Allergy & Rhinology
Volume 9: 1–4

DOI: 10.1177/2152656718800060
journals.sagepub.com/home/aar
SAGE

Effects of Exposure to New Car Interiors in Patients With Asthma and Allergic Rhinitis

Amber N. Pepper, MD[1], Adeeb Bulkhi, MD, MS[1,2], Catherine R. Smith, CMA, CCRC[1], Matthias Colli[3], Karl-Christian Bergmann, MD[4], Torsten Zuberbier, MD, PhD[4], and Thomas B. Casale, MD[1]

Abstract

Rationale: Vehicle interiors are an important microenvironment for atopic subjects. This study evaluated the subjective and objective physiologic and clinical effects of exposing subjects with asthma and allergic rhinitis to new 2017 Mercedes vehicles during 90-minute rides.

Methods: Ten adult asthmatics with allergic rhinitis were assessed before and 45 and 90 minutes into rides in a 2017 Mercedes-Benz S-Class sedan and GLE-Class SUV on 2 separate days. Assessments included spirometry, fractional exhaled nitric oxide, peak nasal inspiratory flow, asthma symptom scores, and physical examinations.

Results: Of the 10 subjects, 6 were women, mean age was 32 years, and 6 and 4 were using chronic asthma controllers or intranasal corticosteroids, respectively. None of the subjects had worsening of asthma or rhinitis symptoms during the rides. There were no statistically significant changes from baseline in forced expiratory volume in 1 second, forced expiratory volume in 1 second:forced vital capacity ratio, forced expiratory flow at 25%–75% of vital capacity, fractional exhaled nitric oxide, or peak nasal inspiratory flow at 45 or 90 minutes into the rides with either Mercedes vehicle (all P values $> .1$ using generalized linear mixed model).

Conclusion: The interior environment of the tested Mercedes vehicles did not cause changes in subjective or objective measures of asthma and allergic rhinitis. We suggest that this model system can be used to test other vehicles for putatively adverse effects on patients with allergic respiratory disorders.

Keywords

allergic rhinitis, asthma, vehicle, air quality

Introduction

Vehicle interiors are an important microenvironment for atopic subjects. The quality of air inside motor vehicles may be compromised by interior and exterior factors, such as volatile organic compounds (VOCs), polybrominated diphenylesthers (PBDEs) and other brominated flame retardants, phthalic acid esters (phthalates), aromatic hydrocarbons, particulate matter, odors, and pollutants.[1–3] VOCs, PBDEs, and phthalates may be released from materials used to manufacture vehicle interiors, and VOC concentrations inside vehicles may exceed those normally detected in residential indoor air.[1,2] Pollutants, chemicals, and other irritants, especially VOCs, in vehicle interiors are capable of exacerbating symptoms in atopic individuals.[3–10] In addition, strong

[1]Division of Allergy and Immunology, Department of Internal Medicine, University of South Florida Morsani College of Medicine and James A. Haley Veterans' Affairs Hospital, Tampa, Florida
[2]Department of Internal Medicine, College of Medicine, Umm Al Qura University, Makkah, Saudi Arabia
[3]European Centre for Allergy Research Foundation, Institute GmbH, Berlin, Germany
[4]Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin, Humboldt-Universität zu Berlin, and Berlin Institute of Health, Department of Dermatology and Allergy, Comprehensive Allergy Centre Charité, Berlin, Germany

Corresponding Author:
Amber N. Pepper, Division of Allergy and Immunology, James A. Haley V.A. Medical Center, University of South Florida, 13000 Bruce B. Downs Blvd. (111D), Tampa, FL 33612, USA.
Email: apepper1@health.usf.edu

odors, often present in new cars, can aggravate asthma, and aeroallergens theoretically may be transferred to vehicle interiors during peak pollen season.[8]

Methods

In this small prospective study, we investigated the physiologic and clinical effects of exposing asthmatics with allergic rhinitis to new vehicle interiors to determine the tolerability to this microenvironment. Testing was performed according to the criteria for allergy friendly car interiors established by the European Centre for Allergy Research Foundation based on an international expert advisory board consensus. This study was funded by Mercedes-Benz USA, LLC and approved by the University of South Florida Institutional Review Board.

