

The Effects of Third-Hand Smoke on Children

Student: Spencer MacLeod

Faculty Advisor: Mark Valacak

University of Michigan – Flint, Department of Public Health & Health Sciences

Abstract

Research has shown that tobacco use is the leading cause of preventable death in the United States, and accompanying research has shown there are associated health risks from second-hand smoke (the smoke emitted from a lit cigarette or exhaled from a smoker). But what do we know about the potential health effects of the smoke once it has settled? The goal of this project was to examine research conducted by various institutions to assess the health risks attributed to third-hand smoke (THS), primarily focusing on those posed to children, and to aid in raising a greater awareness of tobacco related health risks. The research examined in this project used a variety of methods in obtaining their data, these methods included blood panels, liver and lung biopsy for histological analysis, closed room air pollutant analysis, and behavioural observation of both the control and exposed groups. Further research should be conducted to examine any metabolic effects that may contribute to the bioaccumulation of chemicals present in THS as well as any long-term effects that have not yet been noted due to the relatively recent discovery of the concept of THS.

Introduction

Third-hand smoke is considered as the residue that has settled on surfaces from second-hand smoke in the form of dust or other particulate matter. These surfaces can include, but is not limited to, clothing, hair or skin, carpet, bedding, or any surface directly exposed to second-hand smoke. As this residue accumulates on surfaces, there is the potential that the toxicity may increase over time, this is due in-part to a more concentrated residue.

With children being the primary focus, they are particularly susceptible to the effects of third-hand smoke for several reasons: they have a smaller body mass, their breathing rate is much faster than that of an adult, and their body systems are still developing (the primary focus here will be the respiratory, digestive, immune, and nervous systems). Third-hand smoke can be transferred from a contaminated surface to a child in many ways. One way this can happen is if a child exposed to an environment where others have smoked and touches a contaminated surface and then puts their hands into their mouth. This can transmit a variety of harmful chemicals found in cigarette smoke from that surface to the child and get absorbed into the body. Two of the most prevalent chemicals found in this residue is nicotine and ozone. ^[1] These particles are small enough that they can travel deep into the lungs and accumulate over time which can lead to respiratory problems in the future such as asthma and in some cases cancer. The use of tobacco products, or exposure to these products, is the leading cause of preventable death and disease in the United States alone ^[2], to reduce the number of adults and children exposed it is critical to continually educate individuals on the risks associated with tobacco use and exposure as well as continually develop intervention measures.

Health literacy in addition to access to cessation resources has been effective in reducing the number of individuals exposed to tobacco products. Adults who are effectively educated on the risks that children are exposed to when they use tobacco products in or around an environment where a child will be, are more likely to quit as opposed to individuals who are not educated or are misinformed.

The studies reviewed herein explore the health risks children are exposed to as it relates to third-hand smoke. The stated hypothesis is: exposure to third-hand smoke can lead to an increase in health conditions in children. In confirming the hypothesis as true, it

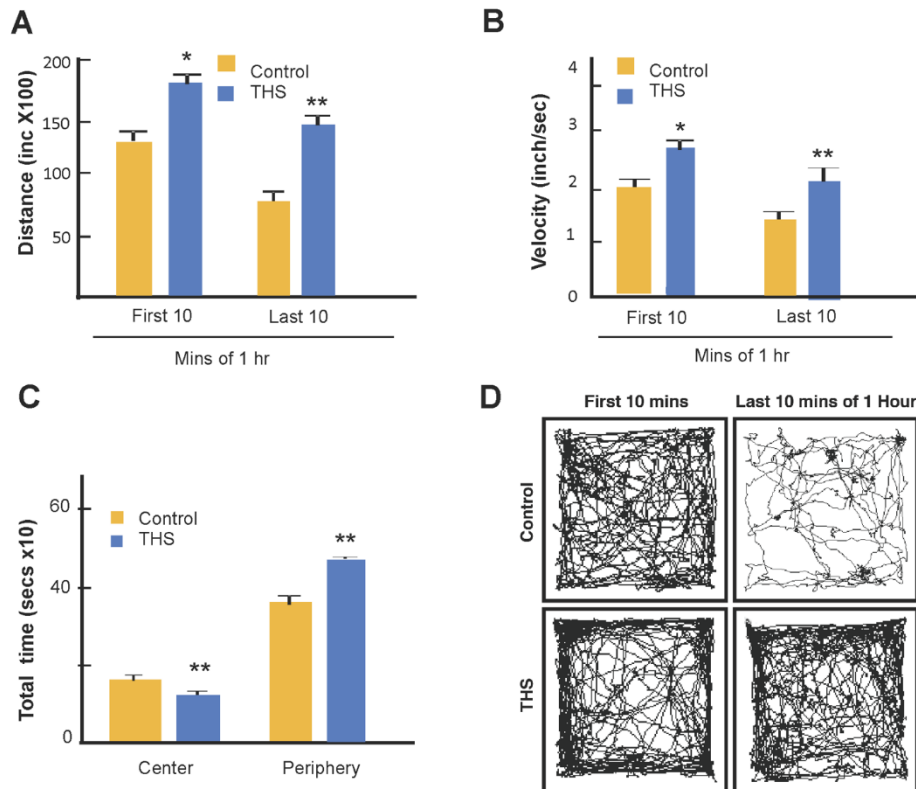
indicates that there is a need to reduce the number of tobacco related illness and disease in children by increasing health literacy and access to tobacco cessation resources.

