Transportation and Air Quality

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Formal acknowledgement of the considerable contribution of motorised vehicles to air pollution dates to the late 1950s, when the state of California imposed the first regulations on motor vehicle emissions. Since then, air pollution from vehicles and trucks has continued to be a focus of laws as well as a continuing issue of public health study. With recent technical breakthroughs the production of air pollutants from individual automobiles and trucks has fallen considerably. Relative to their emissions of thirty years prior, vehicles today release less than 10 percent as much of many pollutants per mile driven, but since miles travelled have climbed thrice over that period, the advantages of lower emissions have been somewhat negated. Air pollutants from the transportation sector can be broadly divided into three categories: greenhouse gases primarily carbon dioxide, a topic discussed criteria air pollutants 6 major ubiquitous air pollutants, including ozone and particulate matter, as described in Chapter Fourteen; and air toxics a larger number of additional pollutants dispersed into the air by transportation and having known toxic health effects.

What comes out of a tailpipe relies primarily on the mix of the gasoline that enters into the engine and the sorts of control mechanisms and filters in the exhaust system. So long as carbon-based fossil fuels are utilised for transportation, burning will always create carbon dioxide. Similarly, the burning of fuels combined with nitrogen-rich air leads to the creation of nitrogen oxides. Air toxics and volatile organic compounds may occur either from partial combustion of gasoline or fuel additives or from components that pass through the engine uncombusted. Volatile organic chemicals can enter the air via evaporation during fuelling. This section outlines the relative contribution of the transportation sector to overall levels of these three categories of pollutants, special considerations for exposures to air pollutants from the transportation sector, and studies of health effects related to transportation sources of air pollution [1]–[3]. The trends over time of transportation-related emissions of criterion air pollutants and the respective contributions of on-road, nonroad or off-road, and stationary sources of the Environmental Protection Agencys six priority mobile source air toxics are illustrated The transportation sector currently accounts for 30 to 50 percent of key criterion air pollutants such as carbon monoxide and the ozone precursors nitrogen oxides and volatile organic compounds VOCs VOCs. Relative contributions fluctuate throughout time and in various regions.

For example, in 1982, motor vehicles in the United States released nearly 70 percent of all lead pollution into the air. By 2002, lead had been eradicated from gasoline, and motor vehicles were generating minimal levels of lead, contributing to the 93 percent decrease in total lead emissions Environmental Protection Agency [EPA] 2004. However even though lead polluted air from motor vehicles is no longer a concern in the United States or other nations that have prohibited lead in gasoline, it remains a major source of low-level lead poisoning in other countries across the globe. For pollutants other than lead, the transportation sector has taken more relative significance in the United States, since cleaner manufacturing technology and the movement of polluting companies have diminished the relative emissions from manufacturing [4]–[6].

Transportation-Related Exposures to Air Pollutants Occur

Regulators divide air pollution sources into three broad categories: stationary sources, which are usually major emitters like large manufacturing facilities and power plants; area sources, which are smaller stationary emitters, such as dry cleaners or auto body shops; and mobile sources, including on-road vehicles such cars and trucks and nonroad vehicles such as construction equipment, locomotives, farm equipment, and even ferries and boats. Transportation sources are usually movable sources of pollution. Because of this, they have generally been dealt with by emissions and fuel solutions that reduce emissions per car, with little thought given to the locations of those vehicles.

Because U.S. land-use and development patterns have involved the creation of huge multilane roadways, however, it has become increasingly clear that transportation sources are not randomly distributed geographically but instead can be thought of as linear sources, with the roadways themselves becoming the sources, even though the pollution is created by the vehicles on each roadway. Certain routes, such as those linking major ports and urban or distribution hubs, are utilised most intensively by heavy vehicles. Since practically all heavy vehicles utilise diesel fuel, these routes are unusually concentrated concentrations of diesel exhaust pollutants. The positioning of residential areas adjacent to these highly utilised roadways presents the possibility for hot spots, small areas with exceptionally high air pollution exposure.