Ten adult asthmatic subjects with allergic rhinitis were recruited for and completed the study. After signing informed consent, pertinent medical histories were recorded for each subject at enrollment. Each subject was driven by a professional driver in 2 new 2017 Mercedes-Benz vehicles, the S-Class sedan and GLE-Class SUV, for 90 minutes on separate days. A physician and study coordinator accompanied the subject on the drives. No measures were taken to air out the vehicles; windows remained closed and the air-conditioning turned on with central circulation during the rides. Assessments were collected before (predrive, time 0), 45 minutes into (middrive), and 90 minutes into (postdrive) each ride. The predrive assessment was either completed as an independent visit or immediately preceding the first drive. The middrive assessment was completed while the vehicle was stopped at a secure location. The subject remained inside the vehicle for the entire 90 minutes. Assessments included spirometry; fractional exhaled nitric oxide (FeNO); peak nasal inspiratory flow (PNIF); asthma symptom scores; and physical examinations of the ocular, nasal, oropharyngeal, cardiovascular, and pulmonary systems. Asthma symptom scores consisted of evaluations of wheezing, shortness of breath, cough, and chest tightness on a 7-point scale from 1 (not bothered) to 7 (extremely bothered). For FeNO and PNIF, the mean of and best of 2 successive measurements were used for each time point, respectively.

Subjects' baseline demographic and clinical variables were assessed by examining means and standard deviation for continuous variables and frequency for dichotomous variables. For variables measured longitudinally, a generalized linear mixed model was used without adjustment. Data analyses were performed using SAS 9.4 (SAS Institute Inc., CA). The level of significance was set at alpha 0.05.

Table 1. Baseline Characteristics of Study Participants.

Characteristic	Subjects (N = 10)
Age (IQR)	32 (22–60)
Male sex (%)	4 (40)
Race—no. (%)	
White	8 (80)
Black	1 (10)
Other (Guyanese)	1 (10)
Smoking history (%)	1 (10)
Time since asthma diagnosis in years (SD)	16.4 (15.57)
Asthma controller usage (%)	6 (60)
Intranasal corticosteroid usage (%)	4 (40)
$FEV_1 < 70\%$ predicted at baseline (%)	1 (10)
FeNO > 150 ppb at baseline (%)	1 (10)

Abbreviations: FeNO, fractional exhaled nitric oxide; FEV_1, forced expiratory volume in 1 second; IQR, interquartile range; SD, standard deviation; ppb, parts per billion.

Results

Baseline characteristics are listed in Table 1. Sixty percent (6/10) of participants were women, 80% (8/10) were white, and the mean age was 32 years. Of note, 1 subject had a baseline forced expiratory volume in 1 second < 70% predicted at study initiation and 1 subject had a baseline FeNO > 150 ppb which remained elevated throughout the study. There were no significant differences in any of the parameters measured for the 3 time points during the rides in either vehicle (Table 2). There were also no clinically significant changes in physical examinations.

Discussion

This study has several limitations. The small sample size limits generalizability, although participants were not excluded due to spirometry, FeNO, smoking status, or medication use. Only acute exposure to 2 vehicle interiors was assessed and results may be different with chronic repeated exposure or delayed assessment of symptoms. The tested vehicles may not be representative of all vehicles of the same make and model. The study was completed outside of peak pollen season in Florida, and results may differ during the height of pollen seasons, especially for sensitized individuals. Nonetheless, the study represents a step forward in assessing whether new vehicles affect asthmatics with allergic rhinitis. Patients often complain that new car odors and other strong smells adversely affect their respiratory symptoms. This model system can be used to determine true effects of new car interiors on patients with asthma and allergic respiratory diseases. Future studies should assess nasal symptoms and measure levels of allergens, VOCs, and other irritants in the vehicle interiors after repeated exposures. In addition, asthma phenotypes/endotypes

Table 2. Change in Airway Parameters and Symptom Scores at Baseline and 45 and 90 Minutes Into Rides in 2017 Mercedes-Benz S-Class Sedans and GLE-Class SUVs.

