Tackling Environmental Tobacco Smoke through Mixed-Use Urban Planning

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ABSTRACT
Environmental tobacco smoke (ETS) is a health hazard triggering hospital admission in both smoker and non-smokers. Moreover, it negatively impacts fetal development. In addition, it affects social environments. This paper proposes a solution to reduce the exposure of the general population to ETS through urban re-design, based on the principles of reduced sprawl and mixed-use city planning.
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Background

Environmental tobacco smoke (ETS), also known as "third-hand smoke," is a health hazard resulting from the build-up of harmful chemicals in the environment (Winickoff et al., 2009). In contrast to passive smoking or "second-hand smoke," ETS refers specifically to the problem of tobacco smoke after a cigarette is put out, as harmful chemicals remain trapped in hair, skin, fabric, carpet, furniture, or toys (Matt et al., 2004; Destaillats et al., 2010). In essence, the impact of tobacco smoke is not just limited to active and passive smokers, but extends to all individuals sharing their physical environment.

As a result, vulnerable population groups (i.e., children, senior adults, persons with respiratory and other health risk factors) are particularly vulnerable for presenting adverse health outcomes due to ETS exposure. This situation creates barriers to achieving health equity – and also to social sustainability.

ETS: A Potent Trigger

ETS is capable of inciting deadly (and costly) health outcomes. Firstly, ETS is strongly connected to emergency admission for asthma attacks in children (Cunningham et al., 1996). Up to 22% of reductions in hospital admissions for childhood asthma have been reported after successful reduction of ETS (Cunningham et al., 1996). Up to 47% of hospital emergency admissions from heart attacks have been connected to environmental tobacco smoke (IOM, 2009). In the Piedmont region of northern Italy, for acute myocardial infarction alone, researchers observed an 11% decrease in hospitalization after smoking bans in January 2005 (Barone-Adesi et al., 2006). Similarly in Graubuenden, Switzerland, rates of acute myocardial infarction fell 22% in the 12 months following implementation of a smoking ban (Trachsel et al., 2010). These findings are consistent with Pell's review of acute myocardial infarction and smoking, for which nine studies found statistically significant reductions after implementation of smoking bans (Pell et al., 2008).

A study on hospital admission after the 2001 smoking ban in Toronto Canada revealed a 17% decrease in the heart attack hospitalization rate, 33% decrease in rates of admissions for respiratory conditions, and a 39% decrease in admissions from cardiovascular conditions such as angina and stroke (Naiman et al., 2010). In the United States, following the 2007 state smoking ban in Arizona, researchers observed reductions in hospital admission of 13% for acute myocardial infarctions, 33% for unstable angina, 14% for acute stroke, and 22% for asthma – resulting in savings amounting to $16 million in the first 13 months of the ban (Herman & Walsh, 2010). Following the 2002 city smoking ban in Bowling Green, Ohio, hospital admission relating to coronary heart disease decreased by 39% after one year and 47% after three years following the ban (Khuder et al., 2007). In the first 18 months after smoking bans in Pueblo, Colorado, hospital admissions for heart attacks dropped 27%, whereas neighboring areas without the ban reported no change (Bartecchi et al., 2006). Similarly in Helena, Montana, the reduction for heart attack rates after a smoking ban was 40% (Sargent et al., 2004). After the 2004 smoking bans in New York, an estimate of nearly 4000 cases of heart attacks were prevented, resulting in savings of $56 million in that year alone (Juster et al., 2007).

Further reductions from the ban tend to be gained as time progresses (Lightwood et al., 2009). Additionally, nonsmokers can contribute to more reductions than smokers (Saner et al., 2010), illustrating the population-level impact of tobacco smoke.

ETS Undermines Social Sustainability

Social sustainability, with regards to education, crime, employment, and poverty, is an important component of sustainable communities. Unfortunately, some children enter into society with impaired cognitive development due chemicals in tobacco smoke.

