

Access to Health Care and Nonemergency Medical Transportation

Two Missing Links

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Although lack of access to nonemergency medical transportation (NEMT) is a barrier to health care, national transportation and health care surveys have not comprehensively addressed that link. Nationally representative studies have not investigated the magnitude of the access problem or the characteristics of the population that experiences access problems. The current study, relying primarily on national health care studies, seeks to address both of those shortcomings. Results indicate that about 3.6 million Americans do not obtain medical care because of a lack of transportation in a given year. On average, they are disproportionately female, poorer, and older; have less education; and are more likely to be members of a minority group than those who obtain care. Although such adults are spread across urban and rural areas much like the general population, children lacking transportation are more concentrated in urban areas. In addition, these 3.6 million experience multiple conditions at a much higher rate than do their peers. Many conditions that they face, however, can be managed if appropriate care is made available. For some conditions, this care is cost-effective and results in health care cost savings that outweigh added transportation costs. Thus, it is found that great opportunity exists to achieve net societal benefits and to improve the quality of life of this population by increasing its access to NEMT. Furthermore, modifications to national health care and transportation data sets are recommended to allow more direct assessment of this problem.

Millions of Americans are transportation disadvantaged because they cannot provide or purchase their own transportation. Members of that population, owing to low income, disability, inability to drive, geographic isolation, or some other reason, cannot transport themselves and are unable to pay for buses or taxis. As a result, this population—which is disproportionately elderly, poor, and disabled—depends on others to access employment, education, shopping, and health care.

That dependency reduces access to routine and other nonemergency medical services, and the reduced access can lead to poor health outcomes. This possibility particularly affects those who have chronic conditions (e.g., heart failure, asthma, and diabetes) and multiple diseases, as well as those who stand to benefit from screening, prevention, and health promotion. Because of poor access to care,

routine conditions can escalate to a need for emergency care, for example, when poorly managed asthma—a problem among children in the inner city—causes a major attack. Therefore, improving access to health care for the transportation-disadvantaged population can reduce national health care costs, possibly offsetting the incremental increase in transportation costs.

Given the concerns raised by missed medical trips and the effects on the health of those who miss the trips, the goals are to identify and describe the population of Americans who experience lack of access, determine their medical conditions, and discuss the consequences of missed care. With that information, an inquiry can begin about the value of increasing the supply of transportation to meet this need in relation to the health care gains achieved. To address those issues, two methods were primarily relied on: (a) a thorough investigation of both the health- and transportation-related literature and (b) an analysis of data from two nationally representative health surveys. The analysis was supplemented with queries of the *2001 National Household Travel Survey* (NHTS).

LITERATURE REVIEW

Because many definitions of transportation-disadvantaged individuals exist, the literature from the health and transportation sectors can be used to support differing estimates of the size of the transportation-disadvantaged population. Much of the literature avoids the term altogether and instead documents discrepancies in transportation access associated with socioeconomic, demographic, and geographic factors. Thus, at one extreme, any household that does not own a vehicle might be defined as transportation disadvantaged, and that amounts to 8.3% of all households in the United States (1). Furthermore, 88% of Americans 15 years of age or higher report that they are drivers, leaving 12% who do not operate personal vehicles for mobility (2). Examining population subgroups, however, Pucher and Renne found that 26.5% of households with incomes less than \$20,000 do not own a vehicle (1). They also found that members of this income group were far more likely to use public transit (4.6% of all trips compared with an average of 1.7% for all Americans) and nonmotorized modes (walk or bicycle, 17.0% of all trips compared with 10.4% for all Americans). Additionally, the Bureau of Transportation Statistics (BTS) reported that households without vehicles also are disproportionately renters, located in urban areas, and composed of a single person (2). Even when transportation is available, the demand may exceed the supply of trips, resulting in denied trip requests. For a paratransit service in southeastern Michigan,

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Wallace found that roughly 15% of trip requests could not be accommodated (3).