Methods

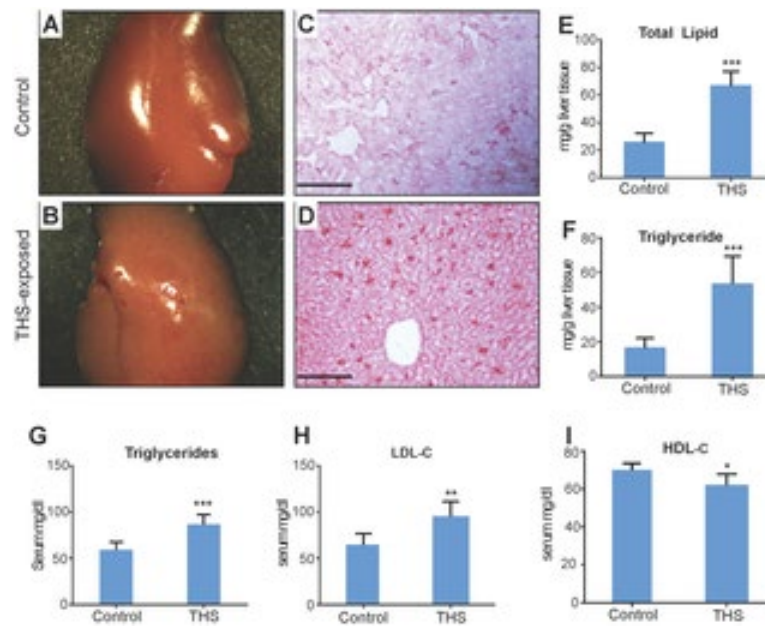
A thorough review of various studies conducted by reputable organisations was done and all relevant data was compiled and analysed. Any further explanations given are from personal research to better understand or better relay the information stated.

Results

A research team at the University of California – Riverside conducted the first animal study on the hazards of third-hand smoke in 2011, and used mice to simulate the exposure to humans. These mice were separated into a control group and an exposed group. The mice in the control group were placed in an enclosed setting under normal conditions for observation while the exposed group was placed in an enclosed setting with cigarette smoke blown into it where it is allowed to accumulate. The lead professor on the study indicated that in conducting various lab tests, such as blood draws and biopsies, on the mice exposed to third-hand smoke there was significant damage that occurred in both the lungs and the liver with further signs of hyperactivity. The table ^[3] below shows recorded activity of the control group compared to the group of mice exposed to third-hand smoke over the course of one hour.