Research in environmental science and fetal development illustrates that environmental tobacco smoke is the most potent inner-city air pollutant impacting human cognitive development (Perera et al., 2005). Wigle and Lanphear (2005) confirm that nicotine found in a mother's blood during pregnancy is a strong predictor of IQ and reading scores of children in school. As an illustrative example, children with prenatal exposure to ETS were twice as likely to be classified as "significantly delayed" in later life (Ruah et al., 2004). Other studies confirm this with test scores of general performance, with effects being dose-related (Fried & Watkinson, 1988; Fried & Watkinson, 1990; Fried, O'Connell, & Watkinson, 1992; Sexton et al., 1990). Children with prenatal ETS exposure tend to have impaired language development (Fried & Watkinson, 1990), lower verbal IQ (Fried et al., 1998), and challenges with auditory aspects of reading (Fried et al., 1997). Remarkably, animal studies on nicotine found the chemical to have a marked disruptive effect on synaptic development in the auditory cortex (Aramakis et al., 2000). Overall, children with prenatal tobacco exposure are more likely to repeat kindergarten or first grade (Byrd et al., 1994).

More severe manifestations of impaired cognitive development, such as "idiopathic mental retardation" increased by 50% for children exposed to prenatal tobacco smoke (Olds et al., 1994; Drews et al., 1996). Impacts on behavior has also been studied; Olds (1997) reviewed that 10 out of 11 studies noted higher levels of attention-deficit/hyper-activity symptoms after controlling for potential confounders (Hardy & Mellitus, 1972; Fergusson et al., 1993; Fried and Watkinson, 1990; Dunn et al., 1977; Naeye & Peters, 1984; Rantakallio et al, 1992; Milberger et al., 1996; Streissguth et al., 1984; Streissguth et al., 1986; Kristjansson et al., 1989; Wetizman et al., 1992; Wakschlag et al., 1997). Moreover, prenatal exposure to tobacco leads to increased hospitalization with substance abuse issues, and also higher incidence of criminal arrests in later life (Brennan et al., 2002). In line with these findings on psychological and behavioral issues, studies have found prenatal ETS exposure to be related to oppositional and aggressive behavior as children (Fried & Watkinson, 2001; Brooks et al., 2000; Day et al., 2000; Fergusson et al., 1993). In their teenage years, ETS produces higher rates of conduct disorder, substance use, and depression (Fergusson et al., 1998; Griesler et al., 1998). In a Finnish study, prenatal tobacco exposure led to later delinquency (Rantakallio, 97); likewise, a U.S. study found prenatal exposure to be linked to higher rates of referral to psychiatric care among boys aged 7 to 12 (Wakschlag et al., 103).

Furthermore, the problem of ETS is cyclical in itself. Children with prenatal ETS exposure are also more likely to use tobacco products in later life (Griesler et al., 1998; Kandel et al., 1994; Cornelius et al., 2000).

Existing research also points to a no-threshold effect of the impact of tobacco smoke; therefore, regardless of dose, fetal development is negatively impacted by ETS (Wigle & Lanphear, 2005).

In essence, the state of the research points to numerous negative impacts on social outcomes for children exposed to tobacco smoke; these include difficulties with education, substance abuse, and crime, painting a gloomy picture for social sustainability.

Case Study: Potential Solution through Sustainable Urban Planning

Law has been successfully used to reduce population exposure to ETS through smoking bans (Callinan et al., 2010). Considering the convergence between law and environmental planning, an opportunity emerges in countries with a history of successful indoor smoking bans. Could the indoor component of everyday life be expanded to extend the impact of indoor-smoking bans?

The Built Environment

In seeking an urban model to extend the impact of indoor smoking bans, it is useful to review features of the existing built environment which keeps individuals in outdoor environments.

The current state of the built environment favors separation of residential, commercial, and public uses of land. Streets are built to connect distinct points of travels and zones, thus requiring the proliferation of personal vehicles (Figure 1). As a direct result, accessing different daily destinations such as work, school, grocery-stores, and public facilities requires travelling in outdoor environments. Through such low-density planning, being outdoors becomes a necessary and integral part of life.

In finding a solution to expand the indoor component, it is useful to employ mixed-use and high-density designs in a mixed-use skyscraper model (Hu, 2010) as shown in Figure 2. The goal is to combine daily destination points within the same building through vertical integration – as opposed to horizontal expansion prevalent in existing cities. This helps to place desired destinations within elevator access, thus reducing the likelihood of being forced to leave an indoor environment to meet daily needs.