Race and ethnicity also are associated with being transportation disadvantaged. Using data from the NHTS, Pucher and Renne found that African Americans and Hispanics have lower mobility and use public transit at higher rates than does the general population (1). Research has shown that compared with members of the white population, 10% to 20% more members of racial minority groups are transportation disadvantaged (4, 5). The Institute of Medicine cited access issues among several factors explaining why members of minority groups receive lower quality health care than do nonminorities, even when there is equivalent insurance coverage (6). Addressing children specifically, a study commissioned by the Children's Health Fund found that 9% of children in families with annual incomes less than \$50,000 miss essential medical appointments owing to transportation, regardless of their insurance status (7). Other studies have shown that lack of transportation is a problem even after accounting for insurance status (8, 9).

Age and location also are important factors in defining the transportation disadvantaged. Although studies have shown that older adults and residents of rural areas continue to rely on personal vehicles, they often have few, if any, options when a car is not available (e.g., Americans over 65 make about 90% of their trips by car, and 97% of rural households own at least one car) (10, 11). Rosenbloom reports that about 40% of rural counties have no public transportation, and only 14% of rural elderly people have transit service available within 0.5 mi of their residences (10). Examining one rural county, Walker found that 40% of patients missed medical appointments and 28% could not get to a pharmacy because of transportation barriers (12). In rural areas, distance contributes to lack of access because medical facilities tend to be farther away from the people who use them. In one study, patients living more than 20 mi from the site of care were twice as likely to miss scheduled appointments as were those living closer (13).

Focusing on the population below age 65 in Dayton, Ohio, Ahmed et al. found that 16% of respondents reported that finding transportation for medical care was "hard" and another 15% reported that it was "very hard" (14). Another study found that patients who were over the age of 50 and whose household income was less than 200% of the poverty line were nearly twice as likely as all patients above age 50 to delay care because of transportation issues, time issues, or both (15). In comparing barriers to care, transportation and time issues were nearly as important as cost (14.3% versus 18.8%) for the same transportation-disadvantaged group.

Having a medical condition—thereby increasing one's need for medical care—can also contribute to difficulty obtaining transportation. The 2001 NHTS revealed that 8.6% of respondents reported having a medical condition that limits their travel, regardless of trip purpose (2). It also revealed that 9% of Americans over the age of 14 have a "travel-affecting medical condition." Furthermore, the NHTS clearly demonstrates that this population makes fewer trips per day than those without such a medical condition (2.8 versus 4.4 trips per day). Another study conducted by BTS revealed that 3.5 million Americans never leave their homes (16). Of these, 1.9 million are persons with disabilities.

The literature clearly documents problems related to nonemergency medical transportation (NEMT) in the United States, but it does not provide a clear estimate of the size of the population that misses nonemergency medical care or document the most important medical conditions faced by that population. By using available health care and other data sources, this paper aims to close that information gap.

NATIONAL HEALTH CARE DATA SETS

The U.S. government maintains several health information sources. Two of them represent the noninstitutionalized population in the United States. They are the *National Health Interview Survey* (NHIS) conducted by the National Center for Health Statistics and the *Medical Expenditure Panel Survey* (MEPS) conducted by the Agency for Healthcare Research and Quality. The NHIS is the most comprehensive nationally representative assessment of the nation's health. For this research, both the 2001 and 2002 NHIS were analyzed because they were the most recent (the 2002 NHIS data were released in December 2003). This study annually samples more than 90,000 persons and covers a range of health-related issues. The 2001 MEPS (full-year data for 2001 were released in April 2004) was also used. The MEPS contains detailed health care utilization and expenditures information on a subset of more than 30,000 individuals from the NHIS sample. To supplement the use of these national health care data sets, two nationally representative transportation data sets were also used—the 2001 NHTS and the 2002 *National Transportation Availability and Use Survey* conducted by BTS.

ESTIMATES OF TRANSPORTATION-DISADVANTAGED POPULATION

An unambiguous estimate of the size of the transportation-disadvantaged population does not exist. Even the definition of "transportation disadvantaged" varies. The literature review indicates that a nationally representative estimate of the population that misses medical care because of a lack of transportation is not currently available. In short, health-related data lack sufficient detail on transportation to directly measure the number of missed trips, and transportation data lack sufficient detail on health conditions to address utilization. Furthermore, these studies use independent samples, precluding linking of data sets. For this research, multiple estimates were made in the belief that convergence implies reasonableness. To make these estimates, results from a recent BTS study (15) were used and data from the NHIS and the MEPS were analyzed.