The influence of these hot zones on human health is a topic of continuous inquiry. Concerns have been expressed that many of these hot areas are low-income neighborhoods that confront severe environmental as well as social hazards to health Some of these communities may have disproportionately high rates of asthma, for instance, which would raise the numbers of individuals most susceptible to damage from rising air pollution levels. For example, investigations in the Harlem district of New York City have demonstrated extensive exposure to diesel particles among teenagers Northridge and others, 1999 and high levels of elemental carbon related with local truck traffic Kinney and others, 2000. In the Roxbury district of Boston, local community organisations have teamed up with the Harvard School of Public Health to educate community members about asthma and air pollution and to measure exposure levels at hot locations in their community. Some towns confront exposures not just from the placement of major highways but also from the local positioning of other parts of the transportation systems such as bus and subway terminals or other services such as waste transfer stations such as trash transfer stations.

Asthma, Respiratory Health, and Transportation-Related Air Pollution

Asthma is a condition characterized by chronic inflammation of the lungs tiny airways and increased responsiveness of those airways smooth muscles to irritants and allergens, resulting in bouts of wheezing, coughing, and trouble breathing. For unknown causes, the number of persons suffering with asthma has risen rapidly in the United States and many other regions of the globe. For example, the frequency of asthma in children under the age of four grew by 160 percent between 1980 and 1996. Transportation-related air pollutants, such as fine particles, ozone, nitrogen oxides, and air toxics, may all irritate the lungs and airways and provoke asthma episodes see Chapter Fourteen. While it is difficult to attribute the health consequences of any given air pollutant to a specific source of that pollutant, a number of studies have examined the relationships between living near highways and different markers of asthma and respiratory health.

Transportation-related air pollution is a well-known danger to children’s respiratory health Studies have shown links between living near busy roads and being diagnosed with asthma Edwards, Walters, and Griffiths, 1994, being hospitalized for asthma, and having asthma outpatient visits English and others, 1997. It is worth noting that studies have shown that excessive truck traffic raises the respiratory health risk of a nearby roadway. Truck traffic, for example, has been linked to asthma diagnoses Van Vliet and others, 1997 and asthma symptoms [5], [6].

Transportation-Related Air Pollution and Mortality

In addition to links to asthma and respiratory health, fine particles have been linked to an increase in cardiovascular mortality Many studies have looked especially at fatalities from cardiovascular and other causes, as well as traffic-related air pollution exposure. According to one study from Amsterdam, 100 g/m3 increases in traffic-related black smoke and nitrogen dioxide were associated with increased relative risks of dying, and another study found a nearly twofold increase in risk of cardiovascular mortality associated with living near a roadway Hoek and others, 2002. Other studies characterized fine particle sources using a different technique, utilizing marker elements for crustal particles silicon, coal combustion particles selenium, and motor vehicle fuel combustion particles lead. Particles connected with motor vehicle fuels exhibited the highest link to death, while particles of crustal origin had no link to mortality.

Transportation-Related Air Pollution and Cancer

Finally, there is worry that air toxics and particles from traffic sources raise the risk of cancer in persons who live near highways. Numerous sources show that diesel particles are the principal cause of cancer risk from air toxics South Coast Air Quality Management District, 2004; Environmental Defense, 2004, which may originate from either on-road sources like trucks and buses or nonroad sources like construction equipment. A Stockholm research Nyberg and colleagues, 2000 found a 40% increase in lung cancer risk for persons in the highest group of average traffic-related nitrogen dioxide NO_2 exposure. There was little correlation found between Sulphur dioxide SO_2, a proxy for indoor heating fuel combustion products and lung cancer. The studys authors found that urban air pollution raises the incidence of lung cancer, and that automobile emissions may be especially significant. Two studies that looked at the link between traffic-related exposures and childhood leukaemia found inconsistent findings.

On the one hand, a study in Denver Pearson, 2000 discovered that children living within 750 feet of roads with the highest traffic density more than 20,000 vehicles per day faced a sixfold increase in the risk of all cancers and an eightfold increase in the risk of leukaemia compared to children living in areas with the lowest traffic density exposures. A case-control study of children with leukaemia in Los Angeles Langholz and others, 2002, on the other hand, revealed no connection between traffic density and leukaemia after adjusting for the kind and quantity of electrical wiring in the house Langholz and others, 2002. For exposure evaluation, the Los Angeles research relied on more current traffic numbers. Nevertheless, the authors were unable to explain the disparity in results between their trial and the Denver study [7].

