Health effects of walking to transit

Alan Hoback[a], Scott Anderson[b], and Utpal Dutta[a]

[a]Department of Civil & Environmental Engineering, [b]Department of Mathematics, University of Detroit Mercy, Detroit MI, USA

hobackas@udmercy.edu, 313-993-1578

ABSTRACT

Post-industrial society is centered on sedentary lifestyles. This has caused obesity rates to rise and related health problems to amplify. Obesity is only one result of sedentary life, but it is a sufficient indicator of physical activity. However, regions of the US with more effective transit systems are less susceptible to obesity because their residents walk more by going to transit. The health benefits of walking to transit are quantified. While walking to transit, riders burn calories, which controls body weight, and the physical activity makes them more healthy. This healthiness is reflected in an improved quality of life. When people are physically active, they have less absenteeism at work, are more productive, and their employers pay less for health insurance.

Keywords: transit; health; transit oriented development

INTRODUCTION

Before the widespread use of the automobile, people in the US commuted mainly through walking and mass transit. During that era people walked more and were much less overweight. Looking at 15 case studies Trowell and Burkitt (1981) concluded that obesity was the first "disease of civilization." Reduced walking was not the sole cause of weight gain in early modern societies. Industrialization that produced autos also mechanized farming and production of surplus food that allowed for excess weight gain. In post-modern or post-industrial societies additional lifestyle changes have become interwoven in the fabric of society. (Crossley 2004) The National Audit Office (2001) cited an estimate that the average individual would have to run one marathon of 26 miles per week to make up for the drop in energy expenditure in since 1951.

The power of automotive and oil industries to change American society was shown in *The Geography of Nowhere*. (Kunstler 1993) Public transportation and walking were discouraged through zoning and transportation funding in favor of automobile transportation.

Car use shaped the process of urban development resulting in that social life revolved around the car. "Much of what many people now think of a social life could not be undertaken without the flexibilities of the car and its availability 24 h a day." (Sheller and Urry 2000) The car is an extension of the body or "corporeal schema" in that it extends the opportunities that a person has, and is thought of as appendage of the self. (Merleau-Ponty 1962)

Post-modern society is dependent upon technology such as the car. However, the societal level change goes beyond car use. Post-modern society has different forms of leisure and entertainment than previously. All are interrelated in a network of practices that constitute what is current society and social process. (Elias 1978) For example, technology allows for more leisure time to watch television, and television has become a primary form of gathering news.

Many of the habits of post-modern society encourage sedentary life. Crossley (2004) argues that because of these changes in society, the habits of sedentary life have lowered a person's threshold for what is reasonable daily energy expenditure. People have become more averse to activity because it is no longer a routine part of their life.

Individual behavior change is necessary to produce healthier lifestyles. However, it is difficult to change individual behaviors because each person is locked into others through a continuous fabric of modern society. (Crossley 2004)

Things can be done to get people to walk. Mehta (2008) showed that perceptions about walking could be positively influence through making the environment pleasurable. If walking has some functionality, people are more likely to do it. (Mehta 2008, Darker et. al. 2007)

People walk as a means of transportation, or as means to get to transit. Encouraging transit use has the potential to provide for improved public health. It will be shown that walking to transit can bring someone to the threshold of minimum physical activity for healthy living.

The research work presented in this paper finds the health benefit for anyone who walks to transit. However, transit oriented development has the possibility going beyond the scope of the work of this paper by challenging the assumptions of post-modern society. Transit oriented development can recast the underlying habits of sedentary life and encourage walking and socializing in different ways than those that now predominate.

There is evidence that using transit has a positive influence on health. Brown and Werner (2009) surveyed residents near light rail transit stops. After adjusting for income and employment, they found that the people who use transit have much lower obesity that those who don't.

Additionally, residents of US Cities with extensive transit systems are healthier than other residents. This is substantiated by looking at transit spending versus obesity statistics. The average number of overweight people in regions that spend at least $200 a year on transit is 53.2% of the total population, while in regions that spend less than $200 a year people on average are 58.0% overweight as shown in Figure 1 (FTA 2002; CDC 2002).