BTS 2002 National Transportation Availability and Use Survey

BTS conducted the 2002 *National Transportation Availability and Use Survey* to investigate the transportation status of Americans with disabilities and to compare their status with nondisabled Americans. BTS sampled 5,000 persons (16), and roughly half of them were persons with disabilities (who were oversampled to allow for better statistical description of this group). This study indicated that 3.5 million Americans never leave their homes. Of these, 1.9 million are disabled. Of these, 528,000 "experience transportation difficulties." That implies that nearly 1.4 million disabled persons who never leave the home do not report experiencing transportation difficulties. Presumably, they could obtain needed transportation if their other problems could be overcome. Thus, these 528,000 persons can be seen as constituting the lowest possible estimate of the transportation-disadvantaged population missing medical trips, because with available transportation, these individuals would have made at least one medical trip during the year related to their disability. Not surprisingly, the homebound disabled population of 1.9 million tends to be older (average age is 66) and more severely disabled (58% report their

disability as severe) than the population at large. As a result, many of the 528,000 who experience transportation difficulties likely are missing more than one medical trip per year.

This study also showed that approximately 12.19% of disabled persons either have difficulty obtaining transportation or cannot get the transportation they need for any purpose. For nondisabled persons, that is 3.32%. Because approximately 23% of the nation's 290 million people are disabled according to criteria used in this BTS study, an estimated 15.5 million persons cannot obtain the transportation they need (regardless of trip purpose). Although an unknown subset of these 15.5 million people cannot make nonemergency medical trips because they lack transportation, 15.5 million stands as a maximum estimate of the population that misses medical care owing to a lack of transportation. The calculations are as follows:

- $0.23 \times 290 \text{ million} \times 0.1219 = 8.13 \text{ million}$ persons with disabilities.
- $0.77 \times 290 \text{ million} \times 0.033 = 7.37 \text{ million}$ persons without disabilities.
- Total: 15.5 million persons.

U.S. 2002 National Health Interview Survey

With its focus on health care and outcomes, the NHIS addresses transportation in regard to impeding access to care. Thus, the NHIS incorporates the concept of transportation disadvantaged (unable to obtain needed transportation) in the specific context of trips for medical care. The NHIS contains the following question (posed in expanded adult and child subsamples): "There are many reasons people delay getting medical care. Have you delayed getting care for any of the following reasons in the past 12 months . . . you didn't have transportation?"

For the 2002 NHIS, the weighted results show that 1.33% of adults ($\pm 0.15\%$ at 95% confidence) reported that they did not have transportation (Table 1). This result is quite consistent for the 5-year period of 1998 through 2002, as shown in the list below (nonweighted results from sample sizes of approximately 30,000 per year). The same question was asked of children, and the weighted results from the 2002 NHIS for the child sample show that 1.31% of children (± 0.24 at 95% confidence) missed medical care because of a lack of transportation (Table 1):

- 1998: 1.78%,
- 1999: 1.46%,
- 2000: 1.74%,
- 2001: 1.75%, and
- 2002: 1.75%.

With the combined results for adults and children, it was found that 3,702,531 individuals delayed getting medical care in the past year

because of transportation difficulties (2,745,947 adults plus 956,584 children), or approximately 3.7 million people. Those numbers derive from respondents who explicitly link a transportation factor to delayed care during a specific 1-year period. Delayed care does not necessarily mean care never received, but with a short reference period, "delay" and "missed" become equivalent. This distinction is not pursued in the NHIS.

2001 Medical Expenditure Panel Survey

The MEPS also investigates barriers to care, including transportation. The questions used to identify transportation barriers, however, are somewhat different and begin with a basic screening question: "Anyone have difficulty obtaining care?"

