
Spontaneous sigh rates during sedentary activity: watching television vs reading

William T. Hark, MD; William M. Thompson, MD; Timothy E. McLaughlin, MD; Lisa M. Wheatley, MD; and Thomas A. E. Platts-Mills, MD, PhD

Background: Spontaneous sighs are thought to play an important role in preventing atelectasis and in regulating airway tone. Recent studies have provided a mechanism by which expansion of the lungs could cause relaxation of smooth muscle.

Objective: To investigate breathing patterns during 2 forms of sedentary behavior: reading and watching television.

Methods: Breathing patterns were monitored for 1 to 2 hours to document respiratory rates and sigh rates. Each participant was monitored while reading and while watching a movie on videotape. During the first experiment (17 controls), metabolic rates were also measured. In the second experiment (18 controls and 9 patients with mild-to-moderate asthma), only breathing patterns were monitored.

Results: There were no significant differences in respiratory or metabolic rates between the 2 activities. In contrast, in the first experiment, 13 of 17 controls had lower sigh rates while watching a videotape than while reading ($P < .01$). In the second experiment, the sigh rate was significantly lower overall while watching a videotape (mean, 13.7 sighs per hour; range, 1.8–26.0 sighs per hour) than while reading (mean, 19.3 sighs per hour; range, 7.7–30.0 sighs per hour) ($P < .001$). A similar decrease was observed in patients with asthma ($P < .01$).

Conclusions: Given that many children and adults watch television for 5 or more hours per day, breathing patterns during this time may be relevant to lung function. Our results demonstrate that prolonged periods of watching a videotape are associated with lower sigh rates than while reading. Further research is needed to determine whether these changes are relevant to increased bronchial reactivity.

Ann Allergy Asthma Immunol. 2005;94:247–250.

INTRODUCTION

It has been known for many years that full expansion of the lungs will decrease airway resistance^{1–3} and that patients with quadriplegia have marked bronchial hyperreactivity.⁴ It has also been demonstrated that healthy individuals become hyperreactive to methacholine if they are prevented from taking deep breaths for as little as 20 minutes.^{5–7} In most cases, a single deep breath would reverse the phenomenon.⁷ In addition, Fredberg and colleagues⁸ presented data showing that the physical extension of bronchial smooth muscle is essential to maintain normal tone. They concluded, on the basis of in vitro experiments, that full extension of bronchial muscle was a more potent bronchodilator than isoprenaline. In addition, they speculated that a decline in spontaneous sigh rates could increase the risk of bronchospasm.⁹

In the late 1990s, we^{10,11} proposed that the decline in physical activity in the Western World might have contributed to the increasing prevalence of asthma and that this might be especially relevant to explaining the otherwise enigmatic increase in asthma among low-income populations in the United States. It may be relevant that several studies^{12,13} have linked extended television viewing not only with obesity

but also with low socioeconomic status. Low socioeconomic status was not thought to be a risk factor for asthma before 1960, and it is not a risk factor for asthma in most other countries today.¹⁴ As part of an overall plan to investigate the relevance of a physically inactive lifestyle to lung function in patients with asthma, we investigated the effects of 2 forms of sedentary entertainment. A review of the literature did not identify any clear information about patterns of breathing during visual entertainment. Given the time people now spend playing video games, watching television, or using computers, it is important to document respiratory rates and sigh rates during these activities.

METHODS

Individuals recruited from the Asthma and Allergic Diseases Center, University of Virginia, and controls were studied while reading or watching a movie of their choice on a television screen. Participants were asked to bring a videotape of a movie. Only books were allowed for the reading segment, ie, no magazines or newspapers. Patients with asthma had mild or moderate persistent asthma and were regularly taking inhaled corticosteroids or were using bronchodilators as needed. None of the patients were symptomatic on the days of study. Breathing was monitored using a Healthdyne Smart Monitor (Healthdyne Technologies, Marietta, GA), which uses transthoracic impedance to determine chest volume. The output was a continuous tape that was read visually, with a sigh defined as a vertical excursion more than twice the height of the surrounding breaths (Fig 1). Multiple

Asthma and Allergic Diseases Center, University of Virginia, Charlottesville, Virginia.

Supported by grants AI20565, GCRC RR-00847, and P01-A1/EHS-50989 from the National Institutes of Health, Bethesda, MD.