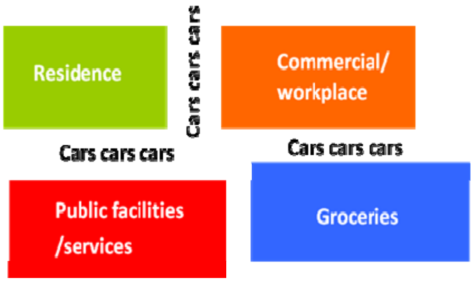


Figure 1. The Traditional Built Environment

Not all desired points-of-travel will be appropriately housed in one skyscraper. Yet, more than one skyscraper can be built to house different elements of a traditional city (Figure 3). As skyscrapers occupy significantly less land compared to traditional sprawl development, the resulting short distances between skyscrapers allows these buildings to be easily linked by walking or cycling paths. For cities with building-periphery smoking bans, the short distances also increase the chances that smokers will not be allowed to smoke in these outdoor paths; for other cities without this ban, indoor walking corridors can be employed to circumvent this issue, with the added benefit of shielding travelers from the elements.

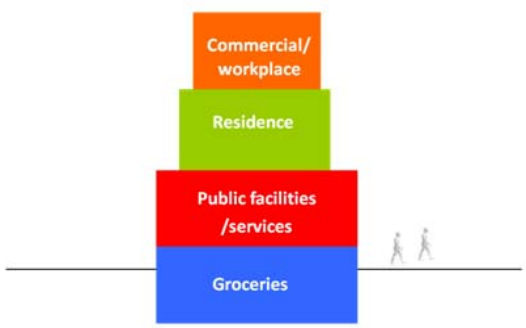
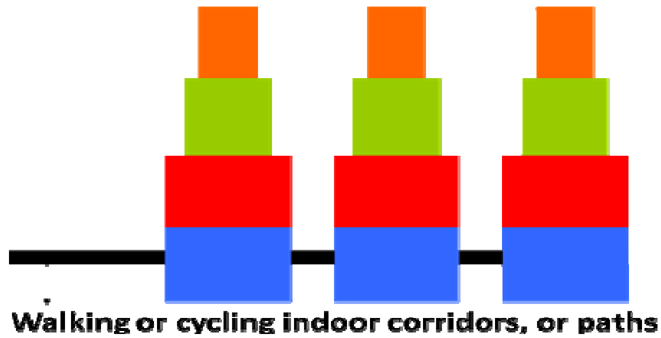


Figure 2. Mixed-use Skyscraper

The successful completion of such clusters of skyscrapers in cities maximizes the chances that the population can access the entire city through a combination of walking cycling, and using elevators. Large, separate clusters can be then linked by train or tram to maximize the mobility of inhabitants (Figure 4).

Figure 3.



The Debate

However, is it worth going through this radical urban transformation just to reduce ETS exposure? At first glance, it appears to be a large-scale and time-consuming intervention that is not proportional to the issue it seeks to resolve; yet through multidisciplinary consideration of the convergence between other health and environmental issues, it becomes clear that ETS-exposure mitigation will not be the only benefit of the proposed solution.

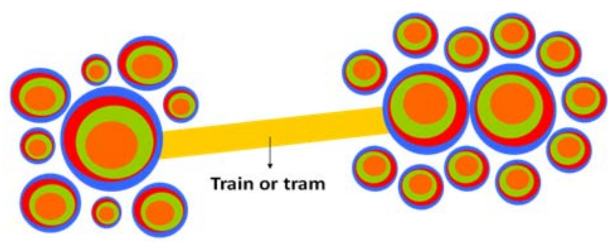


Figure 4. Aerial View of Two Skyscraper Clusters

Environmental Benefits

The skyscraper form minimizes land-use; as land is an increasingly rare resource with world population growth and rapid urbanization, preserving land is important for reducing destruction of natural ecosystems and ensuring access to sufficient land for agriculture (Tweeten, 1998).

The proposed solution eliminates the need for personal vehicles through favoring walking, cycling, and elevator use. Although elevators also consumer energy, the automobile is by far the largest contributor to personal energy expenditures – amounting to over 80% of personal energy expenditures in Western Europe and 90% in the United States (Schipper et al., 1993). The resulting reduction of dependence on automobile contributes to less intensive use of fossil-fuels and reduced emission of greenhouse gases (Hickman & Banister, 2007). In essence, the solution promotes mitigation of climate change and greater community resilience in a peak-oil economy. In essence, radical utilization of mixed-use and high-density development reverses environmental detriments associated with urban sprawl, and helps communities meet two of the most pressing environmental challenges of our times.