To that question, 11.1% of respondents answered "yes." Respondents were then given a list of 14 items from which they were asked to select the main reason for experiencing difficulty. Of these reasons, three are transportation related: (a) medical care too far away; (b) cannot drive, no car, or no public transportation; and (c) too expensive to get there. Next the survey gives respondents an opportunity to cite a secondary reason for missing care. Summing those responses produces a weighted estimate of 1.21% of the U.S. population, amounting to 3.5 million people, who cite a transportation-related reason (main or secondary response) to explain why they had difficulty obtaining care. Although people miss care for a variety of overlapping reasons, this estimate is tightly linked to the intersection of transportation and difficulty obtaining care.

Summary of Estimates

To summarize, the range of estimates that have been calculated and compiled for the number of persons who miss medical care because of a lack of transportation in a year is as follows:

- 528,000 (BTS),
- 3,500,000 (BTS),
- 3,500,000 (MEPS),
- 3,700,000 (NHIS), and
- 15.5 million (BTS).

Despite the relatively large range in these estimates—from 0.5 to 15.5 million persons—the two extreme values are known to understate and overstate, respectively, the size of the population. Furthermore, the remaining estimates converge, despite deriving from significantly different estimation approaches. Because of the closeness of the MEPS and NHIS estimates and their explicit intersection of the health and transportation domains, the authors have most confidence in the estimates arising from these data, particularly

TABLE 1 Lack of Transportation to Medical Care, from 2002 NHIS

Response	Weighted Frequency (adults)	Percentage of Adults	Weighted Frequency (children)	Percentage of Children
Yes	2,745,947	1.33	956,584	1.31
No	201,250,000	97.78	71,615,707	97.78
Refused/NA/don't know	1,827,604	0.89	397,651	0.55
Total	205,830,000	100.00	72,969,942	100.00

N = 31,044 adults, 12,524 children; NA = not ascertained.

for estimating the yearly size of the population of interest, as opposed to estimating the population at risk from lacking access to nonemergency medical transportation. As a result, it is concluded that approximately 3.6 million Americans (the NHIS and MEPS average) miss at least one medical trip in a year because of transportation.

To confirm that these 3.6 million individuals reflect the demographic and socioeconomic conditions documented in the literature about people who lack transportation access to medical care, the NHIS adult sample data were queried to compare characteristics of those who missed care owing to transportation and those who did not. This analysis shows that the population that missed care because of a lack of NEMT is

- Poorer (54.63% have household incomes below \$20,000 per year versus 17.66% for those who did not miss care owing to a lack of NEMT),
- Older (16.28% age 70 or older versus 11.45%),
- Disproportionately female (62.82% versus 51.88%),
- Made up of fewer whites (64.6% versus 81.1%), and
- Roughly half as likely to have a 4-year college degree.

Thus, the transportation-disadvantaged population that lacks transportation to medical care identified through the NHIS using an NEMT criterion matches well with the descriptions of the transportation-disadvantaged population found in earlier studies and discussed in the literature review. That increases the authors' confidence that the estimate of 3.6 million persons who miss medical care because of transportation is on target.

The split of this population between urban and rural America was also investigated. The 2002 NHIS currently lacks geographic location information, so the 2001 NHIS data were considered. The "non-metropolitan statistical area (non-MSA)" field in the 2001 NHIS closely matches the "rural" field in the NHTS. Specifically, the 2001 NHIS indicates that 20.73% of adults and 19.99% of children reside in non-MSA locations, and the 2001 NHTS indicates that 21.9% of all persons live in rural locations. Thus, the non-MSA category in the 2001 NHIS was used as the operational definition of rural in this analysis. From this, it was learned that 22.17% (weighted) of the adults who reported delaying care owing to transportation problems lived in rural (non-MSA) locations, as did 14.83% (weighted) of the children. Thus, the percentage of children in rural areas who miss care owing to a lack of NEMT is well below the overall percentage of rural children, meaning that children who lack access to medical care because of transportation reasons are more concentrated in urban areas. Indeed, the data show that 53.7% of children who missed care owing to a lack of NEMT live in metropolitan areas of 1 million or more, whereas only 47.5% of all children live there.

Medical Conditions Affecting People Lacking Access to Transportation

After the best estimate of the population that misses medical care in a year for transportation reasons was determined, the medical conditions faced by members of this population of about 3.6 million people were determined. Again the 2002 NHIS data set was used, and the conditions reported by respondents identified as delaying care for transportation-related reasons were investigated. Because of the structure of the data sets, adults and children were analyzed separately.