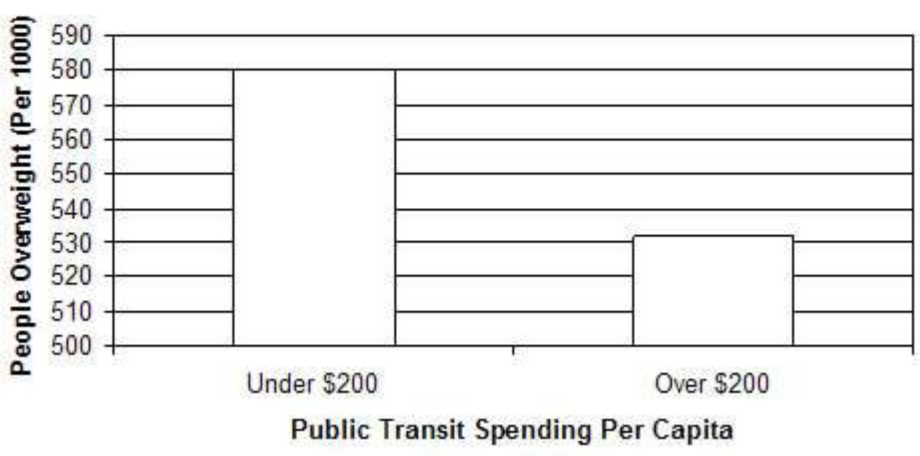

Figure 1. Overweight incidence versus public transit spending

Instead of Figure 1, the relationship transit between use and citizen weight could have been shown in a linear regression with a strong correlation. However, showing such a graph would lead to a different academic investigation and different questions. For example, the focus of the paper would shift to how to create transit systems that would promote the most walking. Additionally, whenever showing a correlation there is much that must go into proving cause and effect and explaining the meaning of the relationship. That is a different academic goal than the one pursued in this paper. Figure 1 is sufficient to show that there is something substantial behind the premise that when people walk to transit, they become healthier. Obesity is not the sole measure of health, but it is sufficient to point out differences between regions of the country. This fact will be built upon to show how much healthier people are who use transit, and how much they are saving in health care expense.

HEALTH EFFECTS OF INACTIVITY

Health implications from physical inactivity and obesity are discussed here. Obesity is defined as having a Body Mass Index (BMI) over 30. Being overweight is defined as a BMI between 25 and 30. Obesity and physical inactivity cause numerous illnesses, including hypertension, coronary heart disease and its complications, stroke and diabetes (Stunkard and Wadden, 1993; NIH 1998).

Obesity is a cause of death; however, lack of physical activity which leads to obesity is roughly ten times more significant as cause of death. The relationship between obesity to health is ambiguous. (Vries 2007) This is because all body fat does not have the same effect on health. Central body fat is much worse for health than other fat distributed through the body. (Bjorntorp 1988) However, when data for physical activity is lacking, obesity can be used as an indicator for level of activity.

Physical inactivity is one of many causes of obesity, because activity expends calories that may reduce obesity. However, someone may be inactive and not overweight, or active but overweight depending upon calorie intake.

The cause of obesity is an imbalance between caloric intake (food) and output (exercise) (CDC 2004). To reduce weight, an individual must either eat less or exercise more, preferably both. There are several factors such as genetics and environment that influence obesity. However, "despite obesity having strong genetic determinants, the genetic composition of the population does not change rapidly. Therefore, the large increase in . . . [obesity] must reflect major changes in non-genetic factors." (Hill and Trowbridge 1998) It is modern lifestyles that are having the greatest effect.

To reduce weight someone must increase the amount of calories spent, decrease calories consumed, or both. However, to become physically active, people need to exercise more. The average person in the US consumes 100 more calories per day than they expend. To keep the weight off either they need to reduce consumption by 100 calories or spend that much in exercise (Booth and Neufer 2005). Unless these calories go into making muscles, each 3500 Calories stored in the body results in one more pound of fat.

The definition of what constitutes physical activity varies between jurisdictions of National and State health departments. One single definition needs to be settled upon for this research in order to have a consistent measure of activity. Some definitions count only incidental physical activity such as exercise, and not activity in places of work. However, all activity whether at work, through exercise, or other incidental activity helps with health. The State of

Michigan definition will be used because this research will use data for walking to transit in Michigan. That definition is that a person is physically active when engaged in at least 150 minutes of moderate physical activity a week.

HEALTH COSTS

Physical inactivity costs society because of lost wages for workers, and lost productivity for employers. In the State of Michigan the cost of worker compensation related to physical inactivity was $39.86 million and the cost of lost productivity was $8,612.85 million (Chenoweth 2003). ($41.55 million, $8.979 billion, 2005) Numbers from 2005 will be used since it was before the recent dramatic fluctuation in wages.

