

Household Structure and Travel Behavior

Joan Al-Kazily, Ph.D., Carole Barnes, Ph.D., and Norman Coontz

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Executive Summary

This report presents a social structural method for analyzing and understanding personal travel behavior. This method is intended to enhance the understanding of personal travel behavior within the context of household structure and the individual's role within the household.

Household structures are based on the presence or absence of dependents, on the number of independent adults in the household, and on relationships among household members. Similarly, person roles are based on the dependence or independence of the traveler, on the presence or absence of other independent or dependent persons in the household, and on certain relationships among household members. In all, twelve household structures and twelve person roles were developed for this study.

To describe personal travel, innovative measures of travel behavior, called person loops and trip chains, are used in addition to the conventional travel variables of person trip, trip length, and travel distance. A trip is defined as uninterrupted travel from one place to another by any transportation mode. Person loop describes a set of trips which begin and end at home. Trip chains are defined as one or more trips between anchors. Home, work, and school are defined as trip anchors because travel to and from work or school is constrained in time and space, and because travelers generally spend a significant amount of time at these locations. Complex chains are defined as a sequence of trips between different anchors (e.g. home and work), consisting of more than one trip, or between two like anchors (e.g. home and home), consisting of more than two trips.

Profiles of each of the 12 household structures used in this study were drawn from descriptive statistics, including household size, household income, vehicle ownership, gender of household members, person role of household members, and work status of independent persons in the household. The travel behavior of households by household structure was studied to determine differences between household structure groups. The household structure profiles are used to relate household structure and the roles of persons within households to travel behavior.

Results

To evaluate ability to differentiate travel behavior, household structure was compared with household income, number of vehicles in the household, number of persons in the household, age of dependents, and travel mode; person role is compared with gender and work status of the traveler. Both household structure and person role were found to be effective in differentiating values for travel variables. The number of vehicles owned by the household, number of persons in the household, and work status were the only conventional variables which are comparable to household structure and person role in this respect.

Travel Behavior by Household Type

Trip frequency and travel distance per household were found to be highest for households with dependents, and tend to vary with household size.

Trip lengths were found to increase with number of independent adults, but decrease when dependents are present.

Trip frequency and number of person loops increase only slightly with the number of independent adults in a household, but increase substantially when dependents are present.

The effect on daily household travel distance is similar to the effect on trip frequency, increasing more with the presence of dependents than with increasing numbers of independent adults in the household.

One independent adult married households with dependents were found to have lower trip frequencies, trip lengths, and travel distances than two independent married adult households with dependents.

Households consisting of two related adults exhibited very low trip frequency and travel distance in comparison with similar size households consisting of two unrelated adults or a married couple.

Households of unrelated individuals exhibited the highest trip frequencies and travel distances among all two person households without dependents.

Household trips per loop and complex chains per loop generally decrease when dependents are present and as the number of independent adults increases. The tendency to combine trips into complex chains was found to be lowest in the largest household (more than two independent adults with dependents).

Travel Behavior by Person Role

Adults living alone were most likely to form complex chains.

Unrelated adults living in the same household exhibited travel behaviors similar to married adults, while related adults had a low propensity to form complex chains.

Single adults with dependents had a relatively high number of complex chains per loop and a high number of trips per loop, but a low number of loops per day. This suggests that their travel tends to be very complex relative to travel for other roles.

Unrelated independent adults without dependents, single adults with dependents and married adults with dependents exhibited the highest trip frequencies and trip length, and married adults with dependents had longer travel distances. Young adult dependents traveled about the same relatively short distance each day as unrelated adults.

Gender was found to have a different effect on trip frequency for each person role. The effect was most marked for dependent adults over 35 years of age; males made fewer trips than females, who were mostly homemakers. Independent married males with dependents also made fewer trips than their female counterparts. On the other hand, single females without dependents made fewer trips than comparable males. In most role categories, however, trip length and travel distance were longest for males, while females had more trips per loop and more complex chains per loop.

The effect of work status was found to be consistent across all person roles. Students, workers, and student workers had the highest trip frequency and the highest average travel distance. Workers also had the highest average trip length. Retired persons and homemakers were more likely to link trips into complex loops than were workers, while students and student workers had the lowest tendency to do this.

Further Research

The use of household structure and person role as explanatory variables for analyzing travel behavior looks promising. However, this study is limited in several ways that should be addressed in subsequent research.

The findings in this report are limited to person level measures of travel. Further work is needed to analyze the effects of structural variables on vehicle use and the effects of vehicle use on person level measures of travel.