Adult Disease Conditions

Table 2 presents a comprehensive, alphabetical list of medical conditions for individuals who also reported difficulties accessing care because of transportation problems and it reports the weighted percentage of these transportation-disadvantaged adults experiencing the condition in question.

It was found that two comparisons between adults who miss medical care for transportation-related reasons and those who do not are instructive:

1. There is a great difference in the percentage of adults experiencing multiple conditions from this list (92% for those missing care versus 64% for those who do not); the difference in the percentage who experienced none of these conditions is also substantial (3% for those who miss care versus 21%).
2. For each condition (except for "no conditions"), the prevalence is higher for those who miss care than for those who do not. Table 3 shows that for highly prevalent conditions.

The ratios in Table 3 illustrate that these conditions disproportionately affect the population that misses medical care. Furthermore, they demonstrate that, in addition to physical conditions, mental health is an important concern for this population. Not only do 49.7% of the adults who miss care report experiencing depression, close to one-third mention excessive sleepiness; nearly 50% note insomnia; and 5% or more report each of the "feeling" categories of "hopeless," "nervous," "restless or fidgety," "sad," and "worthless." Moreover, these related mental health conditions correlate highly with other conditions, again demonstrating the prevalence of comorbidities.

Distribution of Conditions for Adults by Location

The geographic distribution of individuals by transportation status and medical condition was also analyzed. Although this analysis needs to be expanded, it was found that a higher than expected prevalence of diabetes, heart disease, and hypertension for urban, transportation-disadvantaged adults was coupled with a lower than expected prevalence of diabetes, heart disease, and hypertension for urban, nontransportation-disadvantaged adults. The percentages for transportation-disadvantaged adults residing in urban areas are as follows: diabetes (82.8%), heart disease (79.2%), and hypertension (80.5%). These numbers represent the percentages of the disadvantaged adults with each disease who live in urban locations and can be compared with the overall figure of 77.8% of transportation-disadvantaged adults who are urban residents. Conversely, a lower than expected prevalence of diabetes (75.1%), heart disease (75.2%), and hypertension (76.0%) was found for urban, nontransportation-disadvantaged adults. These percentages can be compared with the 79.3% of nondisadvantaged adults in urban locations. For a summary measure of these comparisons, an index was computed that divides the urban, transportation-disadvantaged share for each health condition by the urban share for those without transportation difficulties. The index numbers are as follows: diabetes (1.10), heart disease (1.05), and hypertension (1.06). By contrast, the index for renal disease is 0.94.

Child Disease Conditions

For children who miss care because of transportation problems, the analysis produces results similar to those for adults. Table 4 presents

TABLE 2 Medical Conditions Experienced by Adults Who Lack Transportation to Medical Care

Medical Condition	Unweighted Frequency of Adults with Condition	Weighted Percent of Adults with Condition
Arthritis	235	40.0
Asthma	113	22.1
COPD	101	17.6
Cancer	60	11.3
Dental problems	157	28.0
Depression	280	49.7
Diabetes	96	16.0
ESRD	37	7.2
Excessive sleepiness	176	35.2
Food or odor allergies	97	17.8
Gynecologic problems	55	8.8
Hay fever	72	12.5
Hearing aid needed	35	6.8
Heart disease	167	29.6
High cholesterol	146	25.7
Hypertension	233	37.7
Insomnia	258	49.4
Irritable bowel syndrome	84	12.9
Liver condition	35	6.7
Medication allergies	130	23.2
Menopausal problems	40	6.5
Menstrual problems	73	13.1
Multiple sclerosis	6	1.2
Neuropathy	18	3.1
Pain or aching joints	304	55.8
Parkinson's disease	2	1.4
Poor circulation	158	26.8
Prostate	3	0.5
Recurring pain	261	48.2
Seizures	42	7.5
Severe sprains	99	20.0
Sinusitis	101	16.9
Skin problems	120	21.4
Stroke	44	8.1
Thyroid problems	71	11.7
Ulcer	110	19.6
Urinary problems	119	20.8
Vision problems	219	37.5
Feelings		
Hopeless	30	5.8
Nervous	45	8.5
Restless or fidgety	41	8.8
Sad	28	5.2
Worthless	26	4.8