US nationwide health costs related to obesity were $75 billion in 2003 (Finkelstein et al. 2004). ($76.9 billion in 2005 dollars.) The amount of this spent in Michigan was a total of $2.931 Billion. ($3.007 billion, 2005) Of that $748 million and $882 million were spent by Medicare and Medicaid, respectively. ($767 million, $905 million in 2005 dollars.) This was paid in part by individuals, their employers, their insurance companies and by government agencies that provide health services or insurance. This is such a large expenditure because nationwide about two-thirds of all people exercise very little and are overweight.

BENEFITS OF WALKING

Walking at a brisk pace is moderate physical activity since it causes an increase in heart rate and breathing. Therefore, someone who walks 150 minutes a week is considered physically active. Walking also benefits health by reducing obesity because it burns calories. The walking distance does not need to be done all at once or for a minimum distance to be effective (ACSM 1998). The cumulative daily distance is used to find calories burned and level of activity.

The benefits of burning calories through walking would be short lived if the walker refueled afterwards. However, exercise such as walking can have a short-term effect of suppressing the appetite (Blundell and King 1998).

Dieting alone doesn’t cause improved health, but exercise that causes the body weight reduction improves health (Kazaks and Stern, 2003). Dieting alone is not a good substitute for exercise because dieting alone can reduce the basal or resting metabolic rate. Dieters burn fewer calories throughout the day. However, when people exercise this prevents the basal metabolic rate from decreasing while dieting (Broeder et al. 1992).

Physical activity levels can be found by timing a person’s activities. However, projecting obesity levels is not as straightforward, because it relies on counting calories. The calories burned through various activities are a function of the basal metabolic rate of the person and their weight (ACSM 1998). Calories burned are measured in metabolic equivalents (MET). One MET is the amount of energy used when sitting quietly. One MET is one calorie burned per hour per 2.2 pounds of body weight. (1 calorie per kg per hour.) A person walking 3 mph (4.8 km/hr) burns at a rate of 3.5 METs. Carrying a load adds one more MET.

Calories burned roughly linearly increase with speed walked. By inspection, it is seen that it is the distance that matters when calculating calories burned, not the speed. A faster walker will burn calories at a higher rate, but for a shorter time. The total calories burned walking can be expressed as a function of the distance walked.

A person would burn 1.0 MET sitting in a car. Someone walking to transit would have a higher caloric rate. The increment above 1.0 MET is the net gain in calories burned compared to driving a car.

Many transit users carry things with them. Carrying a load while walking burns more calories than walking without a load. Approximately a third of the riders will be going to or from school or from shopping to home where they would be carrying heavy loads. A majority of the other riders will be carrying something such as coats, lunches for work, purses, or children. Students' backpack weight averages 5.3 kilograms (SD 1.9 kgs) (Grimmer et al. 2002). Another common thing to carry is groceries since a transit rider might stop on the way to pick up items. For reference, a gallon of milk weighs between 8 and 9 pounds (3.6 to 4.1 kg) depending on its fat content. In addition to causing walkers to burn more calories, carrying a load increases the level of physical activity.

WALKING DISTANCE TO TRANSIT

The National Household Transportation Survey (NHTS) has lists of how people travel each day (U.S. DOT 2001). From this it was found that transit users walk 19 minutes per round trip (Besser and Dannenberg 2005). This equates to 0.95 miles (1.6 km) of walking if their speed was three miles per hour.

These walking distances were compared to the results of a Geographic Information Systems (GIS) Analysis of the Detroit Department of Transportation (DDOT) routes. Transit users in Detroit Michigan walk 0.8 miles (1.3 km) per round trip, or 16 minutes walking at three mph. (Hoback et al. 2008) The GIS analysis measured the true walking distance from a home to a bus stop by doing a network analysis of walking paths that followed the streets. The distance was measured from the front of the property, where a car would have been otherwise parked, so that the net distance beyond walking to a car would be found. The walking distances to homes and possible destinations were combined with a statistical analysis of bus rider behaviors to find the average total round trip walking distance. Additionally, the analysis accounted for the rider's preferred direction of travel. Bus riders will not walk to the closest bus stop if the stop is for the North bound bus when they want to go East. Instead they will walk to the East bound route if it will save them time even though the walk is longer.

