

Association Between Secondhand Smoke Exposure and Metabolic Syndrome in Children with Obesity



Alexandra Lawson BA¹, James Ebert MD, MBA, MPH^{1,2,3}, Adrienne Stolfi MSPH², and Abiodun Omolaja MD, MBA^{2,3}
 Wright State University, ¹Department of Community Health & ²Department of Pediatrics and ³Dayton Children's Hospital, Dayton, OH

Background

The growing obesity rates in the United States are of great public health concern, particularly in children. Childhood obesity in children aged 6 to 11 years has more than doubled from 7% in 1980 to 18% in 2012. Childhood obesity not only increases cardiovascular risk, but imposes a higher likelihood of obesity in adulthood and subsequent health problems such as cardiovascular disease, type 2 diabetes, and stroke.¹

Obesity is also commonly associated with metabolic syndrome (MetS), a combination of biochemical abnormalities. As a result of the increasing obesity rates, metabolic syndrome is becoming more prevalent. Like obesity, it also increases risk of cardiovascular disease.²

MetS has been associated with secondhand smoke exposure (SHSe). In a 2009 study, adults with exposure to secondhand smoke had significantly increased risk of MetS (odds ratio = 2.8, p-value = 0.01).³ A 2005 study showed the prevalence of metabolic syndrome was greater in adolescents with SHSe and with tobacco use. SHSe was independently associated with metabolic syndrome with an odds ratio of 4.7 (95% CI 1.7 to 12.9).⁴

While associations between SHSe and MetS have been established in adults and adolescents, there is yet to be a well-described relationship in pre-adolescent children.

Roughly half of pediatricians and family practitioners ask the patients' parents/ guardians about household and family member smoking status. In a recent study, only 41% of parent smokers were advised about the dangers of smoking, and even fewer (36%) received advice on how to quit.⁵

Methods

- Retrospective chart review was conducted on all overweight/obese children aged 6-11 years who were seen as patients from 2008 to 2014 in the Lipid Clinic at Dayton Children's Hospital.
- Data collected included age, sex, race (white vs. black/other), BMI, and six metabolic syndrome criteria (Table 1).
- MetS is defined as a BMI $\geq 85^{\text{th}}$ percentile and any two or more of the criteria in Table 1.

Table 1. Metabolic Syndrome Criteria

Risk Factor	Criteria
Systolic Blood Pressure and/or Diastolic Blood Pressure	$\geq 90^{\text{th}}$ percentile
High Density Lipoprotein	< 35 mg/dL
Triglyceride	> 150 mg/dL
Fasting Glucose	> 100 mg/dL
Fasting Insulin	≥ 17 μ U/mL

- Information about the number of smokers in the household was obtained from parents/guardians.
- Children were classified as exposed to SHSe if one or more smokers resided in the household.
- Comparisons between children exposed (SHSe+) and not exposed (SHSe-) were made with chi-square and Mann-Whitney tests.

Results

- Of 1,027 eligible patients, 514 had data for secondhand smoke exposure and metabolic syndrome. Overall, 58.0% of patients were female and 59.1% were white. Two hundred fifty-five (255) of those patients (49.6%) lived with one or more smokers, and thus were classified as exposed to secondhand smoke (SHSe+). The exposure to secondhand smoke was significantly greater in the white patients compared to patients of other races (Figure 1).
- All patients were at or above the 85th percentile for BMI, meeting one of the necessary three criteria for metabolic syndrome; 42.6% of all patients subsequently met the criteria for metabolic syndrome. However, the SHSe+ patients had a significantly higher rate of metabolic syndrome than SHSe- patients ($p < 0.001$, Figure 2).
- Patients with secondhand smoke exposure were found to have significantly increased systolic blood pressure, increased triglyceride levels, decreased HDL levels, and increased fasting insulin levels (Table 2, Figure 3).
- Results suggest increased risk for metabolic syndrome in pre-adolescent children exposed to secondhand smoke.

Results (continued)

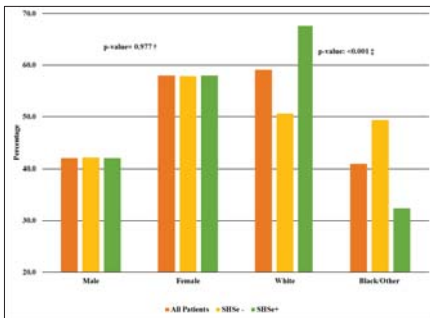


Figure 1: Prevalence of secondhand smoking exposure by patient demographic.

