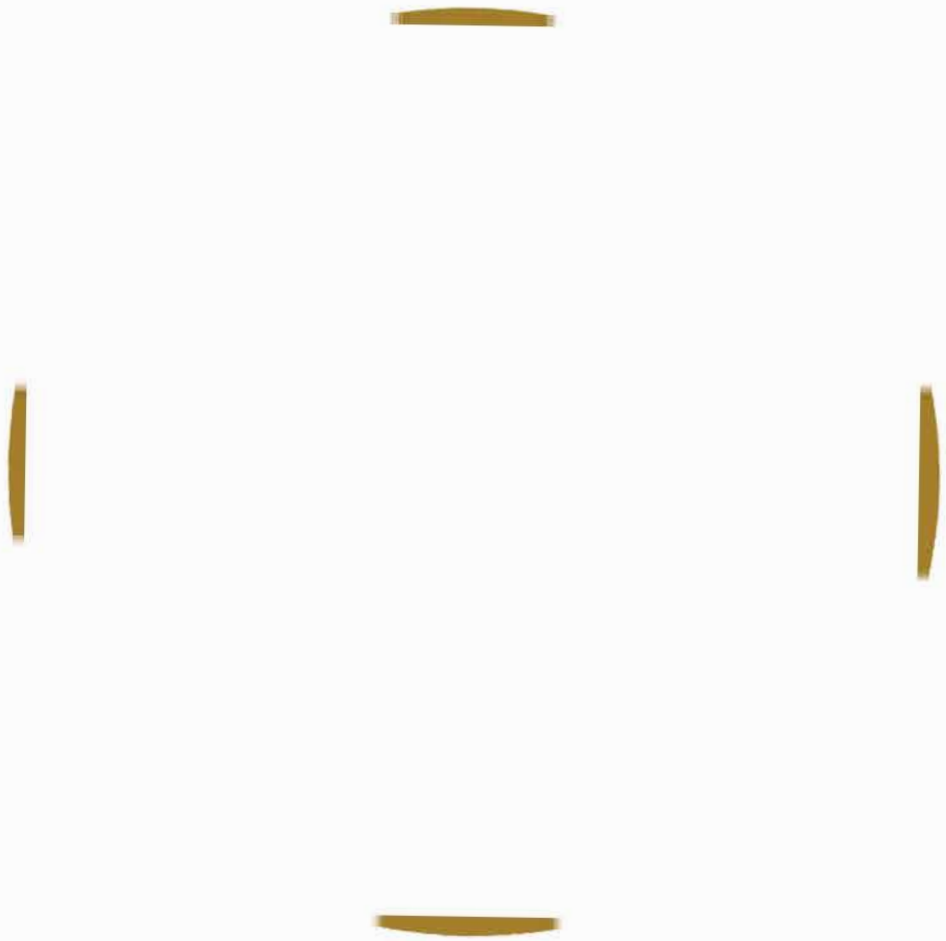

Even if the room is separately ventilated, the pumping action of swing doors when they are opened and closed further enhances tobacco pollutants leakage from smoking rooms; as much as 10% of air can leak out to non-smoking areas at each door movement (Wagner et al., 2004). The US Surgeon General does not recommend enclosed smoking rooms at all, but recommends complete non-smoking in indoor areas to reduce exposure to SHS, as all poisons, toxins, and particles found in SHS cannot be removed by any air cleaning technologies (USDHHS, 2006; ASHRAE, 2005).

Our findings support other studies that DSR at the airport is a major source of SHS exposure for non-smokers in adjacent non-smoking areas. If airport buildings are not smoke-free, workers and travelers of all ages are at risk for SHS exposure. Impact of high $PM_{2.5}$ levels can affect not only smokers who visit DSR, but cleaning and maintenance staff can have occupational exposure to SHS (Lee et al., 2010; Zellers et al., 2007).

Furthermore, children travelling with adults may be taken inside DSR, or left outside the smoking rooms. Findings suggest that actions such as separation of smoking into areas where smokers are exposed to high levels of particulate material can be very dangerous to smokers since the pollutant levels are concentrated to produce an extremely potent mix of environmental toxicants that could have sudden and life-threatening impacts on travelers whose cardiovascular systems have already become compromised by long travel. Both extreme high-level exposure for smokers and lower-level exposure for nonsmokers working in and around DSR over a working lifetime may be of concern.

These concerns should foster further study of both populations since secondhand smoke can be an added health threat to both smokers and nonsmoker depending on concentration and duration of exposure. Study in environments where exposures are both short- and long-term could be useful in further characterizing lifetime threats among various populations and sub-populations. Smoke-free policies that completely eliminate smoking inside airports are recognized as the only way to fully protect the non-smoking public from SHS exposure (CDC, 2012).

5. Conclusions

In summary, study results point to a measurable and statistically significant increase in $PM_{2.5}$ levels outside DSR, with dangerously high levels of $PM_{2.5}$ inside the DSR. These levels near DSR may not be obvious to travelers, but contribute to health damaging exposures above the WHO annual standard for particulate matter in ambient air.

Results of this study should lead to review of present Thai legislation so that international airports are included as smoke-free as with domestic airports. Further studies of tobacco smoke exposure may benefit from using other indicators of SHS to characterize cigarette smoke exposure using nicotine samplers to complement $PM_{2.5}$ measures.

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7. References

American Society of Heating, Refrigerating, and Air Conditioning Engineers 2005 **ASHRAE's Environmental Tobacco Smoke Position Document Committee.** "ASHRAE Position Document on Environmental Tobacco Smoke," June 30, 2005.