There are many possible reasons for this difference between the NHTS and GIS results. Some reasons are: the respondents may have overestimated their walking time, they may have actually walked longer than the optimal route determined in GIS, or because the GIS numbers are for only Detroit but the NHTS numbers are for the whole country. The numbers would agree if the transit riders walked at 2.52 mph instead of the 3 mph assumed. Considering these comparisons, it conservative to use the GIS prediction of 0.8 miles (1.3 km) in Detroit as the US walking distance. It is not practical to do a GIS analysis of every transit system in every metropolitan region to find a national average walking distance. Although, there is some reason to believe that walking distances might vary across the country. Willingness to walk could be effected by several factors such as weather conditions.

PROJECTED OBESITY OF TRANSIT USERS

Obesity rates can be projected for when transit is used. Michigan Obesity rates are 26.5%, 36.6%, and 36.9%, for obese, overweight, or neither (MDCH 2005). National data divides the population into more BMI subgroups. The National rates were used to subdivide the Michigan BMI categories as shown in Figure 2.

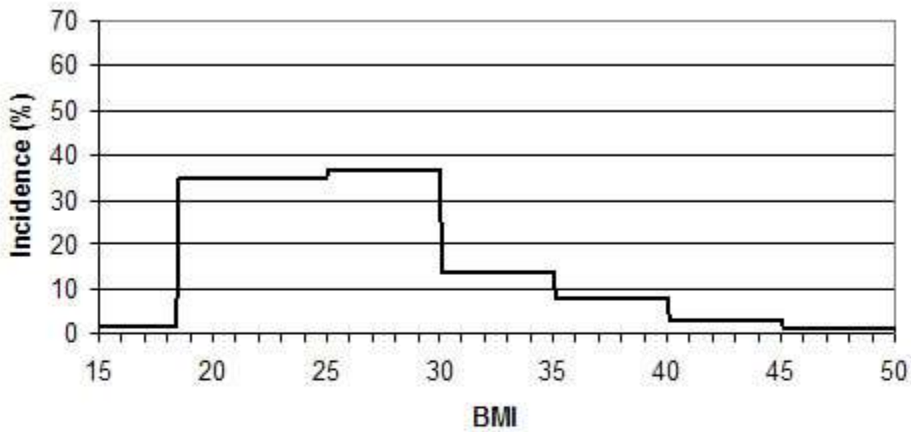

Figure 2. Obesity incidence in Michigan in 2005.

Next, obesity rates are projected for a profile of people who then begin using transit. If those riders don't change their caloric consumption when they walk more, over five years they could lose significant weight. Calculation of calories burned is a function of metabolic equivalents and weight, so BMI numbers need to be converted to body weight. The average male is 177 cm (5 foot 9.5 inches), and the average female is 164cm (5 foot 4 inches). Therefore, considering distances walked to transit discussed above and average body weights we see 68.6 calories per day are burned by the average transit user. Those calories are converted to pounds of fat that is burned. Then projected body weights are calculated, and converted into BMI. The Michigan numbers for those using transit for five years improve to: 12.4%, 20%, and 67.6% for obese, overweight, or neither as shown in Figure 3. Much fewer people are overweight. Using five years is consistent with the findings of Brown and Werner (2009) which showed that new riders become less obese, but over a longer time continue to lose weight.

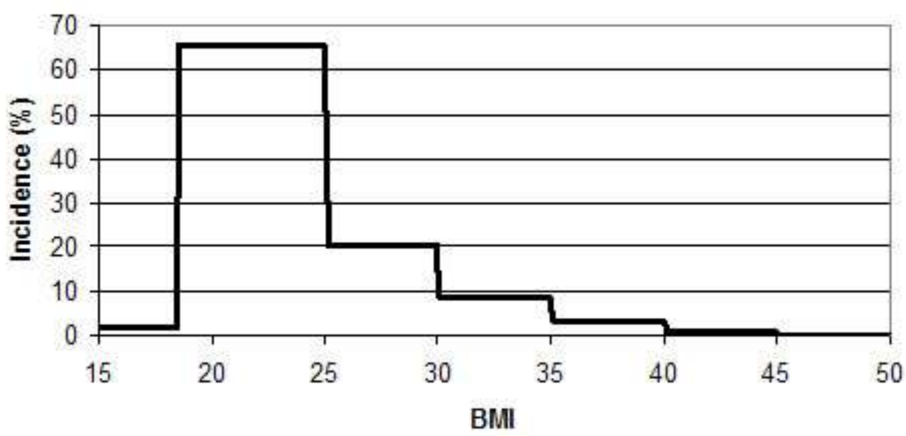

Figure 3. Expected obesity in transit using subpopulation after five years.