Note: † p-value calculated using chi-square test, ‡ p-value calculated using Fisher's exact test

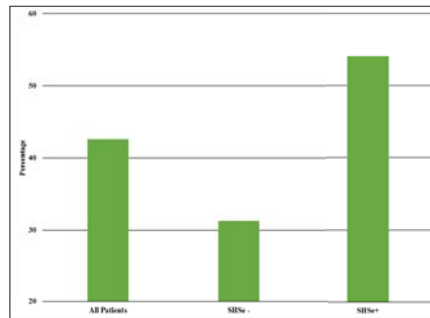


Figure 2: Prevalence of metabolic syndrome in overall sample and by secondhand smoking exposure.

Note: p-value < 0.001 , calculated by chi-square test

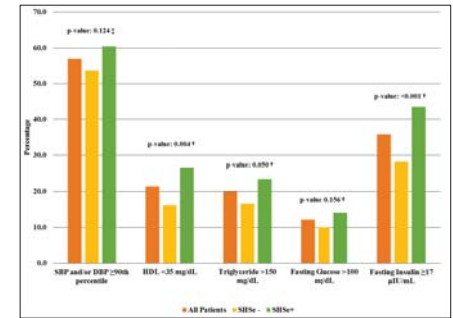


Figure 3: Metabolic abnormalities in overall sample and by secondhand smoking exposure.

Note: † p-value calculated using chi-square test; ‡ p-value calculated using Fisher's exact test

Table 2. Continuous Components in Overall Sample and by Secondhand Smoking Exposure

	All Patients (n=514)	SHSe- (n=259)	SHSe+ (n=255)	p-value
BMI Percentile	99.3 \pm 1.1	99.2 \pm 1.4	99.4 \pm 0.9	< 0.001 †
Systolic BP (mm Hg)	118 \pm 11	117 \pm 11	119 \pm 12	0.018 †
Diastolic BP (mm Hg)	67 \pm 7	67 \pm 7	67 \pm 7	0.488 †
HDL (mg/dL)	43 \pm 10	44 \pm 10	41 \pm 11	0.016 †
Triglyceride (mg/dL)	93 \pm 81	85 \pm 72	100 \pm 86	0.01 †
Fasting Glucose (mg/dL)	92 \pm 7	92 \pm 6	93 \pm 8	0.377 †
Fasting Insulin (μ U/dL)	13.6 \pm 11.7	12.7 \pm 10.1	15.5 \pm 12.5	0.001 †

Note: † Values had normal distribution; the mean and standard deviation are given, and the p-values were calculated from t-tests. ‡ Distributions of the values were skewed to the left or right; the median and interquartile range are given, and the p-values were calculated from Mann-Whitney tests.

Table 3. Distribution of Metabolic Syndrome* Components in Overall Sample and by Secondhand Smoking Exposure

	All Patients (n=514) (%)	SHSe- (n=259) (%)	SHSe+ (n=255) (%)	p-value
0	18.3	20.8	15.7	< 0.001
1	39.1	47.9	30.2	
2	27.2	22.0	32.5	
3	10.3	5.4	15.3	
4	3.5	2.7	4.3	
5	1.6	1.2	2.0	

Note: p-value was calculated with Fisher's exact test; *MetS is defined as BMI $\geq 85^{\text{th}}$ percentile and any two of the criteria in Table 1; all patients had at least one abnormality based on BMI criterion.

Discussion

Obesity and tobacco exposure are important public health concerns, particularly in children. These two conditions can independently increase risk for cardiovascular disease. While MetS in children increases risk of cardiovascular disease, little research has been completed on the impact of SHSe in obese children or children with MetS. The results of this study suggest that an association exists between secondhand smoke exposure and increased rates of metabolic syndrome in pre-adolescent children. The results also demonstrate associations between secondhand smoke exposure and increased systolic blood pressure, increased triglyceride levels, decreased HDL levels, and increased fasting insulin levels.

Conclusion

Children with MetS and exposure to SHS may be at an increased risk for cardiovascular disease. Additional studies are needed to investigate the combined effects of MetS and SHSe on the cardiovascular health of children. Pediatricians and family practitioners should attempt to address the harms of secondhand smoke for children and methods for smoking cessation.

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