGY

Traditionally the health sector is in the lead when it comes to developing tobacco control policy. The Recommendation invites Member States, however, to extend tobacco control beyond the health sector and to develop a comprehensive multi-sectoral approach. In practice this means that other governmental sectors and ministries should support the development of comprehensive tobacco control measures (e.g. through taxation).

A majority of Member States reported that they have a multi-sectorial tobacco control strategy. Most Member States referred to national tobacco control and public health strategies that are either adopted, in the process of adoption or under revision. Most Member States did however not report specifically on the multi-sectorial aspect of tobacco control. The Netherlands commented that although they do not have a multi sectorial strategy as such, the tobacco control strategy is a part of the national prevention policy, for which the engagement of other sectors such as the business sector, civil society, health organisations and care providers is encouraged. Portugal and Cyprus reported that their tobacco control strategies are based on the WHO MPOWER strategy[21] which, inter alia, promotes multi-sectorial collaboration. Lithuania has an inter-sectorial Action Plan for alcohol and tobacco for the period 2012-2014.

The Recommendation also calls for the appointment of focal points with a view to exchange information and best practices between Member States and with the Commission. Focal points have been appointed by all Member States and a meeting is scheduled for February 2013.

3. IMPACTS

Many Member States aim to measure the success of their tobacco control policies including smoke-free environments. Health and economic impacts are measured in particular. Often the attitude of citizens to the some-free policy (acceptance) is also measured.

Only a few Member States have carried out an impact assessment prior to the adoption of the smoke-free measures. However many Member States have carried out evaluations concerning the effectiveness of national smoke-free legislation.

[21] http://www.who.int/tobacco/mpower/en/

For the purpose of this report all studies submitted by Member States were considered. Some of them predate the adoption of the Recommendation taking into account that Member States started introducing smoke-free legislation prior to the adoption of the Recommendation. This does not undermine the relevance of these studies when assessing the impacts of smoke-free policies, as the impacts of smoke-free legislation show only/continue years after implementation. Studies from countries outside the EU where smoke-free legislation has been in place for several years is also useful, in particular for Member States that are still considering to adopt additional measures on smoke-free environments.

3.1. INDICATORS

The Recommendation calls for Member States to cooperate closely on a coherent framework of definitions, benchmarks and indicators for the implementation of the Recommendation. Member States were asked to report on the indicators used for this purpose.

A majority of Member States are monitoring smoke-free and other measures using one or more indicators with an aim to evaluate implementation, functioning and effect of the measures presented in the Recommendation. About one third of Member States have evaluated their smoke-free legislation more comprehensively and another third have evaluated their smoking cessation and tobacco prevention programs.

Smoke-free environments

Belgium, Cyprus, Lithuania, the United Kingdom, Luxembourg, and Ireland report that they use, for example, compliance data for monitoring and evaluation. The Czech Republic, Denmark, Latvia, Portugal, Romania, Spain, and Slovenia include data on exposure to tobacco smoke in their monitoring scheme. Finland, Greece, the Netherlands, and France conduct national surveys. Hungary conducts national surveys measuring, for example, smoking habits and attitudes as well as measuring indoor air quality. Several Member States use a combination of the abovementioned indicators.

Tobacco cessation and treatment for tobacco dependence

Most Member States use annual prevalence data, or more specified quit rate data from cessation services. Some also use data on NRT consumption and the number of prescriptions of Vareniclin and Bupropion, (two specific pharmaceuticals used for tobacco dependence treatment). Evaluations of treatment and cessation facilities/programs are on-going in a number of Member States.

Comprehensive tobacco control strategy

In most Member States tobacco control strategies are monitored by population surveys on smoking prevalence. Some also include data on population support, and reviews and studies on compliance with tobacco control legislation and implementation of other tobacco control measures.

3.2. HEALTH AND SOCIAL IMPACT

3.2.1. Health and environmental impact

Studies from EU Member States clearly indicate the health benefits of smoke-free legislation. Examples include substantial reductions in the incidence of heart attacks in the general population (e.g. in Italy)[22], and in hospital admission for myocardial infarction and other acute coronary events (e.g. Germany, Italy, UK, US)[23]. In England[24] the legislation resulted in a statistically significant

[22] Cesaroni G, Forastiere F, Agabiti N, Valente P, Zuccaro P, et al. Effect of the Italian Smoking Ban on Population Rates of Acute Coronary Events. Circulation 2008; 117:1183-8.