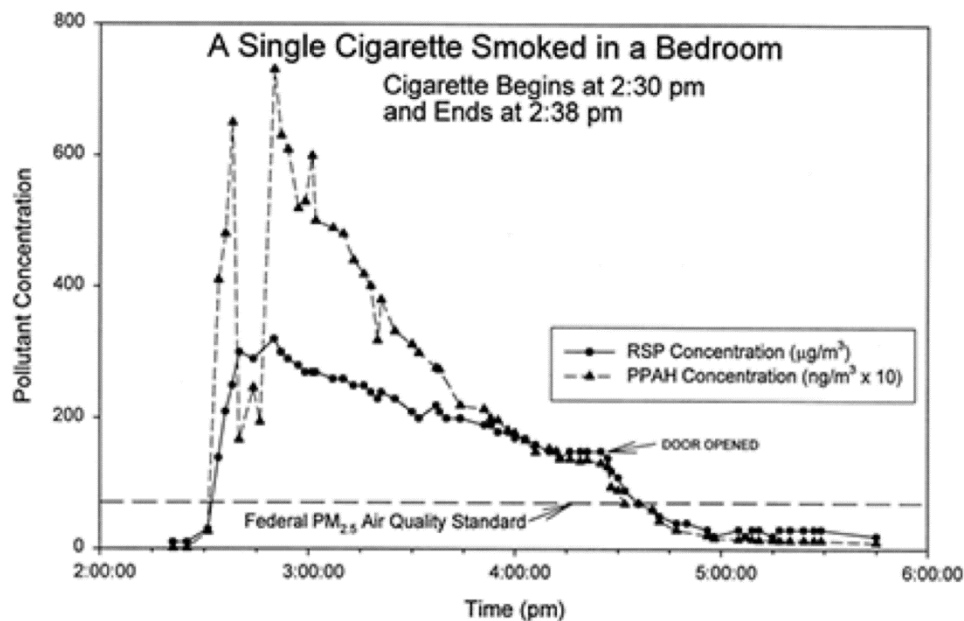
This table indicates that the mice exposed to third-hand smoke displayed an increase in movement, hyperactivity, over the course of the observation time, that is from the first ten minutes to the last ten of the hour. Part D shows that the movement in both groups was relatively uniform during the first ten minutes, but the exposed group continues to be hyperactive into the last ten minutes while the control group shows decreased movement over the timeframe. Under the same conditions, liver and lung biopsies revealed that the exposed group showed significant changes to the liver, consisting of: an accumulation of fat in the liver cells (hepatocytes), change in liver colour (from a deep red to a lighter “pale” red, and a higher level of triglycerides (an increase in LDL and a decrease in HDL). The table³ below displays these results with images of the liver and the histology of the hepatocytes.



The health effects that could result from the data displayed in the table above could include: non-alcoholic fatty liver disease (precursor to cirrhosis of the liver). Other health concerns related to this experiment include, excess collagen production with high levels of inflammatory cytokines (precursor to COPD and asthma); poor wound healing abilities; hyperactivity; and over the course of prolonged exposure there is a large risk of developing severe neurological disorders. [4]

The Dartmouth-Hitchcock Norris Cotton Cancer Centre conducted a study to approximate the environment children would be exposed to in a home with smokers present and smoking for “6 hrs/day, 5 days/wk for 24-26 wks, at a total particulate matter (TPM) of $30 \pm 5 \mu\text{g}/\text{m}^3$, a value that falls within the range detected by the Environmental Protection Agency (EPA) in the homes of smokers ($15\text{--}35 \mu\text{g}/\text{m}^3$)”. [5] This study shows that after two hours off a single cigarette is extinguished, after being smoked in a closed bedroom, smoke particulates begin to settle below the accepted threshold for causing harm. [6] In other words, if someone smoking in a room finishes, puts out their cigarette and leaves, the particulates will still be above the harm threshold for about two hours. The

following table ^[6] shows the monitored air quality with the dashed line representing the EPA's air quality standard.



When the residue of third-hand smoke settles, it settles in dust and can be redistributed in the air when the dust is disturbed. If other pollutants are present there is the potential for the dust to react and cause secondary pollutants. Since children are still growing, developing, and often crawling around or discovering things, they become the most vulnerable to this type of tobacco exposure. These health hazards can also affect children *faster* because of their small body mass, not-as-developed immune system, breathing rate, and their tendency to spend more time indoors than outdoors (especially during the winter months). The study conducted by Dartmouth-Hitchcock also found that smoking in the car is just as harmful to children because the cigarette smoke can react with car exhaust to create TSNA (tobacco-specific nitrosamines), which are carcinogens, with the ability to absorb through the skin, and can settle in the seats and other surfaces of a car's interior. ^[6]

According to the Hong Kong Council on Smoking and Health, Nicotine and other tobacco toxins can absorb into the skin and clothing of smokers and will come back in with them, if smoking outside, and get re-dispersed in the air. It has also been shown that these toxins cannot be sufficiently ventilated using fans or open windows as they will still settle into clothing, hair, furniture, and other nearby surfaces. The Hong Kong Council on Smoking and Health also revealed that the health effects of third-hand smoke can include, cognitive deficits, an increased likelihood of developing lung cancer, pulmonary & respiratory diseases, asthma, and otitis media (an infection of the middle ear). ^[7]