N = 537 adults; ESRD = end-stage renal disease.

an alphabetical list of the conditions for these children, including the weighted percentage of children citing these conditions. The pattern of comorbidities (multiple, simultaneous conditions) and condition prevalence matches that found for adults. For comorbidities, the results show a large difference for both the percentage experiencing multiple conditions from the list (32% for children who miss care ver-

sus 14% for children who do not miss care) and the percentage experiencing none of the listed conditions (39% for children who miss care versus 57% for children who do not). In each case, the prevalence of the conditions is higher for children who miss care because of transportation problems. For the high-prevalence conditions, the percentages are as follows:

- ADHD or ADD (9.4% for children who miss care versus 5.5% for those who do not),
- Asthma (24.4% versus 12.4%),
- Frequent headaches (12.8% versus 5.3%),
- Colds (32.2% versus 20.5%), and
- Learning disabilities (11.7% versus 6.5%).

Summary from Analysis of Critical Medical Conditions

By combining the results of the analyses above, the primary medical conditions (or care needs) affecting those adults and children who lack access to NEMT were identified. These primary conditions and needs were defined as those that have particularly high prevalence for the population that misses care, have disproportionate prevalence among those who miss care, or are amenable to cost-effective amelioration via improved transportation access. These conditions and needs are as follows:

- Obstetrical care (including prenatal, delivery, and postnatal care),
- Cancer treatment and screening,
- Screening for high cholesterol levels,
- Screening for high blood pressure and hypertension treatment,
- Arthritis,
- Asthma,
- Chronic obstructive pulmonary disease (COPD),
- Dental problems,
- Depression and mental health,
- Diabetes,
- Renal disease,
- Heart disease,
- Medical allergies,
- Pain or aching joints,
- Poor circulation, and
- Vision problems.

CONSEQUENCES OF UNMET TRANSPORTATION NEEDS

For both the adult and child samples, the analysis of the NHIS reveals extensive comorbidities and a much higher prevalence of conditions for individuals who miss care because of transportation problems compared with those who do not miss care because of transportation problems. This general finding has important implications for the consequences of missed care. Transportation-disadvantaged status that results in missed trips will potentially exacerbate the diseases and may result in costly subsequent medical care (specialist visits, emergency room visits, and possibly hospitalizations). Even when the potential to decrease subsequent utilization by more prompt care of an existing condition does not exist, quality-of-life concerns remain evident and important. For example, the prevalence of frequent headaches is more than twice as high for children who miss care

TABLE 3 High-Prevalence Medical Conditions for Adults, from 2002 NHIS

Medical Condition	Prevalence in Population That Misses Care Due to Transportation Problems (%)	Prevalence in Population That Does Not Miss Care Due to Transportation Problems (%)	Prevalence Ratio
Arthritis	40.0	20.5	1.9
Asthma	22.1	10.5	2.1
COPD	17.6	5.3	3.3
Cancer	11.3	6.9	1.6
Depression	49.7	15.2	3.3
Dental problems	28.0	12.4	2.3
Diabetes	16.0	6.4	2.5
Heart disease	29.6	15.5	1.9
High cholesterol	25.7	20.5	1.3
Hypertension	37.7	24.0	1.6
Irritable bowel	12.9	5.4	2.4
Medication allergies	23.3	12.9	1.8
Pain or aching joints	55.8	29.1	1.9
Poor circulation	26.8	8.3	3.2
Recurring pain	48.2	17.7	2.7
Severe sprains	20.0	8.1	2.5
Skin problems	21.4	8.5	2.5
Vision problems	37.5	16.1	2.3

N = 537 transportation disadvantaged (TD), 30,223 non-TD.