[23] Bartecchi C, Alsever RN, Nevin-Woods C, Thomas WM, Estacio RO, Bartelson BB, et al. Reduction in the incidence of acute myocardial infarction associated with a citywide smoking ordinance. Circulation. 2006; 114: 1490–6.;

reduction (−2.4%) in the number of hospital admissions for myocardial infarction (MI). This amounted to a reduction of 1200 emergency admissions for MI in the year following the introduction of smoke-free legislation. Denmark, Italy and Malta also have data on reduction in morbidity among the general public.

The United Kingdom and Ireland[25] have also collected data on reduction in morbidity among workers due to second hand smoke. The Irish study showed a rapid improvement in respiratory health. A study of bar workers in England[26] showed that their exposure to second hand smoke reduced on average between 73% and 91% (from 2007 to 2008) and as a result their respiratory health improved significantly after the introduction of the legislation. In Sweden[27] a study found that smoke-free legislation was associated with a substantial reduction in respiratory and sensory symptoms, as well as reduced exposure to environmental tobacco smoke at work, particularly among workers in game centres.

No Member States reported data on the reduction in annual mortality among *workers* due to reduced second hand smoke, but Malta[28] reported data on the reduction in annual mortality in the *general public.*

Improved health also leads to reductions in medical costs as shown by studies in Finland, Spain, Greece and the United Kingdom[29]. A Finnish study[30] has calculated that 85% of life long health care costs could be saved, if every smoker stopped smoking. Cessation at a younger age provides for the greatest savings. An improvement in health also leads to reduction in non-medical costs due to reduced second hand tobacco smoke exposure among staff (e.g increased productivity through reduced sick leaves etc.).

Concerning environmental impacts, seven Member States have studies on the reduction of indoor air pollution. In Spain, England, Scotland, Wales and Ireland concentration of $PM_{2.5}$ (a general measure of air pollutants) decreased by between 84 and 93 % following the introduction of smoke-

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Sargent RP, Shepard RM, Glantz SA. Reduced incidence of admissions for myocardial infarction associated with public smoking ban: before and after study. BMJ. 2004; 328: 977–80.; Francesco Barone-Adesi, Loredana Vizzini, Franco Merletti, and Lorenzo Richiardi. Short-term effects of Italian smoking regulation on rates of hospital admission for acute myocardial infarction. European Heart Journal. 2006. Richiardi L. Vizzini L., Merletti F., Barone-Adesi F. Cardiovascular benefits of smoking regulations: The effect of decreased exposure to passive smoking. Preventive Medicine. 2009.

Juster HR, Loomis BR, Hinman TM, Farrelly MC, Hyland A, Bauer UE, et al. Declines in Hospital Admissions for Acute Myocardial Infarction in New York State After Implementation of a Comprehensive Smoking Ban. Am J Pub Health 2007; 97: 2035-9.

Pell JP, Haw S, Cobbe S, Newby DE, Pell AC, Fischbacher C et al. Smoke-free Legislation and Hospitalizations for Acute Coronary Syndrome. N Engl J Med 2008; 359:482-91.;

Sargent JD, Demidenko E., Malenka DJ, Li Z, Gohlke H, Hanewinkel R. Smoking restrictions and hospitalization for acute coronary events in Germany. Clinical Research in Cardiology 2012; 101: 227-35.

Sims M, Maxwell R, Bauld L, Gilmore A. Short term impact of smoke-free legislation in England: retrospective analysis of hospital admissions for myocardial infarction. BMJ 2010; 340:c2161.

Trachsela LD et al. Reduced incidence of acute myocardial infarction in the first year after implementation of a public smoking van in Graubuenden, Switzerland. Swiss Medical Weekly, 2010, 140: 133-138

[24] As quoted in: Bauld L. Impact of smokefree legislation: evidence review. Report for UK Department of Health.Bath: University of Bath; 2011

[25] Allwright S. et al. Legislation for smoke-free workplaces and health of bar workers in Ireland: before and after study. 2005

[26] As quoted in: Bauld L. Impact of smokefree legislation: evidence review. Report for UK Department of Health.Bath: University of Bath; 2011

[27] Larsson et al. Exposure to environmental tobacco smoke and health effects among hospitality workers in Sweden—before and after the implementation of a smoke-free law. Scand J Work Environ Health. 2008

