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Potential Health Impact of Switching From Car to Public Transportation When Commuting to Work

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We assessed humidity-corrected particulate matter ($PM_{2.5}$) exposure and physical activity (using global positioning system monitors and diaries) among 18 people who commuted by car to Queens College, New York, New York, for 5 days, and then switched to commuting for the next 5 days via public transportation. The $PM_{2.5}$ differed little between car and public transportation commutes (1.41 $\mu g/M^3 \cdot min$; $P=.226$). Commuting by public transportation rather than by car increased energy expenditure (+124 kcal/day; $P<.001$) equivalent to the loss of 1 pound of body fat per 6 weeks. (*Am J Public Health.* 2010;100:2388–2391. doi:10.2105/AJPH.2009.190132)

In 2007, the US population took an estimated 10.3 billion public transportation trips, a 32% increase compared with trips taken in 1995.[1] If sustained, this behavioral change may impact health favorably, by increasing physical activity.

Increased use of public transportation can potentially generate health benefits from the persistent aerobic physical activity that results from walking and climbing stairs when one is riding buses and trains, and from moving to, from, and within stations.[2–6] To determine the magnitude of such effects if car commuters switch to public transportation, we compared personal exposure to $PM_{2.5}$ and levels of physical activity between car and public transportation commutes to work.

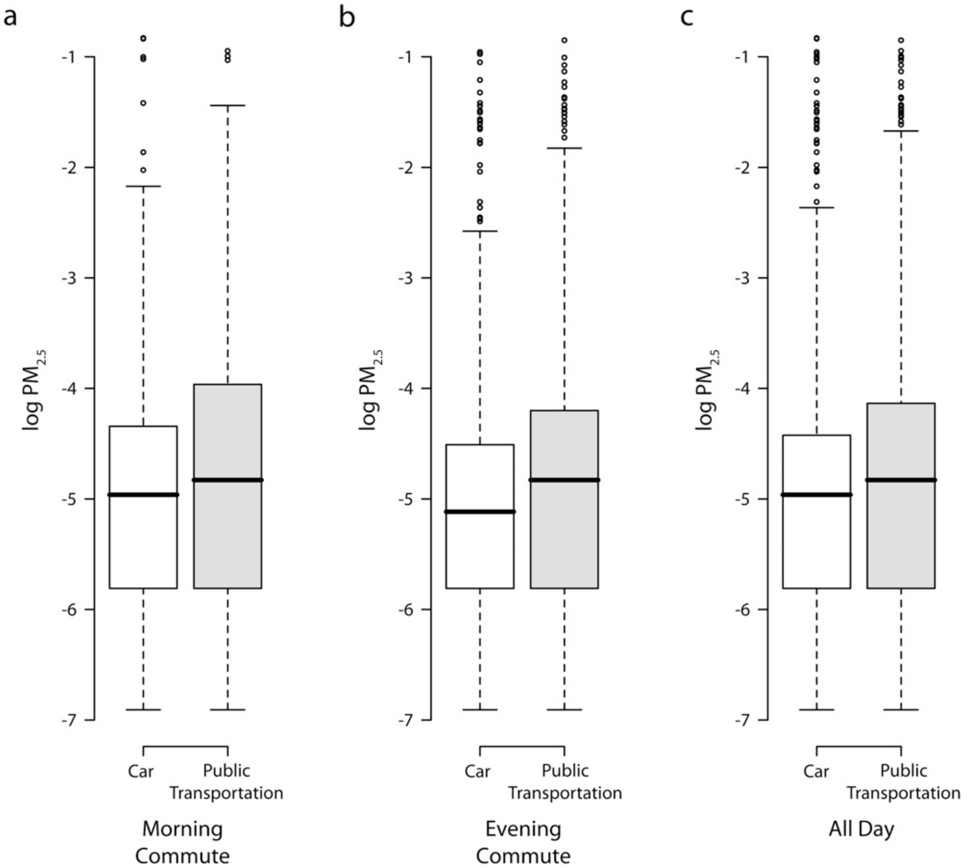
METHODS

Between October 27, 2008, and May 29, 2009, 18 of 21 recruited participants continued commuting by car for 5 days and then switched to public transportation for another 5 days, all while carrying the Forerunner 305 (Garmin, Kansas City, KS) Global Positioning System (GPS) receiver and an AM510 SidePak (TSI, Shoreview, MN) aerosol monitor during the 10-day commute.

Eligibility criteria, equipment, measurements, and analysis had previously been described in detail.[6] The only major change was the addition of an air drier jacket to the AM510 SidePak to prevent the artificial increase in particle detection resulting from the high humidity levels of New York City air.

To match the particulate matter of a diameter of 2.5 microns or smaller ($PM_{2.5}$), and GPS data, each volunteer was required to maintain a time–activity diary with preprinted, minute-by-minute time and activity columns.[6] During car commutes, participants used a hands-free digital voice recorder (Model ICDP520, Sony, Los Angeles, CA), worn with a neck strap, to dictate diary information as they drove. All digital voice recordings (for the car days) or print copies (for the public transportation days) were completed.