TABLE 4 Medical Conditions Experienced by Children Who Lack Transportation to Medical Care

Medical Condition	Unweighted Frequency of Children with Condition	Weighted Percentage of Children with Condition
ADHD or ADD	17	9.4
Anemia (past 12 months)	1	0.6
Arthritis	1	0.6
Asthma	44	24.4
Autism	1	0.6
Cerebral palsy	1	0.6
Depression	1	0.6
Ear infections	7	3.9
Eczema or skin allergies	5	2.8
Food or digestive allergies	3	1.7
Frequent diarrhea or colitis	6	3.3
Frequent headaches or migraines	23	12.8
Hay fever	4	2.2
Head or chest cold (past 2 weeks)	58	32.2
Heart disease	4	2.2
Learning disability	21	11.7
Mental retardation	4	2.2
Muscular dystrophy	1	0.6
Other developmental delay	1	0.6
Respiratory allergies	4	2.2
Seizures	2	1.1
Sickle cell anemia	1	0.6
Stutters or stammers	12	6.7
Vision problem	14	7.8

N = 180; ADHD/ADD = attention deficit hyperactivity disorder/attention deficit disorder.

because of transportation problems than it is for other children. To the extent that medical visits are being delayed for these transportation-disadvantaged children, they could be subject to considerable pain and suffering that otherwise could be effectively treated.

The effects of not obtaining needed nonemergency medical care because of transportation barriers on the health of affected persons depend, to some extent, on whether the missed care was preventive or for treatment for an existing condition. In the preventive arena, lack of transportation can lead to underimmunization (17), difficulties in administering screening programs (18), failure to attend pediatric checkups (19), and lack of prenatal care for poor women (9, 20). For chronic problems, numerous studies have documented a lack of care because of transportation barriers. Conover and Whetten-Goldstein, for example, found that 16.7% of AIDS and HIV patients reported difficulties in obtaining transportation and as a result were much less likely to have a primary care physician or to obtain regular care (21). For people with diabetes, a recent study revealed that those who missed more than 30% of scheduled appointments experienced worse health outcomes than those who attended more often (22). Additionally, patients with asthma entering the emergency room were much less likely to obtain follow-up care if they did not have access to transportation (23–25).

DISCUSSION AND CONCLUSIONS

The United States makes a substantial investment to provide access to medical services for transportation-disadvantaged people. In addition to the services offered by public transportation providers (paratransit and otherwise), other sources of transportation serve the needs of the transportation disadvantaged; indeed, 62 federal programs offer funding for such travel (26). Much of that service is part of the Medicaid program with a patchwork of van services, taxis, ambulance services, and so forth. In many regions, brokerage services or state or local agencies have been established to match riders with available transportation services. In all cases, operators face the challenge of optimizing the use of available transportation to meet a growing trip demand. Studies from Kentucky (27), Georgia (28), Connecticut (29), and North Carolina (30) have shown that factors such as computer-aided scheduling and tight controls on eligibility can increase the capacity of available service by reducing average trip length, transporting multiple passengers simultaneously, and reducing the number of ineligible trips. In that way, average trip cost is reduced and more trips can be provided with fixed resources.

The findings of this paper demonstrate that, despite these existing transportation resources, millions of Americans still lack adequate access to NEMT. In urban and rural areas, many public transportation routes do not provide access to medical care, especially for the most economically disadvantaged neighborhoods (31). Of patients riding public transportation to get medical care in one recent study, 86% reported missing an appointment because of transportation, and 95% reported arriving late, as compared with 27% and 43%, respectively, among patients with cars (32). On the basis of interviews with visitors to a pediatric clinic at a large, urban hospital, this study also found that 60% of respondents had previously missed or arrived late for an appointment because of transportation difficulties. In another study, patients diagnosed with asthma were found to be much less likely to return for a follow-up appointment with a primary care physician if they relied on public transportation, friends, or walking to appointments than were patients with their own cars (23). Older adults are

also affected. Of adults over age 65, there are 21% who no longer drive; these adults reported 15% fewer trips to the doctor compared with elderly people who still drive (33).

This research shows that the transportation-disadvantaged population that missed medical care because of transportation barriers includes about 3.6 million individuals who miss at least one medical trip over the course of 1 year. Compared with the rest of the U.S. population, this population has (a) a higher prevalence of every medical condition that was examined and (b) a far greater prevalence of comorbidities. There is evidence that disease severity is also higher across the respective conditions for the affected population. Furthermore, this population is poorer and older, contains more females and fewer whites, and is less educated than the rest of the population.