[28] http://spo.escardio.org/Abstract.aspx?abstractBookId=98326

[29] As quoted in: Bauld L. Impact of smokefree legislation: evidence review. Report for UK Department of Health. Bath: University of Bath; 2011

[30] Vitikainen K., Pekurinen M., Kiiskinen U., Mikkola H. (2006). Raportteja 1/2006. Helsinki

free legislation[31]. Significant decreases have also been measured in Hungary, the Netherlands and Portugal.[32]

3.2.2. Social impact

Reports from Member States and European survey data show that support for the legislation often increases after the introduction of smoke-free environments. As indicated in a Eurobarometer report from 2009, a majority of EU citizens support smoke-free public places, such as offices, restaurants and bars[33], particularly in those Member States where smoke-free laws are already quite comprehensive. Support for smoking restrictions at workplaces was slightly higher than support for such restrictions in restaurants (84% vs. 79%). Still two-thirds of the participants supported smoke-free bars, pubs and clubs.

Fifteen Member States have reported an **increased support for smoke-free policies**. In Italy support for smoke-free policies increased progressively from 83% before the ban was introduced in 2001 to 93 % in 2006 after the introduction of the ban.[34][35] The same is true for Ireland[36] and Scotland[37]. In Ireland support for total bans among Irish smokers increased in all venues from 2003 to 2005, including workplaces (43% to 67%), restaurants (45% to 77%), and bars/pubs (13% to 46%). Overall, 83% of Irish smokers reported that the smoke-free law was a "good" or "very good" thing. In Scotland 69% of pub goers supported the legislation, up from 56% in May 2005. A study looking at public support in France, the Netherlands and Germany[38] found that comprehensive smoke-free policies attracted more support than partial policies. The study concludes that smoke-free policies seem to have the potential to receive more support once the policy is in place. Public approval of a smoke-free hospitality industry continues to grow in Germany. According to a recent survey[39], more than three quarters of Germans (77.5 percent) are in favour of a smoking ban in restaurants and bars. In Portugal public support is very high at 96,3 % of the population and has increased for pubs, bars, discos commercial centres and malls, schools, public transport and airports. In the Czech Republic support for the smoking ban in restaurants increased from 65,4 % in 2010 to 68,4 % in 2011. In Finland,[40] support for smoke-free restaurants rose from 34% in 2004 to 61% in 2005. Surveys from Slovenia show that support for smoke-free legislation increased from

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[31] Semple et al. UK Smoke-Free Legislation: Changes in $PM_{2.5}$ Concentrations in Bars in Scotland, England, and Wales. The Annals of Occupational Hygiene. 2009,
McCaffrey, M, Goodman, PG, Clancy, Luke (2005) Particulate pollution levels in Dublin pubs pre and post the introduction of the workplace smokingban. Dublin: Scientific symposium "The Health Impacts of Smoke-free Workplaces in Ireland",March 2005

[32] Pacheo et al. Occupational Exposure to Environmental Tobacco Smoke: A Study in Lisbon Restaurants. Journal of Toxicology and Environmental Health 75. 2012. Zwerfrook en alternatieven voor rookruimten, Opperhuizen A, Sleijffers A, Cremers H, Jacobs P, Knoll B, Borsboom, *http://www.rivm.nl/bibliotheek/rapporten/340004001.html*

[33] Flash Eurobarometer 253: Survey on Tobacco – Analytical support, 2009.
http://ec.europa.eu/health/ph_determinants/life_style/Tobacco/Documents/eb_253_en.pdf

[34] Gallus S, Zuccaro P, Colombo P et al. Smoking in Italy 2005–2006: Effects of a comprehensive national tobacco regulation. Prev Med 2007;45: 198–201.

[35] http://www.epicentro.iss.it/passi/pdf2012/Scheda%20F_R%20Nazionale%20fumo_2011.pdf

[36] G T Fong et al. Reductions in tobacco smoke pollution and increases in support for smoke-free public places following the implementation of comprehensive smoke-free workplace legislation in the Republic of Ireland: findings from the ITC Ireland/UK Survey. Tobacco Control. 2006

[37] Office of Tobacco Control. Press release. Ireland: OTC; 2005. http://www.otc.ie/article.asp?article=267 (accessed 6 Dec 2012);
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ASH Scotland. Smoke-free success. ASH Scotland presents the Scottish experience. Edinburgh: ASH Scotland; 2007.
http://www.ashscotland.org.uk/media/2825/Smokefreesuccess07.pdf (accessed 17 Sept 2012).;
Norwegian Directorate of Health. National representative opinion polls in the period 2004 -2011:
http://www.helsedirektoratet.no/folkehelse/tobakk/tall-og-undersokelser/holdninger/Sider/default.aspx (accessed 06 Dec 2012);