Solutions for Transportation-Related Air Pollution

Technological advancements have significantly decreased air pollution emissions per automobile. Fuel composition modifications, such as the removal of lead and the inclusion of gasoline additives such as oxygenates, engine design improvements, and the installation of catalytic converters in automotive exhaust systems, have all resulted in lower air pollutant emissions. The greenhouse gas carbon dioxide, which is directly tied to fuel usage and automotive use, is one significant exception to this trend. Since both of these have been constantly increasing, so have transportation-related carbon dioxide emissions.

In the United States, automobiles, light trucks, and other passenger vehicles sold after 2004 must meet a new set of Tier 2 requirements EPA, 2000c. These regulations restrict vehicle emissions of many pollutants, including nitrogen oxides NO_x, particulates, and nonmethane chemical gases. Together with limiting vehicle emissions, Tier 2 rules restrict the amount of sulphur in petrol eventually to 30 parts per million, preventing the creation of secondary particulate matter. These stringent new emissions regulations were acknowledged as required to counteract the air pollution effects of the nations continued development in VMTs. Beginning in 2007, stricter pollution control regulations will be imposed for diesel vehicles.

Automobile and truck emission requirements are becoming more stringent. If these new criteria are completely implemented, additional reductions in transportation-related air pollutants are most easily accomplished by limiting the manufacturing of more polluting vehicle types or lowering vehicle miles travelled. As previously stated, the only approach to minimise carbon dioxide emissions from automobiles is to replace current fleets with greater efficiency vehicles or reduce kilometres travelled.

Transportation and Physical Inactivity

The requirement for the passenger to exert physical energy has diminished as transportation technology has evolved. People are spending more and more of their waking hours driving or riding in vehicles, resulting in more and more hours of relative physical inactivity.e amount of energy needed for various modes of transportation. Walking, at 2.8 metabolic equivalents METS, burns about 75% more calories than driving a vehicle, at 1.6 METS.b A nationwide study to monitor personal energy expenditure discovered that, while using little energy, driving a vehicle was the top-ranked category of personal energy expenditure, accounting for 10.9 percent of a daily total. This decrease in nonmotorized mobility is part of a larger public health concern caused by physical inactivity. Only 25% of Americans aged eighteen and older get the recommended amount of physical activity, which is half an hour of moderate intensity activity, such as walking or slow biking, performed at least five days per week, or twenty minutes of vigorous activity performed at least three days per week U.S. Department of Health and Human Services [DHHS], 2003. Centers for Disease Control and Prevention [CDC], 2001.

Children, in particular, seem to be becoming less and less physically active. Just around half of individuals aged 12 to 21 participate in regular, strenuous physical exercise, while preschool children spend the bulk of their playtime inactive DHHS, 1996; Strauss, 1999. Just around two-thirds of high school pupils engage in moderate-intensity physical exercise DHHS, 2003. Between 1977 and 1996, childrens walking trips declined from 16% to 9% of overall trips. This trend away from walking and bicycle has been most obvious in school-related excursions. According to a recent poll, just 14% of students who live within a mile of school walk or ride their bikes to school.

Health Impacts of Physical Inactivity

Less physical activity has been linked to cardiovascular disease, diabetes, colon cancer, obesity, and an increase in total mortality. Mortality is especially noteworthy. Physical activity was studied as a risk factor for all-cause and cause-specific death in a cohort of 10,000 men and 3,000 women followed for over eight years. All-cause death rates climbed from 18.6 per 10,000 person-years in the fittest males to 64 per 10,000 in the least fit men, and from 8.5 to 39.5 per 10,000 person-years in the fittest and least fit women Blair and others, 1989. Cardiovascular disease is the leading cause of death in the United States, and sedentary lifestyle is a key risk factor. Numerous studies have shown a link between physical inactivity and cardiovascular disease. Males who do not exercise are three to five times more likely to die from cardiovascular disease than guys who exercise regularly Wei and others, 1999. Women who walk at least 10 blocks each day had a 33% decreased risk of cardiovascular disease than women who do not exercise Blair and others, 1996. It is anticipated that with, roughly 35% of excess cardiovascular disease may be avoided.