This report uses only group means to quantify personal travel behavior. Future work could include other descriptive statistics, such as modes and quintiles, and should use multivariate techniques to analyze travel behavior by person role. Understanding of the effects of gender, household income, and work status could be significantly enhanced by the use of more advanced statistical techniques.

Time of day of travel and total travel times are important dimensions of travel behavior that should be examined in subsequent research.

The study of trip chaining could also be greatly expanded. Many variables developed in this research and available in the customized data base were not used in this study. Trip purpose could also be introduced to investigate complex trip chains in work or school trips in contrast to complex trip chains formed by trips for other purposes.

Introduction

1.1 Background

This report presents a social structural method for analyzing and understanding personal travel behavior. Rarely engaged in for its own sake, travel typically derives from the need to connect socially structured activities that are dispersed geographically and through time. These activities, defined as events in which individuals and groups interact, are complex behavior because the actions of the individuals engaged in them are structured - tied to and coordinated with the actions of others through relationships. Personal travel reflects this complexity because it is itself a structured activity that links two or more other activities. Consequently, the structure of activities and a person's roles within them can exert a powerful influence over choice of travel destinations, travel times, trip chaining alternatives, and travel mode.

In travel planning and forecasting, trip making is typically aggregated at the person level and at the household level. Individuals have traditionally been described by conventional socio-economic variables such as age and gender. Households are usually described by income level, number of persons in the household, and number of automobiles in the household; less frequently, households are described by lifecycle categories. Thus, in analysis of the Nationwide Personal Transportation Survey (NPTS) data, measures of trip making are correlated with these individual and household characteristics. However, conventional individual and household variables do not accurately specify the structural characteristics of activities important for explaining or predicting travel behavior.

For example, the correlation of trip making with individual trip-maker characteristics does not reflect the relationships that tie the individual trip-makers' travel behavior to their work status or to the travel needs of others within the household. With seventy percent of women in the labor force today, the use of gender without reference to work status and family structure may leave too much variability in travel behavior unexplained. Similarly, household income, size, and vehicle ownership, while important, do not account for the structural characteristics that affect members' travel behavior.

The lifecycle approach is sometimes used to attempt to explain behavioral differences in an individual or group. Lifecycle concepts describe a birth to death developmental process consisting of a sequence of household stages, and assume that individuals progress through a "normal" series of these stages. Lifecycle measures used in the 1990 NPTS are described as follows:

- 01 Single adult, no children
- 02 2+ adults, no children
- 03 Single adult, youngest child 0 -5 years old
- 04 2+ adults, youngest child 0 -5 years old
- 05 Single adult, youngest child 6-15 years old
- 06 2+ adults, youngest child 6-15 years old
- 07 Single adult, youngest child 16-21 years old
- 08 2+ adults, youngest child 16-21 years old
- 09 Single adult, retired, no children
- 10 2+ adults, retired, no children

However, lifecycle descriptors only loosely correspond to some of the structural influences on trip making. Although lifecycles reveal whether there is more than one adult and whether there are children in

the household, they cannot account for the growing diversity of household types that exist today. For example, households with 2+ adults may consist of married couples, other related adults, or unrelated individuals. The 2+ adult lifecycle thus combines several different types of household structure. For this reason the lifecycle approach also fails to provide a consistent theoretical basis for shifting the level of analysis between households and individuals. At the same time, lifecycle descriptors confound household structural influences with other determinants of travel. For example, separating households by age of youngest child confounds age effects with structural influences; and separating no child households by retired status confounds work status with household structure.

Travel data analysis and travel demand forecasting should also be sensitive to the structured quality of activities when travel behavior is described and quantified. Conventional travel surveys measure travel activity as an aggregation of individual trips. Trips are classified as home-based or non home-based, and each trip has a separate purpose. In this way each trip is disconnected from the other trips that are linked with it to form a chain of activities. Trip measures that abstract trips from their structural contexts can obscure how the timing and linking of trips are critical elements of structured travel strategies. Recognizing this shortcoming, transportation researchers are beginning to develop methods for measuring complex chains of linked trips (Oster, 1978; Hanson, 1979; Oster, 1979; Adler, 1979; Hanson, 1980; Kitamura, 1983; Golob, 1986; Hanson and Huff, 1986; Kondo and Kitamura, 1987; Kondo and Kitamura, 1988; Goulias et al, 1988; Goulias and Kitamura, 1989; Strathman et al, 1992). There is as yet no clear consensus on how best to conceptualize and measure trip chains.