[38] Mons U. et al. Comprehensive smoke-free policies attract more support from smokers in Europe than partial policies. EJPH, 2012

[39] http://www.dkfz.de/en/presse/pressemitteilungen/2012/dkfz-pm-12-36-Smoke-free-restaurants-and-bars-in-Germany-2012.php (accessed 6 Dec 2012)

[40] Health Behaviour and Health among the Finnish Adult Population – Survey
http://www.julkari.fi/bitstream/handle/10024/90868/URN_ISBN_978-952-245-640-3.pdf?sequence=1

73 % in 2007 to 84 % in 2011. Research from Norway[41] also shows that public support for smoke-free legislation has increased significantly after the introduction of smoke-free legislation in bars and restaurants; from 54 % in 2004 to 90 % in 2011.

3.3. ECONOMIC IMPACT

Several studies from the EU indicate that the **economic impact of smoking bans** on the restaurant/hospitality sector is limited (neutral or even positive). This is also confirmed by international studies covering also countries outside the EU**.** Two recent systematic reviews show that smoke-free laws do impact businesses in the hospitality industry in a number of ways, many of them positive, e.g. improved health of employees.[42] As outlined in the International Agency for Research on Cancer (IARC) Handbook concerning the evaluation of smoke free policies, insurance, cleaning, maintenance and potential litigation costs can all be reduced when smoke-free workplaces are introduced. While some studies indicate that there are short-term costs associated with the legislation for all businesses (e.g. new signage and training for employees), evidence from developed countries suggests that smoke-free laws have a net positive effect on businesses.

Studies using a high quality methodology consistently find that smoke-free policies have no negative economic impact on restaurants, bars, and other segments of the hospitality sector, with the possible exception of gaming establishments. Indeed, many studies provide evidence of a small positive effect of smoke-free policies on business activity. The Cochrane review identified three studies that examined the economic impact of smoke-free legislation on the hospitality industry in the US, Italy and New Zealand. All three found no significant decrease in bar patronage pre and post-legislation, and two of these reported no significant decrease in restaurant attendance, with one study finding a significant increase in the number of non-smokers who attended restaurants.[43]

Another review analysed a significant number of studies on the economic effects of smoke-free policies on the hospitality industry.[44] It was established that 47 of the 49 studies that are best designed, report no negative economic impact on measures such as taxable sales. According to a WHO Report, smokefree environments result in either a neutral or positive impact on businesses, including the hospitality sector.[45] These findings were similar in all places studied, including in Australia, Canada, the United Kingdom and the United States, Norway and New Zealand. This finding is also confirmed in a recent US Centre for Disease Control factsheet.[46] Moreover, the US

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[41] Norwegian Directorate of Health. National representative opinion polls in the period 2004 -2011: http://www.helsedirektoratet.no/folkehelse/tobakk/tall-og-undersokelser/holdninger/Sider/default.aspx (accessed 06 Dec 2012);

[42] As quoted in Bauld L. Impact of smokefree legislation: evidence review. Report for UK Department of Health.Bath: University of Bath; 2011:
IARC (International Agency for Research on Cancer). *IARC Handbook of Cancer Prevention Vol. 13: Evaluating the effectiveness of smokefree policies*. Lyon: IARC; 2009.
Callinan JE, Clarke A, Doherty K and Kelleher C. Legislative smoking bans for reducing secondhand smoke exposure, smoking prevalence and tobacco consumption. Cochrane Db Syst Rev 2010; 4. Art. No. CD005992.

[43] Biener L, Garrett CA, Skeer M, Siegel M and Connolly G. The effects on smokers of Boston's smoke-free bar ordinance: a longitudinal analysis of changes in compliance, patronage, policy support, and smoking at home. J Publ Health Manag Pract 2007; 13:630–6.
Gallus S, Zuccaro P, Colombo P et al. Smoking in Italy 2005–2006: Effects of a comprehensive national tobacco regulation. Prev Med 2007;45: 198–201.
Waa A, McGough S. Reducing exposure to second hand smoke: changes associated with the implementation of the amended New Zealand Smoke-free Environments Act 1990: 2003–2006.,Wellington: HSC Research and Evaluation Unit; 2006. http://archive.hsc.org.nz/sites/default/files/publications/SFEWorkplace_Final.pdf (accessed 17 Dec 2012)

[44] Scollo, M. and Lal, A. Summary of Studies Assessing the Economic Impact of Smoke-Free Policies in the Hospitality Industry. Melbourne: VicHealth Centre for Tobacco Control; 2008. http://www.vctc.org.au/tc-res/Hospitalitysummary.pdf (accessed 17 Sept 2012).