Cardiovascular illness is connected to heart disease and diabetes, both of which have been proven to rise when physical activity levels decline. After controlling for age, gender, baseline BMI or body mass index, which is a measure of weight in relation to height that is associated with body fat and health risk, and baseline blood pressure, a 12-year cohort study of 4,800 men and women found that low levels of physical fitness improved relative risk for the development of hypertension Blair, Goodyear, Gibbons, and Cooper, 1984. Diabetes mellitus that is not insulin-dependent has been demonstrated to decrease when energy expenditure rises. The Nurses Health Study included 70,102 women who were disease-free at the start and were assessed for their likelihood of developing type 2 diabetes.

Throughout the eight-year follow-up period, there were 1,419 new instances of type 2 diabetes. After controlling for age, smoking, alcohol use, hypertension history, and hypercholesterolemia history, a quicker typical walking speed was shown to be independently related with a lower risk Hu and others, 1999. Physical inactivity also contributes to the rising obesity pandemic, which is linked to worse health outcomes and higher mortality. Daily energy expenditure is now lower than it was in preindustrial culture Hill and Melanson, 1999. According to the National Health and Nutrition Examination Survey III, 39.4 percent of men and 24.7 percent of women are overweight, with a BMI more than 25 but less than 29.9, while 19.9 percent of men and 24.9 percent of women are obese, with a BMI greater than 30. Flegal, Carroll, Ogden, and Johnson, 2002.

Childrens health is also reliant on proper physical exercise. The Committee on Atherosclerosis, Hypertension, and Obesity in the Young and the American Heart Association have concurred that atherosclerosis starts in childhood. These groups propose that children should participate in regular activities, ideally generating energy expenditures at 50 to 60 percent of maximal exertion, in order to reap the benefits associated with a physically active lifestyle, such as weight control, lower blood pressure, continued to improve psychological well-being, and a predisposition to more exercise in adulthood

Many of the negative health impacts of physical inactivity in children arise from obesity. Rates of obesity increased in U.S. children from the 1970s to the 1990s Troiano and Flegal, 1998, with 13 percent of six- to eleven-year-olds and 14 percent of twelveto seventeen-year-olds being overweight in 1999 Wang and Dietz, 2002. Wang and Dietz, 2002. Childhood obesity is connected with diabetes Rocchini, 2002, asthma, sleep apnea, and gallbladder disease Barlow and Dietz, 1998. Barlow and Dietz, 1998. A study that examined changes in hospital discharge rates for obesity-associated diseases over twenty years found that the number of discharges for diabetes doubled, from 1.43 percent in 1981 to 2.36 percent in 1997, and the discharges for gall bladder diseases tripled, from 0.18 percent to 0.59 percent. Sleep apnea discharges also increased, from 0.14 percent to 0.75 percent Wang and Dietz, 2002. Wang and Dietz, 2002. While these percentages cannot be equated with illness prevalence, they suggest the potential that rates for certain disorders are growing.

Additional advantages of physical exercise include lower risk of colon cancer and decreased symptoms of depression and other mental disease. The highest level of physical activity is associated with a 30 to 50 percent reduced risk of colon cancer, as shown in dozens of studies that used different measures of occupational or leisure-time activity and controlled for diet and other risk factors Colditz, Cannuscio, and Frazier, 1997; Lee, 2003. For healthy persons, twenty to forty minutes of one-time aerobic-type movement decreases anxiety and improves mood. The economic expenses arising from the health consequences of physical inactivity and obesity among Americans run fairly high. Of the entire expense of cardiovascular illness, $31 billion is related to obesity and overweight American Heart Association, 2003. Hospital charges for treating obesity-related disorders among children climbed thrice between 1979 and 1999, from $35 million to $127 million Paluska, 2002. Paluska, 2002. According to the American Heart Association, increasing physical activity among sedentary Americans over the age of fifteen may reduce annual national medical expenses by $76 billion.