The structural approach presented in this report uses traveler typologies that reflect socially structured differences among households and person roles. Structural measures of trip making are also developed and utilized. The work builds on that of earlier researchers who have adopted an activity-based approach to the analysis of trip making (Neale and Hutchinson, 1981; Hanson and Hanson, 1981; Clark et al, 1981; Damm, 1982; Recker et al, 1987), and on the work of researchers investigating life cycle as a household descriptor (Kostyniuk and Kitamura, 1982; Zimmerman, 1982; Chicone and Boyle, 1994). Other researchers have adopted an approach which is closer to that used in this work. Studies of person-role as a descriptor of traveler (Koppleman 1978), of the travel behavior of non-traditional households (Van Knippenberg et al, 1988), and of the effect of household structure on trip-making behavior (Strathman et al, 1992) all attempt to address the influence of social interaction within the household on travel behavior.

The goal of this report is to develop and evaluate a social structural approach for analyzing travel behavior. Data from the NPTS are used to understand the relationships between complex social characteristics and travel behaviors, not to predict the number of trips, chains or loops in a given population. In this report, simple descriptive statistics (means and standard deviations) are used to describe travel behavior of persons varying in age, income, and gender; of 12 differently structured households; and of individuals in one of 12 person roles. Model-building, seeking which combination of factors best explain the variation in simple and complex chains, loops, and trips, is planned for a later analysis.

This report compares the variation in travel behaviors obtained by conventional definitions of individual travelers with the variation derived from social structural concepts. It is hoped that the results of this work will contribute to improvements in the way travel behaviors are measured and the way individuals and their travel-related relationships are described and understood. It may also improve the precision with which personal travel behaviors are explained and predicted, and, in doing so, may assist planners, public officials, and interest groups in evaluating alternate plans for reducing traffic congestion, supporting energy conservation, and reducing motor vehicle emissions to help to attain ambient air quality standards.

The remaining sections of Chapter One outline the approach used to extract data from the NPTS. Conventional demographic predictors are then discussed in Chapter Two, and household structure and role are introduced as significant predictors of travel strategies with supporting rationales from the social science literature on the behavioral significance of social relationships. Recent developments in the measure-

ment of travel behavior are also reviewed. In Chapter Three the structural descriptors of traveler and travel behavior utilized in this study are presented. The results of the analysis follow in Chapter Four, focusing first on profiles of household structure and person role categories, then on trip making behavior of these categories, and finally assessing the relative strength of structural and conventional measures of travel behaviors and person characteristics. Some implications of our findings are discussed in Chapter Five.

1.2 The Nationwide Personal Transportation Survey Data Base

The 1990 Nationwide Personal Transportation Survey (NPTS) is the fourth such survey conducted in the United States. Of the several files included in the NPTS survey, only three are used here - the "household file", the "person file", and the "travel day file." Hereafter, these files will be referred to as the NPTS files. The file generated in conjunction with these data will be referred to as the CSUS file.

Given that each of the NPTS files describes a different unit of analysis (i.e., persons or households), information was compiled for the smallest unit of measure (persons) and then aggregated for the respective households. Put simply, the newly generated data file (the CSUS file) takes the survey respondent as the unit of analysis and appends the respective household information to the information already compiled for each individual. The variables taken from the NPTS files and the new variables developed for the current study are described in Appendices to this report as follows:

- Variables taken directly from the NPTS person file Appendix A
- Variables taken directly from the NPTS household file and matched to the appropriate respondent. Appendix B
- Variables taken directly from the NPTS travel day file (provided for persons) and matched to respondent. Appendix C
- Computed household variables derived by analysis of information provided in the person file for all persons in the respective household (e.g., age of youngest child) Appendix D
- Computed household travel variables derived by aggregating personal travel information for all persons in the household. Appendix E
- Analysis of statistical data on conventional and structural concepts of travelers and travel behavior. Appendix F

The Appendices are not included in this report, but are available upon request from the FHWA Office of Highway Information Management.

The formulation outlined above implies several instances where cases will be eliminated given that the information provided is not complete. In particular, this is the case when not all of the members of a household were surveyed. In such a case it is not possible to determine whether the missing person is someone's spouse, a relative, a dependent adult, or has some other attribute which describes the role of a person who has been included. In short, the base number of valid cases (persons) in the CSUS file is the same as that presented in the NPTS person file minus persons whose households were not completely surveyed.

Counts of households and associated statistics generated from the CSUS file were derived by selecting one person per household and only for households where all persons were surveyed. The total count of households matches those described in the NPTS household file minus those with incomplete person surveys. In some cases, no person surveys were conducted for persons residing in households described by the NPTS household file.