Although this analysis attempts to directly connect the disparate transportation and health disciplines using the best available data sets—specifically how many individuals missed health care because of a lack of transportation—it undoubtedly underestimates the overall population at risk of having transportation problems affecting access to health care. That is due to persistence—the dynamics of health care utilization for a given population. In general, health care utilization varies considerably over time, though greater persistence is expected for the transportation-disadvantaged population because of the higher prevalence of chronic conditions and a higher rate of comorbidities (34). Nevertheless, although many of the 3.6 million people will fall into the transportation-disadvantaged group that misses care in a succeeding year, many will not. Others will certainly take their place when they unexpectedly require medical care, and this year-to-year variation suggests an overall transportation-disadvantaged population with health risks greater than 3.6 million. Indeed, it was found that potentially as many as 15.5 million people are at risk for missing care because of transportation barriers in a given year, even though nearly 12 million of these either did not need care in the study year or managed to obtain transportation when it was needed, despite difficulties in doing so.

This analysis of conditions reveals that, even for large-scale and nationally representative studies such as NHIS and MEPS, the process of analyzing data at the condition level raises substantial concerns over sample size. Although the results above convincingly demonstrate the problem of transportation disadvantage vis à vis disease conditions in the aggregate, the respective sample sizes of those who miss or delay care for transportation reasons are small to begin with (e.g., 537 adults in 2002 according to the NHIS) and become dramatically smaller at the condition level. This presents a difficulty for analysts and policymakers interested in examining the costs and benefits of providing missed transportation. (Recent research, employing a comprehensive framework of health care access for low-income individuals, failed to mention transportation at all. (35))

The authors are confident in the estimate of 3.6 million transportation-disadvantaged individuals who annually miss care because of transportation barriers, but believe that estimating the number of trips and associating these trips with particular conditions strains the reliability of the data sources. To close that gap, it is recommended that specific transportation follow-up questions be added to the NHIS and MEPS via a special supplement that leverages the richness of the existing health care information and provides enough transportation detail so that researchers can more fully investigate the transportation disadvantaged and missed health care. Careful consideration is needed to establish sample sizes, and the supplement might need to focus on a subset of the primary conditions identified here so that statistical analyses have sufficient power. Furthermore, the next round

of the NHTS could include additional questions on access to medical care to further close the data gap. Other data sources can be used to enhance the knowledge of diseases and comorbidities associated with those experiencing transportation difficulties; however, only these national data sets, appropriately modified, can provide reliable estimates for national policy development.

For affected individuals, the consequences of missed health care are more important than missing data. Consequences range from quality-of-life concerns, such as the large proportion of transportation-disadvantaged people who experience pain or aching joints, up to life-threatening consequences, such as the importance of consistent care for the high percentage of transportation-disadvantaged children with asthma. An emerging perspective in the health arena promotes evidence-based medicine and emphasizes that integrated disease management has the potential to reduce health expenditures, lower mortality, and increase quality of life (36). Transportation-disadvantaged persons, however, are poor candidates for well-managed care protocols that are based on frequent checkups to avoid costly specialist care and unnecessary hospitalizations. Therefore, a clear need is seen for cost-effectiveness analyses that investigate transportation interventions to determine their effects on increasing compliance with demanding care protocols for well-chosen (i.e., amenable to successful treatment) conditions. Many conditions faced by the roughly 3.6 million people that have been identified (e.g., asthma, heart disease, and renal disease) can be managed if appropriate care is made available. The authors have begun to use a method to conduct these cost-effectiveness calculations. In essence, it uses the literature to distinguish well and poorly managed care by condition and then applies these designations to the MEPS expenditure estimates. The difference in average expenditures between poorly and well managed individuals, by condition, can then be used as a proxy for the benefits that might be realized if improved transportation access enables disadvantaged individuals to access better health care. From this preliminary work, based on study of asthma and heart disease, great potential has been found for net societal benefits accruing from improving the quality of life of this transportation-disadvantaged population by increasing its access to NEMT.

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