There are a variety of harmful chemicals that exist in cigarette smoke ranging from 4,000-7,000 (depending on the source) 69 of which have been found to be carcinogens. These chemicals include, and are not limited to: hydrocyanic acid, butane, toluene, arsenic, carbon monoxide, nicotine, formaldehyde, acrolein, ammonia, nitrogen oxides, pyridine, vinyl chloride, acrylonitrile, N-nitrosodimethylamine, and nitrous acid.^{3,7,8,9} A study published in the January 2009, Volume 123/Issue 1 of Paediatrics, found that children, on average, ingest up to 0.25 grams per day of dust (nearly twice that of adults), with health results similar to that of low level lead exposure. This study also mentions that children can be exposed to harmful chemicals from the breath of a smoker even up to several minutes after the cigarette has been extinguished. ^[10]

Discussion

While we all know that smoking is harmful, not many people know that third-hand smoke exists and is just as harmful as second-hand smoke. There are many hazards associated to second-hand smoke, but the pollutants from this smoke can react with other components in the air increasing toxicity and potentially exacerbating the harmful effects on the body. It is important for smoking families to be aware of the hazards they are exposing

themselves and other family members to, especially those that have toddlers or infants.

After researching third-hand smoke, it was found that the effects of third-hand smoke are just as bad as those of second-hand smoke, with the potential to be even worse for the fact that you can't see or sometimes even smell third-hand smoke. To further eliminate or reduce the risk of illness and disease in children as a result of exposure to third-hand smoke, it is evident that additional health policies need to be put in place and enforced to further reduce the risk of innocent exposure to the toxins of cigarette smoke. Furthermore, an increase in health literacy may also help to educate tobacco users of not only the harm they are doing to themselves, but also those who are exposed to it around them.

Further research needs to be conducted to observe the long-term effects associated with this type of tobacco exposure and monitor the implementation, if any, of health policies working to reduce children's exposure and the overall use of tobacco products. It is important for individuals to be fully educated on the harm that can be done through tobacco exposure as well as the harm that it has on children as a high-risk population.

References

- [1] Goodman, M. B. (2011, January 13). Risks of Thirdhand Cigarette Smoke Can Linger. Retrieved November 17, 2015, from <http://www.webmd.com/smoking-cessation/news/20110113/risks-of-thirdhand-cigarette-smoke-can-linger>
- [2] Tobacco Use. (n.d.). In *Office of Disease Prevention and Health Promotion*. Retrieved June 22, 2017, from <https://www.healthypeople.gov/2020/topics-objectives/topic/tobacco-use>
- [3] Martins-Green, M., Adhami, N., Frankos, M., Valdez, M., & Goodwin, B. (2014, January 29). Cigarette Smoke Toxins Deposited on Surfaces: Implications for Human Health. Retrieved November 17, 2015, from <http://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0086391#pone-0086391-t001>
- [4] Pittalwala, I. (2014, January 30). Third-hand Smoke Shown to Cause Health Problems. Retrieved November 17, 2015, from <http://ucrtoday.ucr.edu/20236>
- [5] {3} Martins-Green, M., Adhami, N., Frankos, M., Valdez, M., & Goodwin, B. (2014, January 29). Cigarette Smoke Toxins Deposited on Surfaces: Implications for Human Health. Retrieved November 17, 2015, from <http://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0086391#pone-0086391-t001>
- [6] Protect Children from Third Hand Smoke Exposure. (2013, February 4). Retrieved November 17, 2015, from http://cancer.dartmouth.edu/focus/children_third_hand_smoke.html
- [7] Risks: Thirdhand Smoking. (n.d.). Retrieved November 17, 2015, from <http://smokefree.hk/en/content/web.do?page=ThirdhandSmoking>
- [8] Tobacco Reduction Program, Alberta Health Services. (2015, July 1). Quitting Smoking. Retrieved November 17, 2015, from <https://myhealth.alberta.ca/alberta/Pages/Second-Hand-and-Third-Hand-Tobacco-Smoke.aspx>
- [9] CCOHS. (2015, November 17). OSH Answers Fact Sheets. Retrieved November 17, 2015, from http://www.ccohs.ca/oshanswers/psychosocial/ets_health.html
- [10] Ckoff, J. P., Friebely, J., Tanski, S. E., Sherrod, C., Matt, G. E., Hovell, M. F., & McMillen, R. C. (2009, January). Beliefs About the Health Effects of “Thirdhand” Smoke and Home Smoking Bans. Retrieved November 17, 2015, from <http://pediatrics.aappublications.org/content/123/1/e74.full>