Received for publication July 10, 2004.

Accepted for publication in revised form September 7, 2004.

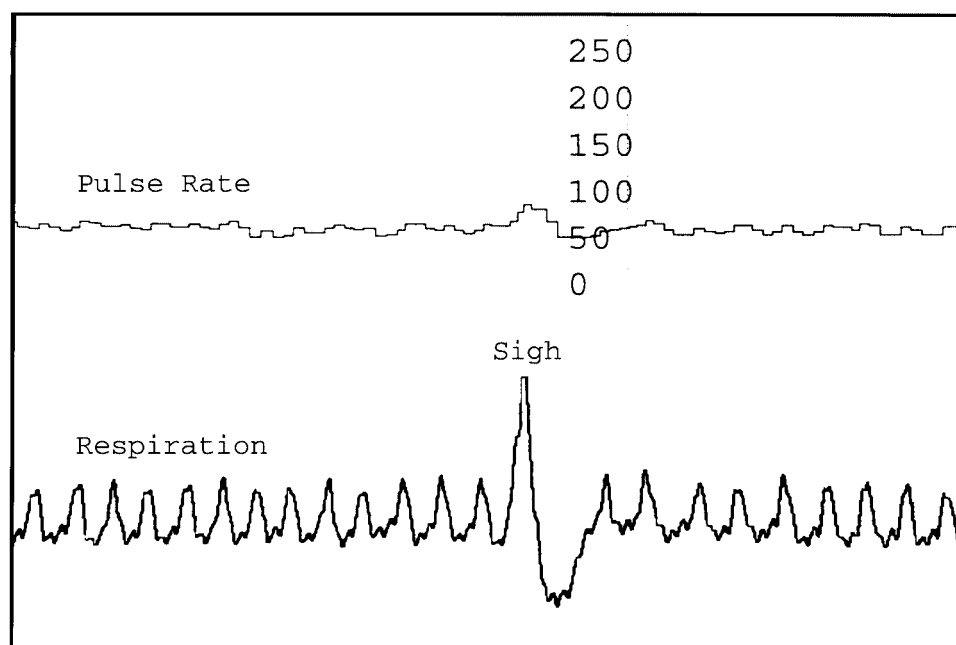


Figure 1. Output from the Healthdyne Smart Monitor tracing the pulse rate and respirations with sigh.

events occurring within a 30-second period were scored as 1 sigh. To prevent conscious or subconscious alterations of breathing patterns, participants were told that heart rate variability was being studied. It has been shown that awareness of the measurement of breathing affects breathing patterns.¹⁵ An energy expenditure monitor with a face mask (Aerosport TEEM 100 Metabolic Analysis System; Aerosport Inc, Ann Arbor, MI) was used to measure metabolic rate in the first set of experiments but not in the second. The monitor measures energy expenditure indirectly via calorimetry, measuring carbon dioxide by nondispersive infrared analysis and oxygen saturation using a galvanic fuel cell. Three controls participated in both phases of the study, but there was at least 1 month between studies. Because of excessive motion artifacts, 5 participants (2 controls and 3 patients with asthma) were excluded. Results for the 2 activities were compared using *t* tests; $P < .05$ was considered statistically significant. These experiments were approved by the institutional review board of the University of Virginia.

RESULTS

In the first experiment, 17 controls aged 18 to 25 years (8 men and 9 women) were monitored for respiratory patterns and metabolic rates for 1½ hours while watching a movie of their choice on a television screen and for 1 hour while reading a book of their choice. Participants were asked to choose their own material so that their level of interest would be comparable. The order of the 2 activities was randomized, and the Smart Monitor output was read to count respiratory rate and the number of sighs per hour. The results showed no differences in respiratory rates but significantly lower sigh

rates while watching the movie ($P < .01$ by paired *t* test) (Fig 2). Thirteen of 17 controls had more frequent sighs while reading. Metabolic rate was monitored at the same time in these 17 individuals using an energy expenditure monitor with a face mask. The mean $\pm$ SEM total number of calories per 24 hours was $1,949 \pm 90$ during reading and $1,932 \pm 91$ during viewing, and there was no significant difference between the 2 activities ($P = .77$ by paired *t* test).