An obesity index is created to project health care costs. This is not just a measure of the number of people that are obese, but also of the severity of the obesity. The obesity index is defined here as the area of the incidence curve that is obese in percent times a factor for how obese they are in BMI. Currently, the Michigan obesity index is 16.01.

For those who begin riding transit, after five years their index would be 5.66. The new index has a 65% improvement in obesity based on severity, not just count of obese individuals. This assumes that other physical activity is not being replaced by walking to transit. This is a safe assumption because the people who are of most interest in this study are the inactive people. It is they who are causing the health expense due to physical inactivity and obesity.

PROJECTED PHYSICAL ACTIVITY OF TRANSIT USERS

Of Michigan's 7.6 million adults, 50.5% (3.84 million) are physically inactive, of those 22.6% have no activity (MDCH 2005). Although it is not true that some people do absolutely no activity, some do not do enough of incidental walking, carrying or lifting in order to raise the heart and breathing rates. A physical activity incidence plot is shown in Figure 4. This assuming that there is an even distribution of physically inactive people in the range from no activity to just below being active.

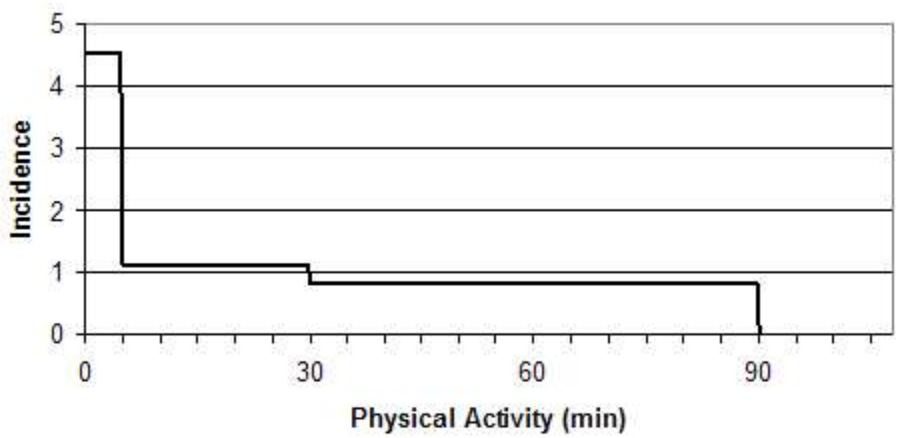

Figure 4. Incidence of physical activity before transit

Transit riders walk on average of at least 0.8 miles (1.27 km) per day, or 16 minutes as discussed above. A person carrying a load would have a more rigorous workout. For example, considering net Metabolic rates a person carrying a ten pound (4.54 kg) load would get 40% more workout. Considering an assumed average weight carried of 3.1 lbs (1.4 kg), the equivalent workout is 18 minutes. That 18 minutes of exercise makes one third of inactive people become active as shown in Figure 5. The actual physical activity in Figure 4 is shifted to the right by 18 minutes to get the projected physical activity in Figure 5.

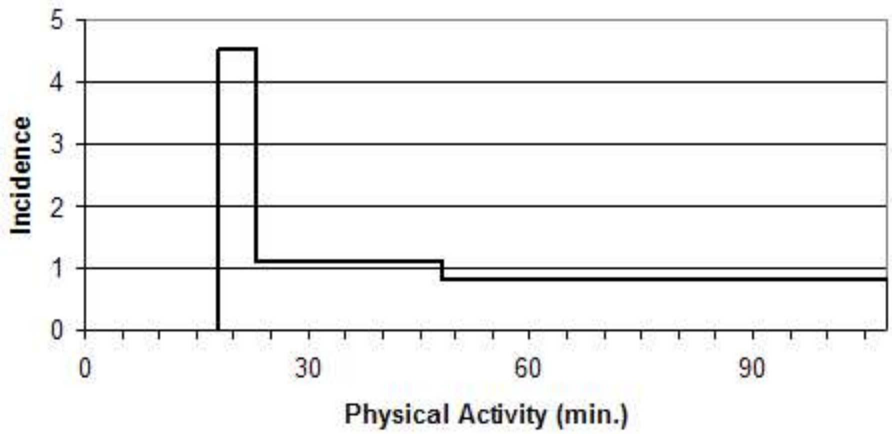

Figure 5. Incidence of physical activity after transit

Next a Physical Inactivity Index is defined, much like the Obesity Index above. It is the percent of the population inactive times the magnitude of their inactivity in minutes. The Inactivity Index reduces 70% from 10.97 to 3.38 for people walking to transit. Therefore, the count of inactive people reduces, but also the severity of inactivity lessens.