[45] WHO. WHO Report on the Global Tobacco Epidemic, 2009 - Implementing smoke-free environments. Geneva: WHO; 2009. http://whqlibdoc.who.int/publications/2009/9789241563918_eng_full.pdf (accessed 17 Dec 2012).

[46] CDC. Smoke-Free Policies Do Not Hurt the Hospitality Industry. Atlanta, GA: CDC; 2012. http://www.cdc.gov/tobacco/data_statistics/fact_sheets/secondhand_smoke/protection/hospitality/index.htm (accessed 17 Dec 2012)

Surgeon General's report[47] concluded that "evidence from peer-reviewed studies shows that smoke-free policies and regulations do not have an adverse economic impact on the hospitality industry". These findings are supported by more recent studies in different countries (e.g. Norway, Mexico, Italy).[48]

Very few Member States reported data on the economic impact of smoke-free legislation on hospitality revenues. In Spain and Finland studies are underway. Some of the reported studies show a decline in revenues in the short term, whereas others show there is no significant long – term effect. Ireland reported a study showing a decline in bars sales of 4,6 % following the ban.[49] Data from Norway[50] indicate that revenues in restaurants and pubs show that the law did not have a statistically significant long-term effect on revenue in restaurants. Similar analysis for pubs in Norway shows that there was no significant long-term effect on pub revenues.

The introduction of smoke-free policies can also have other economic effects such as private and governmental costs, changes in tax revenue and revenue in the tobacco industry. Comprehensive smoke-free legislation incurs less private costs than partial legislation as shown by a study from Scotland[51] that describes that building designated smoking areas incurs extra costs for employers. The study from Scotland[52] also shows that smoke-free workplace arrangements without designated smoking areas reduce employer costs and increase productivity. Another study[53] found that exposure to second hand smoke caused additional absenteeism among non-smokers.

Governments also incur costs in enforcing smoke-free legislation. The Netherlands reported an estimated cost for this to be around 4-5 million euros annually.

Seven countries reported on results of revenues from tobacco taxes after the introduction of smoke-free legislation. In Finland, revenues are not reduced, even though prevalence has declined. In Italy revenues from tobacco taxes increased by 25 % in the period 2004 – 2011 even though sales decreased. France has also had increased revenues over the last few years. In Latvia the revenues from tobacco taxes were reduced by 8% from 2009 to 2011 and in Spain by 2 % from 2010 to 2011.

Finland is preparing new studies concerning annual lost revenues in the tobacco industry and working productivity related to smoking breaks.

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[47] U.S. Department of Health and Human Services (HHS). The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General. Atlanta, GA: HHS, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2006.

[48] Melberg HO, Lund KE. Do smoke-free laws affect revenues in pubs and restaurants? Eur J Health Econ 2012; 13(1): 93–9.
Guerrero López CM, Jiménez Ruiz JA, Reynales Shigematsu LM, Waters HR. The economic impact of Mexico City's smoke-free law. Tob Control 2011; 20(4):273-8.
Gallus S, Zuccaro P, Colombo P et al. Smoking in Italy 2005–2006: Effects of a comprehensive national tobacco regulation. Prev Med 2007;45: 198–201.

[49] This followed a similar decline of 4.2% in bar sales in 2003. However, in 2005, sales increased by 0.1%. Employment in the hospitality sector as a whole and in bars specifically increased during 2005. Visitor numbers to Ireland increased by 5.0% in 2003, 3.2% in 2004 and 6.1% in 2005. Ireland Central Statistics Office.

[50] Melberg HO, Lund KE. Do smoke-free laws affect revenues in pubs and restaurants? Eur J Health Econ 2012; 13(1): 93–9.