In a second experiment, breathing was monitored in 18 controls aged 18 to 26 years (10 women and 8 men) and 9 patients with asthma aged 19 to 30 years (6 women and 3 men) while watching a videotape for 90 to 120 minutes and also while reading for 90 to 120 minutes. In these studies, energy expenditure was not measured. The order of the 2 activities was randomized, and the traces were read by an investigator (T.E.M.) masked to the order of the activities. The results showed similar decreases in sigh rates while watching a videotape in the control and asthmatic groups (Table 1). As in the first experiment, there were no differences in respiratory rates, and the order of the activities did not affect the results. Reading and watching videotapes were associated with low rates of full expansion of the lungs, ie, approximately 1 sigh every 4 minutes.

DISCUSSION

The rise in the prevalence and morbidity of asthma has occurred during a period when there has also been a marked increase in obesity.^{16,17} Furthermore, both these changes have been more marked among children living in poverty.^{18,19} Several lines of evidence suggest that declining physical activity has played a major role in the increase in obesity.^{20–22}

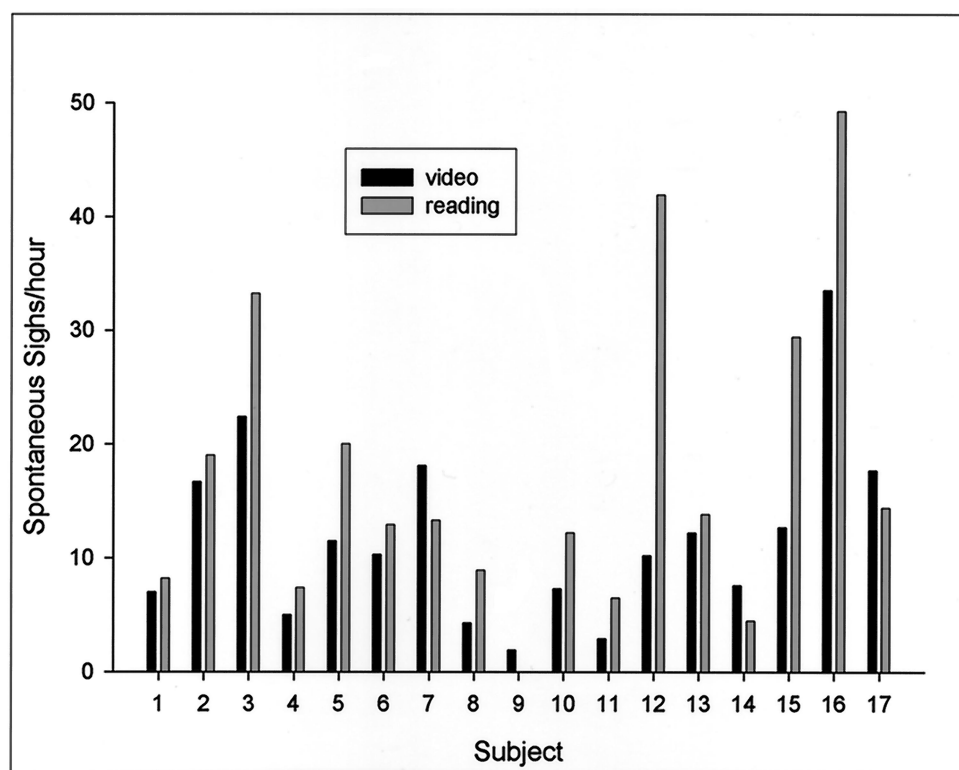


Figure 2. Spontaneous sighs recorded using a Healthdyne Smart Monitor in 17 controls while they were watching a videotape or reading. Sigh rates were significantly lower while watching a videotape ($P < .01$).

Table 1. Sigh Rates Among Patients With Asthma and Controls While Watching a Videotape Compared With While Reading

	Sigh rates, mean (range), No./h	P value*
Controls (n = 18)		
Reading	19.7 (7.1–29)	< .002
Videotape	14.4 (1.8–26)	
Patients with asthma† (n = 9)		
Reading	18 (13–25)	< .01
Videotape	12.3 (4.7–16)	
Total (N = 27)		
Reading	19.3 (7.7–30)	< .001
Videotape	13.7 (1.8–26)	

* P values relate to differences in means between activities within each group (paired *t* test).

† Patients with mild-to-moderate asthma who require regular or occasional treatment with bronchodilators and inhaled corticosteroids.