HEALTH COST SAVINGS

Heath care needs would go down if more people walked to transit instead of driving. An uninsured person would save on health care. However, the uninsured often avoid health care. The uninsured may have a health care budget, and the money is spent on the most urgent needs. Any improvement in health might mean that an uninsured person just redirects the money saved into less urgent health needs. Heath would improve, but there may not be much savings.

It is easier to predict what happens to an insured person. The US government provides Medicare health insurance to segments of the population. The government would save money if people with Medicare walked to transit.

Employers who provide health insurance and sick leave have the biggest expense for when their employees are physically inactive. In that case the employer pays a larger share of the health costs than the employee. Employers lose again when someone is unable to work since they also have to pay for sick days. Finally, as shown below, when people are physically active, they are more productive. The remainder of this paper will focus on savings that employers reap when employees become physically active.

There are no studies that relate an exact amount of activity to a reduction in health care cost. However, it is reasonable to assume that there is a linear relationship between the level of physically activity and the amount of the health cost related to inactivity. Therefore according the index created above, physical inactivity related health costs would be reduced by 70% for new transit users. Likewise, obesity related health costs would reduce by 65%.

A physically inactive employee loses 0.079 of their productivity due to the inactivity (Chenoweth 2004). Additionally, $54 per year is spent on worker's compensation for accidents that would not happen with physically active people. For obesity the numbers are 0.126 and $26, respectively.

The mean wage in Michigan is $22.68 per hour (U.S. Division of Labor 2004). Wages are 82.8% of total compensation (EBRI 2004). Therefore, the mean total yearly compensation is $57778, not including overtime.

Each physically inactive employee causes productivity loses at their employer of 0.079($57778) = $4564 per year. Including workers compensation of $54 the total is $4618 per inactive employee. Each obese employee causes a productivity loss of 0.126($57778) = $7280. Including workers compensation of $26 the total is $7306 per obese employee. The costs are additive for inactivity and obesity if the employee meets both criteria.

From the section above, we found that walking to transit should be 65% effective at reducing obesity after 5 years. Therefore, each employee that uses transit would save the employer $3002. A 70% reduction in inactivity results in a savings of $5114.

Estimated insurance savings are on the order of $3000 per employee. However, this is subject to some assumptions. The group rate negotiated by the insurance carrier is dependent upon the utilization or number of diagnoses in the group. Employers with physically inactive employees have higher rates because of higher utilization. Over time as the number of diagnoses goes down, it is assumed that the insurer would provide a better group rate.

Employers who provide health insurance and sick leave will have a cost savings of $11,116 for each employee that becomes physically active reduces obesity through walking to transit. This is for an average Michigan employer. Achieving savings depends upon several characteristics of the employer compensation package and employee health profiles.

Since employers are one of the biggest winners when someone becomes physically active, and people can become physically active through how they commute to work, a connection between the two can be made. A number of employer initiatives could be considered to encourage transit use. Many employers already encourage other forms of physical activity.

One possible employer initiative is to encourage a ride-a-bus day or week. That might encourage employees to try transit. Another possible initiative is to sponsor bus passes. An employer would likely see enough gains in productivity to offset the costs of sponsoring the program. A final suggestion is to offer to reduce the employee share of health insurance or copays for employees who ride the bus. An insurance company might be willing to partner with the employer for this.

CONCLUSIONS

Post-industrial society revolves around a sedentary lifestyle that promotes health problems. Shifting that lifestyle so it revolves around transit for transportation helps to get people up and walking.

People riding transit walk to bus stops which burns calories, helping to control body weight, and the physical activity makes them more healthy. This healthiness is reflected in paybacks to the individual in an improved quality of life. Employers are the biggest financial beneficiaries when employees walk to transit because they save on health insurance, workers compensation, hiring and training replacement workers, and reduction in lost productivity due to sick days.

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