[51] As quoted in : Heloma A. et al. Exposure to secondhand smoke in Finnish workplaces and compliance with national smoke-free workplace legislation. Scandinavian Journal of Public Health. 2011 (Parrot S. Costs of employee smoking in the workplace in Scotland. Tob Control 2009;9)

[52] As quoted in: Heloma A. et al. Exposure to secondhand smoke in Finnish workplaces and compliance with national smoke-free workplace legislation. Scandinavian Journal of Public Health. 2011

[53] Heloma A. et al. Exposure to secondhand smoke in Finnish workplaces and compliance with national smoke-free workplace legislation. Scandinavian Journal of Public Health. 2011 (Tsai SP et al. Workplace smoking related absenteeism and productivity costs in Taiwan). Tob Control 2005;14

4. CONCLUSIONS

Overall, there has been good progress in transposing the Recommendation on smoke-free environments into national law. All Member States report that they have adopted measures to protect citizens from exposure to tobacco smoke, partially even before the Recommendation. However national measures differ considerably in extent and scope, which may reflect diverging national circumstances (e.g. climate in winter), national preferences or different levels of ambition.

The most comprehensive measures typically relate to educational establishments, health care facilities and public transport. Exemptions are more common in the hospitality sector. A number of Member States have also reported about enforcement problems, caused in particular by a lack of resources. The complexity of legislation was also mentioned as an important reason why enforcement might be challenging.

The progress to protect citizens against second hand smoke in public places is reflected in EU citizens' actual exposure rates, which dropped from 2009 to 2012. There are however very significant differences in citizens' overall exposure to second hand smoke between Member States, ranging from 3% in Sweden to 71% in Greece. The examples of Belgium, Spain and Poland show that the adoption of comprehensive legislation can lead to very significant drops in exposure rates within a short period of time.

A limited number of Member States are in the process of taking action against smoking in private places. Cyprus is the only Member State at this stage which has prohibited smoking in cars in the presence of children under 16. In Ireland, which was the first Member State to introduce a comprehensive ban on smoking in public places, the Ministry of Health has proposed similar legislation.

Reports from Member States confirm that citizens' support for the legislation often increases after the introduction of the smoke-free policies. Overall the support is very high for such policies.

Studies on the health effects of smoke-free legislation indicate that positive impacts appear very quickly after starting to implement smoke free legislation. They include reduction in the incidence of heart attacks in the general population and improvements in respiratory health. The economic impact of smoking bans on the restaurant/hospitality sector is limited (neutral or even positive). Positive impacts include the improved health of employees for example in terms of improved respiratory health.

Monitoring and evaluation is on-going in many Member States. Regular exchange of information between Member States and the Commission is therefore considered useful and continued monitoring and efforts are needed.

Endnotes referring to figure 1

[i] Federal legislation allows smoking in bars and restaurants smaller than 50m2.In venues between 50m2 and 80 m2 smoking may be permitted if there is a partition between the areas. In venues larger than 80 m2 enclosed smoking rooms are allowed. In enclosed public places and other workplaces enclosed smoking rooms are allowed. Smoking is also allowed if smokers have their own offices and there is no contact with clients. Regional authorities can adopt stricter legislation.

[ii] General ban with an exemption for clearly designated, enclosed smoking rooms with appropriate ventilation. In the hospitality sector all service is forbidden in smoking rooms.

[iii] Comprehensive ban with a limited exemption for designated, ventilated smoking rooms in airports and minors are not allowed to enter.

[iv] In restaurants, bars and enclosed public places, smoking is only allowed in open outdoor places. In other workplaces enclosed smoking rooms are allowed.

[v] The operator may allow smoking, or provide structurally separated areas for smokers and non-smokers and there must be sufficient ventilation. In other workplaces there is an obligation for the employee not to smoke where non-smokers can be exposed.

[vi] Smoking is allowed in bars smaller than 40 m2. In enclosed public places, restaurants and other workplaces smoking is allowed in enclosed smoking rooms.

[vii] Smoking allowed in smoking rooms or smoking areas in workplaces and enclosed public places, whereas smoking is only allowed in enclosed smoking rooms in the bars and restaurants.

[viii] In the hospitality sector smoking is allowed in enclosed, ventilated smoking rooms where no food or drink can be served or consumed. In other workplaces smoking is allowed in enclosed, ventilated smoking rooms.

[ix] In the hospitality sector smoking is allowed in enclosed, ventilated smoking rooms where no food or drink can be served. In other workplaces smoking is allowed in enclosed, ventilated smoking rooms.