Links Between Transportation and Physical Activity]

From the preceding discussion it is evident that physical activity levels are dropping in the United States at the same time as individuals are depending less on their own power to go about and more on personal motorised vehicles. Yet establishing which specific variables are driving these changes, and the degree to which losses in walking and biking impact overall levels of physical activity is more challenging. This is in part owing to the fact that the government does not collect as many statistics regarding nonmotorized travel as about motorised travel, therefore data on nonmotorized trips and who is taking them are less accessible. In addition, academics have not reached agreement on how to define and assess, for the sake of studying personal mobility habits, the many aspects associated to urban and transportation planning and sustainable patterns. Notwithstanding these challenges certain inferences may be derived from the current literature, and the recent increasing research interest in this field should provide a clearer knowledge of these concerns in the near future. Some are cultural, as evidenced by variances across nations and even among cities within the United States. Yet some are structural or environmental; they are dictated by the way societies are conceived and developed.

These characteristics include the existence of sidewalks, trails, crosswalks, pedestrian bridges, and other pedestrian and cycling amenities Nelson and Allen, 1997; Pucher, 1997. Nelson and Allen, 1997; Pucher, 1997. As discussed previously, community design considerations such as closeness and connectedness of commercial destinations to residential areas significantly impact both real and perceived ability of individuals to walk or bicycle for short excursions. This has been proved in various studies that analysed the transportation mode choices of people in communities that vary in design. Several studies have shown that residents of neighbourhoods with more traditional designs greater connectivity, access to transit used nonmotorized and public transportation far more than did residents of neighborhoods with newer designs that reduced connectivity Friedman, Gordon, and Peers, 1994; Handy, 1992; Shriver, 1997. Further investigation is required to establish the specific reasons responsible for these disparities in transportation behaviour.

Mental Health

Transportation has long been connected with both good and negative impacts on mental well-being. Travel, especially solo travel, is employed as a metaphor for personal growth and enlightenment throughout international literature, and contemporary advertising surely capitalises on ideas of tranquil, lonely, mood-enhancing travel, particularly in vehicles. At the same time, travel may be incredibly stressful. State-of-the-art, long-distance transportation before to the nineteenth century that is, on horseback or in horse-drawn carriages was not only physically difficult but worrisome, owing to chances of thievery, injuries, being stranded, and so on. With the introduction of motorized traffic, the physical comfort of long-distance travel has improved dramatically, yet travel still may bring great mental stress, whether that travel is for daily commuting or merely for pleasure. It is possible that variables other than psychological stress have a role in creating these health issues. Exposure to carbon monoxide and other air pollutants is likely to impact heart disease, while extended sitting and whole body vibration are likely to influence back and neck discomfort. Yet, the fact that driving elevates physiological indicators of stress makes this process a probable contribution to driving-associated health issues. ving-associated health concerns.

Another indication of driving-related stress is violent conduct. The term road rage has been created to characterise excessive, uncontrollable acts of violence by car drivers. In addition to being an indication of emotional anguish, road rage is also a risk factor for more catastrophic accidents and deaths. One investigation of injuries and fatalities connected with aggressive driving behaviour revealed 218 deaths and 12,610 injuries in 10,037 occurrences reported to the police or the press. These fatalities and injuries resulted not just from automotive wrecks directly due to aggressive driving but also from personal attacks by drivers and passengers engaged in these occurrences. These most catastrophic occurrences, however, represent the tip of iceberg. Aggressive driving habits, ranging from waving or screaming at other drivers to stopping another vehicle from changing lanes, have been found in various polls to be surprisingly widespread.

According to a 1995 poll, 90 percent of victims had encountered aggressive driving and 60 percent had perpetrated some kind of aggressive driving behaviour, the most prevalent of which was flashing their headlights. 45% or making obnoxious gestures 22%. Joint, 1997. Traffic congestion and urban development, in addition to masculine gender, young age, and certain personality types, are predictors of aggressive driving Hennessy and Wiesenthal, 1997; Shinar, 1998; STPP, 1999. To the degree that traffic congestion and sprawl-like development patterns contribute to these dysfunctional behaviours, public health experts have an opportunity to collaborate with transportation and planning professionals to reduce these effects.

Noise and Transportation

Noise may be described as unpleasant or unwelcome noises, as well as sounds that are harmful to ones health. The kind and distance from noise sources in the surroundings influence ambient noise levels. According to the Federal Highway Administration 2000, a pickup truck releases 70 decibels dB of noise at a distance of 50 feet and at a speed of 50 mph, a medium truck emits 80 dB of noise, and a customised motorbike emits 90 dB of noise DOT, 2004. The noise level generated by highways is directly determined by speed limit, traffic density, and vehicle type. More cars, quicker speeds, and heavier vehicles tend to make more noise DOT, 2004. Light traffic releases around 50 decibels of noise at a distance of 25 feet, whereas heavy traffic may surpass 90 decibels. Planes are also significant noise generators. Overhead jet flights produce noise levels of more than 80 decibels for persons living within 2 miles of a large airport. Some aircraft really produce more than 100 decibels of sound.

