

PublisherInfo		
PublisherName	:	BioMed Central
PublisherLocation	:	London
PublisherImprintName	:	BioMed Central

Ventilatory responses to ozone are reduced in immature rats

ArticleInfo		
ArticleID	:	1651
ArticleDOI	:	10.1186/rr-2001-68585
ArticleCitationID	:	68585
ArticleSequenceNumber	:	62
ArticleCategory	:	Paper Report
ArticleFirstPage	:	1
ArticleLastPage	:	4
ArticleHistory	:	RegistrationDate : 2001-9-20 Received : 2000-7-25 Accepted : 2001-9-20 OnlineDate : 2001-9-20
ArticleCopyright	:	Biomed Central Ltd2001
ArticleGrants	:	
ArticleContext	:	129312211

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Keywords

Inflammation, lung injury, ozone, plethysmograph, rat, respiration

Introduction

Air quality is a risk factor for the development of asthma. There is currently an upsurge in the incidence of asthma in children and it is consequently of great importance to understand the effects of inhaled pollutants in children. Few studies have attempted to model the effects of ozone early in life.

The degree of lung injury caused by ozone inhalation is a function of the inspired concentration, the duration of the exposure, and the minute ventilation rate. Inhalation of ozone results in a decrease in minute ventilation; this protective response may ameliorate the degree of injury. No previous studies have examined the ventilatory response of immature animals after ozone inhalation; this is the first study to characterize and compare responses of mature and immature rats to inhaled ozone.

Comments

This important study has identified significant differences in specific minute ventilation between immature and mature rats, and in the effects and susceptibilities to inhaled ozone. At a given level of ambient ozone, immature rats received a five- to six-fold greater dose than mature animals. The dose of ozone used is high (2 ppm, 3 h), perhaps distracting from a direct relationship of the findings to air pollution. The age-dependent differences may pertain to the effects of environmental levels of the gas, which, if studied along with alterations in airway reactivity, could provide additional insights into the effects of ozone during development.

Methods

After acclimation to nose-only-exposure plethysmographs, ozone (2 ppm for 3 h) or air was delivered while measuring chamber pressure changes

Software was used to compute (on a breath by breath basis) minute ventilation, tidal volume, inspiratory time, and expiratory time and rate

In separate animals bronchoalveolar lavage (BAL) fluid was collected 0 h or 4 h after exposure for measurement of protein, prostaglandin E₂ (PGE₂) and cell count (neutrophils, macrophages, epithelial cells)

Results

A comparison was made of the effects of treatment with 2 ppm ozone on minute ventilation of rats 2, 4, 6, 8 and 12 weeks old. Before exposure, immature animals had a greater minute ventilation and tidal volume than mature animals (after normalization for body weight). Mature rats (8 and 12 weeks) responded with a decrease (50-60%) in minute ventilation due to a fall in tidal volume. No decrease in minute volume occurred in immature rats (2 and 4 weeks) in response to ozone and 6-week-old animals were intermediate in their minute ventilation response. Protein concentration of BAL medium was elevated after a delay (4 h post-exposure) to a greater degree in 2-week-old rats compared to 8-week-old rats. PGE₂ levels in BAL were elevated in 2-week-old rats; this response was not seen in adult animals. Neutrophils and epithelial cells in the BAL fluid were elevated in 4-week-old rats; this response was absent in 2-week-old animals.

Additional information

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