	Pre (0 min) (N = 10)	Mid (45 min) (N = 10)	Post (90 min) (N = 10)	*P*
Sedan				
Asthma questionnaire (IQR)	5.9 (4–13)	5.5 (4–12)	5.5 (4–11)	.44
FEV_1 (L) (SD)	3.18 (0.95)	3.12 (0.89)	3.13 (0.91)	.11
FEV_1:FVC ratio (SD)	0.75 (0.09)	0.76 (0.09)	0.75 (0.1)	.17
$FEF_{25–75}$ (L/s) (SD)	2.73 (1.28)	2.78 (1.3)	2.68 (1.23)	.42
Mean FeNO (ppb) (SD)	40.85 (64.39)	38.15 (56.37)	39.55 (60.35)	.60
Best PNIF (SD)	137 (50.56)	134.4 (51.41)	139 (55.07)	.51
SUV				
Asthma questionnaire (IQR)	5.3 (4–9)	5.8 (4–10)	5.3 (4–8)	.46
FEV_1 (L) (SD)	3.09 (0.89)	3.01 (0.86)	3.04 (0.86)	.32
FEV_1:FVC ratio(SD)	0.74 (0.1)	0.74 (0.1)	0.74 (0.1)	.49
$FEF_{25–75}$ (L/s) (SD)	2.63 (1.3)	2.52 (1.33)	2.57 (1.25)	.59
Mean FeNO (ppb) (SD)	35.15 (48.1)	36.15 (48.05)	34.6 (44.23)	.39
Best PNIF (SD)	145 (50.61)	144 (41.42)	143 (43.73)	.98

Abbreviations: $FEF_{25–75}$, forced expiratory flow at 25%–75% of vital capacity; FeNO, fractional exhaled nitric oxide; FEV_1, forced expiratory volume in 1 second; FVC, forced vital capacity; IQR, interquartile range; L, liter; PNIF, peak nasal inspiratory flow; ppb, parts per billion; SD, standard deviation.

and severity could be assessed in future studies to determine whether a subtype of asthmatics is impacted.

In conclusion, the interior environments of the tested 2017 Mercedes-Benz S-Class sedan and GLE-Class SUV did not cause any significant changes in subjective or objective measures of asthma and allergic rhinitis. We suggest that this model system can be used to test other vehicles for putatively adverse effects on patients with allergic respiratory disorders.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

This article does not contain any studies with animal subjects.

Statement of Informed Consent

The study does involve human subjects and informed consent was obtained for all participants.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Torsten Zuberbier is head of the foundation European Centre for Allergy Research Foundation (ECARF) which is awarding this seal for allergy friendly products and services which Mercedes has received based on the tests described in this paper. Neither the foundation nor Torsten Zuberbier himself has received any donations or personal payments from Mercedes. Matthias Colli works for ECARF. Karl-Christian Bergmann works for ECARF. Amber Pepper, Catherine Smith, Adeeb Bulkhi, and Thomas Casale have no conflicts of interest to report.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was funded by Mercedes-Benz USA, LLC.

References

1. Müller D, Klingelhöfer D, Uibel S, Groneberg DA. Car indoor air pollution—analysis of potential sources. *J Occup Med Toxicol*. 2011;6(1):33.
2. Geiss O, Tirendi S, Barrero-Moreno J, Kotzias D. Investigation of volatile organic compounds and phthalates present in the cabin air of used private cars. *Environ Int*. 2009;35(8):1188–1195.
3. The Ecology Center. *Model year 2011/2012 guide to new vehicles*. The Ecology Center. http://www.ecocenter.org/healthy-stuff. Published 2012. Accessed October 11, 2017.
4. Marino E, Caruso M, Campagna D, Polosa R. Impact of air quality on lung health: myth or reality? *Ther Adv Chronic Dis*. 2015;6(5):286–298.
5. Sarnat JA, Golan R, Greenwald R, Raysoni AU, Kewada P, Winquist A, et al. Exposure to traffic pollution, acute inflammation and autonomic response in a panel of car commuters. *Environ Res*. 2014;133:66–76.
6. Li J, Li M, Shen F, Zou Z, Yao M, Wu CY. Characterization of biological aerosol exposure risks from automobile air conditioning system. *Environ Sci Technol*. 2013;47(18):10660–10666.
7. Hulin M, Simoni M, Viegi G, Annesi-Maesano I. Respiratory health and indoor air pollutants based on quantitative exposure assessments. *Eur Respir J*. 2012;40(4):1033–1045.
8. Vethanayagam D, Vliagoftis H, Mah D, Beach J, Smith L, Moqbel R. Fragrance materials in asthma: a pilot study using a surrogate aerosol product. *J Asthma*. 2013;50(9):975–982.

9. Cakmak S, Dales RE, Liu L, Kauri LM, Lemieux CL, Hebbern C, et al. Residential exposure to volatile organic compounds and lung function: results from a population-based cross-sectional survey. *Environ Pollut*. 2014;194:145–151.

10. Paciencia I, Madureira J, Rufo J, Moreira A, Fernandes Ede O. A systematic review of evidence and implications of spatial and seasonal variations of volatile organic compounds (VOC) in indoor human environments. *J Toxicol Environ Health B Crit Rev*. 2016;19(2):47–64.