ANR. Americans for nonsmoker' rights. 2010. **Smoking policies in the 30 busiest US airports. July 5, 2010**. Accessed on September 28, 2015 at: http://www.no-smoke.org

Brennan E, Cameron M, Warne C, et al. 2010 Secondhand smoke drift: examining the influence of indoor smoking bans on indoor and outdoor air quality at pubs and bars. **Nicotine & Tobacco Reserch**. 12(3):271-277. doi: 10.1093/ntr/ntp204.

Burress, J. 2015 **Surgeon General Calls Out Atlanta Airport's Smoking Lounges. NPR Station, WABE, Atlanta, Georgia. May 18, 2015.** Accessed on September 28, 2015 at: http://wabe.drupal.publicbroadcasting.net/post/surgeon-general-calls-out-atlanta-airport-s-smoking-lounges

Cameron M, Brennan E, Durkin S et al. 2012 Secondhand smoke exposure ($PM_{2.5}$) in outdoor dining areas and its correlates. **Tobacco Control**. 2(19):19-23

Centers for Disease Control and Prevention 2012. Indoor Air Quality at Nine Large-hub Airports with and without designated smoking areas – United States, October-November 2012. **MMWR**. 61:1-5.

Charoenca N, Kungskulniti K, Hamann SL, et al. 2002. Exposure levels of carbon monoxide and nicotine at restaurants and nightclubs in Bangkok. **Bulletin of Health Science and Technology**. 5(2):115-124.

Glantz SA. 2013 Israel is failing to protect its citizens from secondhand smoke : underestimating public support. **Israel Journal of Health Policy Research**. 2(1):24

Kaufman P, Zhang B, Bondy SJ, et al. 2011 Not just 'a few wisps': real-time measurement of tobacco smoke at entrances to office buildings. **Tobacco Control,** 20(3):212-18. doi: 10.1136/tc.2010.041277

Krishnan RM, Adar SD, Szpiro AA, et al. 2012 Vascular responses to long- and short-term exposure to fine particulate matter: MESA Air

(Multi-Ethnic Study of Atherosclerosis and Air Pollution). **Journal of the American College of Cardiology**. 60(21): 2158–2166. doi: 10.1016/j.jacc.2012.08.973

Lee K, Hahn EJ, Robertson L, Whitten L, Jones LK, Zahn B. (2010). Air quality in and around airport enclosed smoking rooms. **Nicotine & Tobacco Reserch**. 12(6):665-668. doi:10.1093/ntr/ntq054

Legacy Tobacco Documments Library.1990. **Airport strategy plan, 1990.** San Francisco, California**:** University of California, San Francisco**.** Accessed on September 28, 2015 at http://legacy.library.ucsf.edu/tid/ajm30c00.

Liu KS, Alevantis LE, Offermann FJ. 2001. A survey of environmental tobacco smoke controls in California office buildings. **Indoor Air**. 11(1):26-34.

Pion M, Givel MS. 2004. Airport smoking rooms don't work. **Tob Control**, 13(Suppl I):37-40. doi:10.1136/tc.2003.005447

Repace JL. 2007 Exposure to secondhand smoke. In: Ott WR, Steinenmann AC, Wallace LA, eds. **Exposure Analysis. Boca Raton**. Louisiana: CRC Press, 201-235.

Royal Thai Government.2010 **Nonsmokers' Health Protection Act: Notification 19**. Bangkok: Royal Thai Government.

Schmidt CW. 2007. A change in the air: Smoking bans gain momentum worldwide. **Environmental Health Perspectives**. 115(8):A412-A415.

See the Shocking Difference Between This Airport's Smoking and Nonsmoking Rooms. (April 16, 2015).Available at: http://www.popsugar.com/fitness/Smoking-Room-Washington-Dulles-Airport-37289979. Accessed on December 11, 2015.

Stillman Frances A., Soong, Andrea, Kleb Cerise, Grant,Ashley, Navas-Acien,Ana. 2014. A review of smoking policies in airports around the world. **Tobacco Control.** doi:10.1136/tobaccocontrol-2013-051364.

Sureda X, Martinez-Sanchez JM, Lopez MMJ, et al. 2012 Secondhand smoke levels in public building main entrances: outdoor and indoor $PM_{2.5}$ assessment. **Tobacco Control**. 21(6):543-48. doi: 10.1136/tobaccocontrol-2011-050040

Tantadprasert A, Nutmagul W, Uyasatian U, et al. 2011. Ambient TSP and PM_{10} concentrations in public parks in Bangkok, Thailand. **Environment and Natural Resources Journal.** 9(1): 24-30.

TSI Incorporated. 2006. **Model AM510 SidePak Personal Aerosol Monitor User Guide**. Shoreview, Minnesota, USA

U.S. Department of Health and Human Services. 2006.**The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General**. Atlanta, GA: US Department of Health and Human Services, 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.

U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. 2014 **The health consequences of smoking – 50 years of progress: a report of the Surgeon General**. – Atlanta, GA..

Wagner J, Sullivan DP, Faulkner D , et al. 2004. Environmental Tobacco Smoke Leakage from Smoking Rooms. **Journal of Occupational and Environmental Hygiene**. 1(2):110-118

Zellers L, Thomas MA, Ashe M. 2007. Legal Risks to Employers Who Allow Smoking in the Workplace. **American Journal of Public Health**. 97(8): 1376-1382. doi:10.2105/AJPH.2006.094102