Today, it is common for children, even in the poorest segments of the population, to have a television or computer in their own room, and it is not unusual for children, including those with asthma, to be sedentary for 5 hours per day.^{20,21}

Although it is clear that sigh rates were lower while watching videotapes, the results do not indicate whether these levels are sufficiently low to have consequences for lung function. In studies by Togias and colleagues, subjects who

took no deep breaths for 20 minutes developed increased nonspecific bronchial hyperreactivity.^{6,7} Thus, a fall in the sigh rate to less than 4 sighs per hour could be relevant to changes in lung function. Overall, in this study, 8 participants had sigh rates lower than 5 sighs per hour while watching a videotape. It has also been reported that sigh rates can fall to 2 sighs per hour or less during sleep.²³ However, whether that decrease is relevant to increased wheezing at night or on arousal has not been studied. Although it is inevitable that the sigh rate is controlled by the central nervous system, there is little information about the control of sigh rates in healthy individuals. On the other hand, there is extensive literature on abnormal sigh rates in individuals with psychological conditions, such as panic disorder.²⁴

Evidence that patients with asthma are becoming heavier has been found in several studies. For example, in New York City, NY, where children are heavier than the national average, children with asthma are heavier than those without symptoms.¹⁸ Initially, these findings were dismissed as secondary to a decrease in exercise owing to shortness of breath. More recently, prospective data^{25–27} with adults and children have shown that increased body mass index is a risk factor for new-onset asthma. Although it is possible that obesity itself predisposes to wheezing, the alternative is that some aspect of physical activity is protective. In epidemiologic studies, the most consistent risk factor for asthma is sensitization to 1 or

more of the indoor allergens, and this relationship is very strong in all sections of the community.^{10,21,27–30} However, it is also well established that many allergic individuals do not develop asthma. It has been suggested that thickening of the airway wall, eg, by inflammation, would inhibit full extension of bronchial smooth muscle.^{8,9,31} Thus, the effect of low sigh rates on the bronchi might be exaggerated in individuals who have inflamed lungs.³¹ Our results provide information about changes in breathing patterns associated with those sedentary activities that are becoming common in the modern lifestyle. It is possible that these changes alter lung physiologic processes toward increased airway reactivity. However, further research is needed to examine the effects of prolonged periods of watching a screen and whether this could be associated with the increasing prevalence of asthma.