[x] Smoke-free legislation is regulated at regional level. In most states in Germany, separate, enclosed smoking rooms are allowed, and smaller establishments that do not serve food are exempted from the smoking ban altogether. Total smoking bans for the hospitality sector are in place in Saarland, Bavaria and North Rhine-Westphalia..

[xi] Comprehensive smoking bans in workplaces and enclosed public places, and smaller venues in the hospitality sector. However, smoking is allowed in entertainment centres larger than 300 m2 with live music and casinos.

[xii] Comprehensive ban, the only exemptions are cigar rooms in hotels, prisons, police detention cells, psychiatric institutions and certain types of workplaces with increased risk of fire and/or explosion. In these workplaces smoking rooms are allowed under certain conditions.

[xiii] Comprehensive ban, smoking is only allowed in dwellings, prisons, hotel bedrooms, nursing homes, hospice settings and psychiatric hospitals

[xiv] In the hospitality sector smoking is allowed in enclosed, ventilated smoking rooms which cover less than half of the serving area. In other workplaces smoking is allowed in enclosed, ventilated smoking rooms.

[xv] Total smoking ban in enclosed public places and the hospitality sector. In other workplaces smoking allowed in enclosed smoking rooms.

[xvi] Total smoking ban in enclosed public places and the hospitality sector. In other workplaces smoking allowed in enclosed, ventilated smoking rooms.

[xvii] There is a smoking ban in brassiere's during dining hours (12.00 -14.00 and 19.00-21.00). Smoking is allowed in enclosed smoking rooms in restaurants and tea rooms, and other workplaces .Total ban in enclosed public places.

[xviii] Comprehensive ban, smoking only allowed in hotel bedrooms

[xix] Smoking is allowed in bars that are smaller than 70 m2 and that have no serving staff. In enclosed public places, restaurants and other workplaces smoking is allowed in enclosed smoking rooms.

[xx] Total ban in enclosed public places. Enclosed, ventilated smoking rooms allowed in the hospitality sector and other workplaces.

[xxi] Smoking allowed in enclosed smoking rooms in hospitality venues smaller than 100 m2. In venues larger than 100 m2, owners may designate up to 30 % of the total area as a smoking area, or 40 % if it is an enclosed smoking room, as long as the area does not include areas destined exclusively for workers, or where workers have to be permanently. In enclosed public places and other workplaces smoking rooms or smoking areas are allowed.

[xxii] In restaurant and bar venues smaller than 100 m2, smoking may be allowed. In larger hospitality venues, other workplaces and enclosed public places enclosed, ventilated smoking rooms are allowed.

[xxiii] Smoking is allowed in enclosed smoking rooms in restaurants, whereas in bars the owners can decide whether to allow smoking or not, given that food is not served on the premises. In other workplaces smoking is banned where non-smokers work. In enclosed public places there is a total ban.

[xxiv] In the hospitality sector smoking is allowed in enclosed, ventilated smoking rooms where no food or drink can be consumed. In other workplaces smoking is allowed in enclosed, ventilated smoking rooms.

[xxv] There are no exemptions to the ban on smoking in the workplace as such, but private smoking clubs established under certain, strict conditions are allowed. Minors are not allowed in the private smoking clubs

[xxvi] In the hospitality sector smoking is allowed in enclosed, ventilated smoking rooms where no food or drink can be consumed. In other workplaces smoking is allowed in enclosed, ventilated smoking rooms.

[xxvii] Comprehensive ban, smoking is only allowed in designated hotel rooms, care home and hospice rooms and prison cells, as well as offshore installations, research and testing facilities, in specialist tobacconists and on stage if needed for artistic integrity

[xxviii] Comprehensive ban, smoking only allowed in hotel bedrooms and prisons

[xxix] Total smoking ban in the hospitality sector. In other workplaces and enclosed public places, smoking is allowed in enclosed smoking rooms.

[xxx] Smoking is banned completely in workplaces and enclosed public places. However smoking is permitted in 50 % of bars and restaurants smaller than 80 m2. Larger businesses can allow smoking and non-smoking areas, provided they have ventilation.

Links Fumo Ambiental

OMS training resources

http://www.who.int/tobacco/publications/building_capacity/training_package/smoke_free/en/

Facilitators Guide

http://whqlibdoc.who.int/publications/2011/9789241501354_TP1_facilitators_guide_eng.pdf

Participants work book

http://whqlibdoc.who.int/publications/2011/9789241501354_TP1_participants_workbook_eng.pdf?ua=1