We assessed commute-specific energy expenditures based on GPS tracking and diary entries.[6] The GPS device failed to record waypoints for 7.3% of the segments, mostly at the beginning of the commute, while the GPS receiver was searching for a satellite connection. These missing waypoints were easily imputed on the basis of commutes with complete recordings. We used conventional metabolic equivalents (METs; 1 MET=1 kcal/kg of body weight/hour) for various modes of activity.[7] Travel by subway was assigned a MET of 2.0.[6]



Note. Five-day averages of each commute are presented. Boxplots depict the 25th and 75th percentiles (edges of the box), the median (line within the box), and the 2.5th and 97.5th percentiles (whiskers) Circles indicate outliers.

FIGURE 1—Boxplots of the logarithm of exposure to particulate matter of a diameter of 2.5 microns or smaller ($PM_{2.5}$; μg/M^3·min) for (a) morning work commutes, (b) evening work commutes, and (c) all day: New York, NY, October 27, 2008–May 29, 2009.

Geometric means from log-transformed $PM_{2.5}$, 95% confidence intervals, and statistical tests were computed from the data recorded on a 1-minute interval time base, with variance corrected for the clustering of observations within participants, by using the SAS version 9.1 procedures Surveymeans and Surveyreg (SAS Institute, Cary, NC). The commute-specific energy expenditure was computed as described previously.[6]

RESULTS

On average, the 7 men and 11 women were aged 31 years, were 66 inches (167 cm) tall, and weighed 159.5 pounds (72.3 kg); two thirds of the participants were White. The group difference in $PM_{2.5}$ over the 5 commute days by car (5.60 μg/M^3·min) and 5 commute days by public transportation (7.01 μg/M^3·min) was weak (1.41 μg/M^3·min; $P=.226$; Figure 1).

The excess cumulative energy expenditure for public transportation commutes of 622 kcal ($P<.001$; Table 1) corresponds to 622 kcal/5 days=124 kcal/day, or 124 kcal/day×30 days=3720 kcal/month, and would amount to approximately 1 pound of body fat over 6 weeks, assuming 5 commutes per week and 3500 kcal per pound of fat.

DISCUSSION

This study has demonstrated the feasibility of having car drivers switch to public transportation when they commute to work. The extra energy spent by public transportation commuters in this sample could amount to substantial weight loss if the public transportation commute were sustained over 6 weeks. The humidity-corrected excess exposure to $PM_{2.5}$ for public transportation versus car commute was modest, not statistically significant, and unlikely to exceed the current recommended threshold of 15 μg/M^3 per year.[8]

In the absence of a direct subway line to the Queens College campus, public transportation commuters are forced to use a combination of buses and subways, which makes public transportation commutes substantially longer (median=104 min/day) than car commutes (median=57 min/day). Also, the suburban location of Queens College—where, by Manhattan standards, traffic is fluid and parking spaces abound—resulted in shorter commute times by car than if the college had been located in Manhattan. Thus, the advantage of using Queens College commuters was

TABLE 1—Physical Activity Energy Expenditure, Duration, and Walked Distance for 5 Days of Car or Public Transportation Commute to Queens College Among 18 Participants: New York, NY October 27, 2008–May 29, 2009

Variables	Car	Public Transportation	Paired Difference	t; P
Cumulative energy expenditure, kcal				5.76; < .001
Mean	612	1234	622	
SE	51	150		
Median	598	1117		
Total duration, min				4.44; <.001
Mean	321	545	224	
SE	28	61		
Median	284	520		
Metabolic equivalents, (kcal/kg·hour)				3.84; .001
Mean	1.61	1.88	0.27	
SE	0.04	0.07		
Median	1.58	1.74		
Energy expenditure per minute (kcal/min)				3.5; .003
Mean	1.94	2.24	0.3	
SE	0.10	0.10		
Median	1.96	2.17		
Total distance walked, km				5.8; <.001
Mean	3.42	9.82	6.4	
SE	0.50	0.96		
Median	2.89	9.32		
Cumulative number of steps				5.8; <.001
Mean	5682	16 093	10 411	
SE	871	1517		
Median	4739	15 919		

a greater statistical power in detecting public transportation–car differences. On the other hand, it is probable that workplaces located in dense urban environments with rich public transportation service, slow traffic, and poor parking availability may produce longer car commute times and shorter public transportation commute times when compared with those for Queens College. In a denser urban environment, both $PM_{2.5}$ and energy expenditure differences may be weaker, but switching to public transportation may also be more sustainable and may provide long-term benefits.[9]

Because of budgetary constraints, our exposure assessment focused solely on $PM_{2.5}$, just 1 of the many air pollutants present in urban environments.[10–15] Noise-induced hearing loss among riders of bus lines and subways may also be a concern.[16] Our assessment of energy expenditure could be improved by using a pedometer integrated to a GPS receiver, which would provide time-stamped stride.