REFERENCES

- Nadel JA, Tierney DF. Effect of a previous deep inspiration on airway resistance in man. *J Appl Phys*. 1961;16:717–719.
- Parham WM, Shepard RH, Norman PS, Fish JE. Analysis of time course and magnitude of lung inflation effects on airway tone: relation to airway reactivity. *Am Rev Respir Dis*. 1983;128:240–245.
- Fish JE, Peterman VI, Cugell DW. Effect of deep inspiration on airway conductance in subjects with allergic rhinitis and allergic asthma. *J Allergy Clin Immunol*. 1977;60:41–46.
- Singas E, Lesser M, Spungen AM, Bauman WA, Almenoff PL. Airway hyperresponsiveness to methacholine in subjects with spinal cord injury. *Chest*. 1996;110:911–915.
- Malmberg P, Larsson K, Sundblad BM, Zhiping W. Importance of the time interval between FEV₁ measurements in a methacholine provocation test. *Eur Respir J*. 1993;6:680–686.
- Skloot G, Permutt S, Togias A. Airway hyperresponsiveness in asthma: a problem of limited smooth muscle relaxation with inspiration. *J Clin Invest*. 1995;96:393–403.
- Kapsali T, Permutt S, Laube B, Scichilone N, Togias A. Potent bronchoprotective effect of deep inspiration and its absence in asthma. *J Appl Physiol*. 2000;89:711–720.
- Fredberg JJ, Inouye DS, Mijailovich SM, Butler JP. Perturbed equilibrium of myosin binding in airway smooth muscle and its implications in bronchospasm. *Am J Respir Crit Care Med*. 1999;159:959–967.
- Fredberg JJ. Airway smooth muscle in asthma: flirting with disaster. *Eur Respir J*. 1998;12:1252–1256.
- Platts-Mills TA, Sporik RB, Chapman MD, Heymann PW. The role of domestic allergens. In: Chadwick DJ, Cardew G, editors. *The Rising Trends in Asthma*. Chichester, England: John Wiley & Sons; 1997:173–189.
- Crater SE, Platts-Mills TA. Searching for the cause of the increase in asthma. *Curr Opin Pediatr*. 1998;10:594–599.
- Dennison BA, Erb TA, Jenkins PL. Television viewing and television in bedroom associated with overweight risk among low-income preschool children. *Pediatrics*. 2002;109:1028–1035.
- Kimm SY, Obarzanek E, Barton BA, et al. Race, socioeconomic status, and obesity in 9- to 10-year-old girls: the NHLBI Growth and Health Study. *Ann Epidemiol*. 1996;6:266–275.
- Woolcock AJ, Peat JK. Evidence for the increase in asthma worldwide. In: Chadwick DJ, Cardew G, editors. *The Rising Trends in Asthma*. Chichester, England: John Wiley & Sons; 1997:122–139.
- Han JN, Stegen K, Cauberghs M, Van de Woestijne KP. Influence of awareness of the recording of breathing on respiratory pattern in healthy humans. *Eur Respir J*. 1997;10:161–166.
- Gergen PJ, Mullaly DI, Evans R. National survey of prevalence of asthma among children in the United States, 1976–1980. *Pediatrics*. 1988;81:1–7.
- US Bureau of the Census. *Statistical Abstract of the United States*. Washington, DC: US Bureau of the Census; 1997:566.
- Luder E, Melnik TA, DiMaio M. Association of being overweight with greater asthma symptoms in inner city Black and Hispanic children. *J Pediatr*. 1998;132:699–703.
- Heini AF, Weinsier RL. Divergent trends in obesity and fat intake patterns: the American paradox. *Am J Med*. 1997;102:259–264.
- Gortmaker SL, Must A, Sobol AM, Peterson K, Colditz GA, Dietz WH. Television watching as a cause of increasing obesity among children in the United States, 1986–1990. *Arch Pediatr Adolesc Med*. 1996;150:356–362.
- Carter MC, Perzanowski MS, Raymond A, Platts-Mills TA. Home intervention in the treatment of asthma among inner-city children. *J Allergy Clin Immunol*. 2001;108:732–737.
- Thomson CC, Clark S, Camargo CA; MARC Investigators. Body mass index and asthma severity among adults presenting to the emergency department. *Chest*. 2003;124:795–802.
- Perez-Padilla R, West P, Kryger MH. Sighs during sleep in adult humans. *Sleep*. 1983;6:234–243.
- Wilhelm FH, Trabert W, Roth WT. Characteristics of sighing in panic disorder. *Biol Psychiatry*. 2001;49:606–614.
- Camargo CA, Weiss ST, Zhang S, Willett WC, Speizer FE. Prospective study of body mass index, weight change, and risk of adult-onset asthma in women. *Arch Intern Med*. 1999;159:2582–2588.
- Camargo CA, Field AE, Colditz GA, Speizer FE. Body mass index and asthma in children age 9–14 [abstract]. *Am J Respir Crit Care Med*. 1999;159:A150.
- Guerra S, Wright AL, Morgan WJ, Sherrill DL, Holberg CJ, Martinez FD. Persistence of asthma symptoms during adolescence: role of obesity and age at the onset of puberty. *Am J Respir Crit Care Med*. 2004;170:78–85.
- Sporik R, Chapman MD, Platts-Mills TA. House dust mite exposure as a cause of asthma. *Clin Exp Allergy*. 1992;22:897–906.
- Squillace SP, Sporik RB, Rakes G, et al. Sensitization to dust mites as a dominant risk factor for asthma among adolescents living in Central Virginia: multiple regression analysis of a population-based study. *Am J Respir Crit Care Med*. 1997;156:1760–1764.
- Rosenstreich DL, Eggleston P, Kattan M, et al. The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. *N Engl J Med*. 1997;336:1356–1363.
- Thomson RJ, Bramley AM, Schellenberg RR. Airway muscle stereology: implications for increased shortening in asthma. *Am J Respir Crit Care Med*. 1996;154:749–757.

Requests for reprints should be addressed to:

Thomas A. E. Platts-Mills, MD, PhD
Asthma and Allergic Diseases Center
University of Virginia
Box 801355, HSC
Charlottesville, VA 22908
E-mail: tap2z@virginia.edu