Noise has been linked to a variety of health impacts, including hearing loss, higher blood pressure, heart disease, hormone abnormalities, and circulation difficulties Ising and Kruppa,; Stansfeld and Matheson,. Exposure to impulsive noises, such as fireworks or loud motorbikes, puts persons at a higher risk of hearing loss than continuous noise does National Institute on Deafness and Other Communication Difficulties, 2002. Wallace and Doebbling. Noise-induced hearing loss occurs at noise levels over 70 decibels dB World Health Organization, 2004, although the US Occupational Safety and Health Administration has set the top allowable limit at 85 decibels over eight hours. Levels between 70 and 85 dB may put more vulnerable groups at danger, particularly those with concurrent disorders affecting the inner ear. Residential exposures are unlikely to reach 85 dB consistently, although residents and employees exposed to urban traffic noise have been demonstrated to suffer varied degrees of hearing loss.

Noise exposure has been linked to a variety of cardiovascular health impacts, including hypertension and myocardial infarction. These relationships have been highest in occupational situations, where noise exposure has been linked to considerably higher diastolic blood pressures in individuals who have been exposed Talbott and others, 1999. Noise has long been recognised to raise adrenergic hormone levels, which may be a main mechanism for chronic vascular consequences Spreng, 2000. The links between noise and cardiovascular health in populations exposed to traffic noise have been less consistent. A metaanalysis of literature, largely from Europe, linked hypertension to exposure to aircraft noise and myocardial infarction to exposure to traffic noise, however the authors cautioned that these results might have been influenced by uncontrolled confounders van Kempen and others, 2002. More recent research discovered that males who lived in a residence with sound levels over 70 decibels for more than 10 years had an 80 percent increased risk of myocardial infarction.

Noise has also been linked to negative psychological and developmental effects. Both aeroplane and traffic noise have been linked to increased psychiatric symptoms and medication usage, but not to an increase in the prevalence of mental disorder. Poor classroom conduct Lercher, Evans, Meis, and Kofler, 2002, noise annoyance, or perceived disturbance or discomfort caused by noise, and impaired reading comprehension Haines and others, 2001a are other significant consequences of noise. Reading ability has been demonstrated to be hindered in schools near airports Haines and others,Evans, and Alternatives, 2002. Yet, socioeconomic considerations might skew the relationship between noise and reading comprehension. Reduce the amount of noise generated per vehicle, lower the number or speed or both of cars travelling by towns, build sound barriers around big roads, and route new or enlarged highways via less densely populated regions are all strategies to limit community exposure to traffic noise.

An EPA noise regulation for medium- and heavy-duty vehicles established in 1988 establishes a limit of 80 decibels at a distance of fifteen metres. Nonetheless, most roads are under state or municipal administration, resulting in a range of customs in various places. To limit noise exposures, several urban districts have implemented restrictions on truck movement at all times or during certain hours. The Federal Highway Administration 2000 established maximum outdoor noise levels for various types of land use, ranging from 57 decibels dB in areas requiring serenity and quiet for example, memorials to 72 decibels dB in developed areas without hospitals, schools, or other similar facilities nearby. Many new highway projects now need the installation of sound barriers beside highways to guarantee that sound levels in surrounding residential areas do not exceed these limitations. Aviation noise in communities near airports may also be minimised by designing quieter engines, modifying airport usage based on time of day and kind of aircraft, and establishing land-use laws [2], [8], [9]. According to the Federal Aviation Administration, government noise reduction measures since 1970 have lowered the number of individuals exposed to excessive aeroplane noise from 7 million in 1975 to 600,000 in 2000. U.S. General Accounting Office, 2000. This has been done mostly via limits on the louder turbojet engines, but also through the installation of sound barriers surrounding runways and taxiways and the establishment of stricter soundproofing regulations for buildings near airports.

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