Because there were much greater differences in energy expenditure than in exposure to air pollution, we conclude from this analysis that the physical activity benefits associated with using public transportation to commute to work probably outweigh the risks associated with the greater exposure to $PM_{2.5}$. ■

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Contributors

A. Morabia had primary responsibility for the study design, supervision, measurement of physical activity, and article drafting. F.E. Mirer, M.S. Wolff, and S.B. Markowitz shared in the study design. T. Amstislavski was the study coordinator and data collector. H.M. Eisl and J. Gorczynski were responsible for the air pollution data collection and quality assessment. J. Werbe-Fuentes and C. Goranson were responsible for the geographic information system analysis. All authors contributed to the final writing of the article.

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Human Participant Protection

Signed informed consent was obtained with a protocol approved by the institutional review board of Queens College.

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Reductions in Cigarette Smoking and Acute Myocardial Infarction Mortality in Jefferson County, Texas

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After litigation against the tobacco industry ended in a settlement, the Texas legislature funded pilot projects to reduce tobacco use in selected areas of the state. Subsequent telephone surveys showed that well-funded activities were successful in reducing population rates of self-reported cigarette smoking. We present evidence that the reduction in smoking promptly led to lower rates of death from acute myocardial infarctions. (*Am J Public Health.* 2010;100:2391–2392. doi:10.2105/AJPH.2010.192211)

In 2000, the Texas Department of State Health Services received significant new funding for tobacco control from the proceeds of a settlement of litigation against the tobacco industry. Because the amount was not considered sufficient for effective statewide action, various activities of different levels of intensity were organized in southeast Texas. This area was selected because its rates of tobacco-related diseases were higher than in the rest of the state.

The most intensive pilot activities (receiving approximately $800 000 per year) were organized in Jefferson County (population approximately 250 000), beginning in the autumn of 2000 and continuing for 5 years. Activities for adult smokers included intensive mass media promotion of cessation,[1] mobilization of health care providers to advise patients to quit, and a heavily advertised telephone cessation counseling service provided by the American Cancer Society.[2] This pilot project was evaluated by analyses of telephone surveys in Jefferson County and other parts of the state in 2000 and 2004. The analyses showed a statistically significant relative decrease in the reported prevalence of adult cigarette smoking, with rates decreasing from 22% to 16% in Jefferson County and from 19% to 17% in the remainder of the state.[3]

METHODS

The Texas Department of State Health Services reports rates and causes of death within each county in Texas, including acute myocardial infarction (AMI), defined according to *International Classification of Diseases, 10th Revision,* criteria.[4] We compiled the numbers of deaths attributed to that primary cause, with age and gender records, for Jefferson County and other counties in the state and converted them into age-adjusted annual rates according to the US 2000 standard population.[5]

To examine changes in AMI mortality rates that could be attributable to differing levels of reduction in tobacco use, we fitted a bivariate piecewise linear regression model to the data. The model had linear segments for 1996 through 2000 and for 2001 through 2005. These lines represented yearly AMI mortality rates per 100 000 persons, and the slopes of the segments represented the trends (increase or decrease) per year. We determined the AMI mortality trends in Jefferson County separately for the intervals from 1996–2000 and 2001–2005, and we calculated the net change in trends, along with the standard error. We separately determined the trends for other Texas counties for the same intervals and calculated the change in trends and standard error. We then compared the change in trends for Jefferson County with the change in trends for other Texas counties with the *t* test.

RESULTS

Figure 1 shows the trends in AMI mortality rates for Jefferson County and for other Texas counties, along with their 95% confidence intervals. The slopes of the line segments represent the trends (i.e., rates of change per year in AMI mortality rate per 100 000 persons). For Jefferson County in 1996–2000, the trend was 3.74 (SE=2.82); in 2001–2005, the trend was –17.07 (SE=2.82). The net change in trends was –20.81 (SE=3.98). Trends in other Texas counties were –2.55 (SE=0.514) for 1996–2000 and –4.48 (SE=0.514) for 2001–2005; the net change in trends was –1.93 (SE=0.727).

The difference in the changes in trends (change in Jefferson County versus change in other Texas counties) was –18.88 (SE=4.201). This difference in changes was significantly less than zero, with an approximate P value of .004 (t=–4.49). This implied a greater rate of decline in AMI mortality rates in Jefferson County than in other Texas counties during 2001–2005. The 95% confidence interval for the difference in trends for 2001–2005 ranged from 8.6 to 29.2 fewer AMI deaths per 100 000 persons per year for Jefferson County than for other Texas counties. Because no other major health improvement in Jefferson County was observed during the time of the intervention, the substantial change in AMI mortality rates can reasonably be attributed to the reduction in cigarette smoking that was achieved there through successful state-sponsored tobacco control activities.

DISCUSSION

Our findings are consistent with data from other population studies in which AMI hospital admission rates and deaths from ischemic heart disease decreased after vigorous public health actions to reduce cigarette smoking.[6–8]