Health Benefits

As the proposed solution shifts the primary mode of transportation from personal vehicles to a combination of elevator use and walking or cycling, the immediate health benefits include: reduced motor vehicle crashes (which contributes to significant injury, disability, and deaths each year); improved air quality through the elimination of need for personal vehicles; and increased exercise from reduced car-dependence and more walking and cycling (Frumkin, 2001). Overall, the combined impact of improved air quality and increased exercise can help reduce the incidence of obesity, lung disease, heart disease, diabetes, and certain cancers – which are all listed among the most deadly and costly health issues (World Health Organization, 2008).

Furthermore, through eliminating the need for personal vehicles, excess concrete surfaces (for roads, parking lots, highways, etc.) can be minimized. The reduction in concrete coverage results in more room for green space – which provides numerous benefits. As concrete contributes to more run-off of water than foliage, increased green space promotes water security of a region (Stephenson, 1994). Secondly, as concrete surfaces tend to retain excess heat in comparison to green space, the conversion of concrete surfaces to green spaces shrinks the urban heat island and lowers the risk of heat-stroke incidents (Oke, 1973). Lastly, access to green space has been repeatedly linked to better mental health (BCMCD, 2008).

Economic and Social Benefits

On top of environmental and health benefits, there are numerous economic and social benefits. The high-density, mixed use skyscraper model has been studied for its impacts on health care delivery and health system costs. The study indicated that mixed-use, high-density developments help cuts health costs in three major ways: (1) concentrating the population to exploit economies of scale; (2) physically unifying the built environment to reduce fragmentation and resulting wastages from repeated health information-related activities; and (3) decreasing distances to lower transportation costs of non-local medical goods, equipment, and ambulatory costs (Hu, 2010).

Compact development helps reduce distances between points of travel – which subsequently reduces financial cost of travel, the time required for travelling, and the risk of travelling for vulnerable populations (Hu, 2009). For example, in the case of travelling for seniors, walking from skyscraper to skyscraper is much less costly, risky, and time-consuming than having to travel across the city with public transportation and crossing busy streets (Mitchell, 2009). The result is that seniors and persons living with disabilities will benefit from greater physical mobility, thus allowing for equitable access to employment, community activities, social networks, and health services. The value of this increased mobility will likely grow over time as the population ages – which results in greater need for continued participation in the labor force by seniors and persons with disabilities.

Less road coverage and more compact development helps reduce service and maintenance costs at the city-level. Studies have pointed out the savings from designing mixed-use and compact communities, and such savings over decades have been estimated to amount to billions (DSF, 2003). Overall, high-density, mixed-use development increases the economic viability of a city, and spares tax dollars to be used for meeting many other future challenges such as population ageing, rise in disability rates, urbanization, peak-oil, and climate change.

Conclusion

Environmental tobacco smoke is a triple threat: it impacts health of smokers, passive smokers, and “third-hand smokers” who are exposed to tobacco chemicals trapped in the environment. Specifically, it has been linked to hospital admission rates for asthma and other cardiovascular emergencies. As a prenatal exposure, ETS has been shown to impact cognitive development of children, leading to issues with learning and crime in later life.

The proposed solution seeks to amalgamate urban planning with law; furthermore, it uses an existing solution proposed to remediate negative environmental and health impacts of sprawl development.

True benefits and tradeoffs of a proposed solution can be revealed through an interdisciplinary lens. The proposed solution in this paper is based on a convergence of law, health, environment, and urban planning; likewise, it requires evaluation from the perspective of more than one discipline.

Traditionally, it would be unlikely for a researcher working in the field of environmental tobacco smoke to consider urban planning as a field capable of offering potential solutions. It is even more unlikely that the researcher would consider other issues related to the potential solution, such as population aging, land preservation, and peak-oil. Yet, at the same time, all these linkages offer synergies for improving health and environment simultaneously. The importance and potential of interdisciplinary education is thus highlighted, and the inseparable connection between health and environment reaffirmed.

The proposed solution is in its early stages, and needs to be further evaluated (from multiple perspectives) to minimize tradeoffs and ensure the accuracy of proposed benefits. The success of both this solution – and of the general protection of vulnerable populations from environmental tobacco smoke – await in further innovation.

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