There are 48,385 persons in the 21,707 households included in the 1990 NPTS sample. However 4,658 persons, 9.6% of the persons in the data base, are excluded from this study because trip data was

either not obtained, or was incomplete for these persons. In Table 1.1 these cases are identified as either missing persons or missing variables. The removal of these individuals eliminated their households since household trip data were then incomplete. This resulted in a loss of 4504 households, or 21% of the households in the data base. It also resulted in a loss of 16% of the sample persons when household level variables were analyzed. In other words, the person level analysis includes some individuals who could not be included when the household data were analyzed.

In NPTS weighting factors (or expansion factors) have been provided to expand the data to the entire population of the United States. Consideration was given to adjusting these weighting factors to compensate for the persons and households excluded from this study. However, since the objective of this study is to better understand the relationships between trip making and household structure and person role, and not to predict trip making measures for the entire population, weighting factors were not utilized. It is noted that the missing data occur more frequently for larger households and for households with higher incomes. Thus smaller households and lower income households are slightly over-represented in the useable data set in comparison with the entire data base.

Table 1.1 CASES EXCLUDED FROM STUDY DUE TO MISSING DATA

	<i>Person Level Analysis</i>	<i>Household Structure</i>	
		Households	Persons
Database Total	48,385	21,707	48,385
Person missing	4,197	4,304	7,298
Variable missing	461	200	551
Study Total	43,727	17,203	40,536

Literature Review

2.1 Conventional Demographic Descriptors

A number of economic, demographic, and other factors have been found to influence travel patterns in the United States. Household income is directly related to travel time to work (Wachs, 1987). Using the 1980 Public Use Microdata Sample (PUMS), McLafferty and Preston found that: persons in managerial positions have longer commutes than non-managers; minorities generally face longer commute times than caucasians; and women spend less time commuting than men (McLafferty and Preston, 1991). The reasons for these patterns are less well-established. Commute times for different groups can be influenced by residential choice, the geographic dispersion of jobs and industries, variations in occupational choice, family responsibilities, or transit options in different metropolitan areas. The emphasis on demographic categories (women vs men, minorities vs non-minorities) obscures the increasing diversity in family structure, educational and occupational levels, lifestyles, and economic interdependencies within these groups. Given the possibility of greater diversity within than between these categories, their use in the prediction of other variables, including travel behavior, may result in less precision than utilization of structural variables.

The intersection of economic changes with the alterations in family structure that have taken place primarily in the past twenty years sets the stage for creative new approaches to the analysis of travel behavior. Since 1970, the size of households has decreased 16%, from 3.14 members in 1970 to 2.63 in 1991 (Table 2.1), while the number of household units has increased by almost 50%, from 63.4 million in 1970 to 94.3 million in 1991 (Bureau of the Census, National Data Book, 1992). The increased number of households is due to a number of factors: the coming of age of the baby boom generation; greater longevity, seniors living independently from their children; higher divorce rates; and the postponement of marriage. For example, the proportion of family households headed by women increased from 8.7% in 1970 to 11.9% in 1990, while the proportion of two parent households declined during the same time period from 40% to 26% (Table 2.2).

Table 2.1 AVERAGE HOUSEHOLD SIZE

1960	1970	1980	1990	1991
3.33	3.14	2.94	2.63	2.63

Source: U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 461.

Table 2.2: DISTRIBUTION OF FAMILY AND NON-FAMILY HOUSEHOLDS 1970 - 1991

	1970	1980	1990	1991
Family Households	81.16	73.72	70.80	70.32
Married Couples With Children	40.27	30.90	26.29	25.87
Married Couples Without Children	30.28	29.90	29.76	29.42
Male Without Spouse With Children	0.54	0.76	1.24	1.25
Male Without Spouse Without Children	1.40	1.38	1.85	1.83
Female Without Spouse With Children	4.51	6.74	7.07	7.23
Female Without Spouse Without Children	4.17	4.04	4.60	4.71
Non-Family Households	18.84	26.28	29.20	29.68
Single Persons	17.11	22.65	24.64	25.01
Male Alone	—	8.62	9.70	10.02
Female Alone	—	14.03	14.94	15.00
Other Non-Family Households	—	3.63	4.56	4.67

Source: U.S. Bureau of the Census, Current Population Reports, Series P-20, N. 461.

The structural changes in household composition have occurred in conjunction with significant changes in the participation of women in the labor force, which, in turn, is gradually altering the division of labor within households. Married working females with children in 1990 made up 16.6% of the full-time labor force, compared with 10.2% in 1960 (Table 2.3). Looked at another way, the percentage of women over the age of 25 who were in the labor force has risen considerably between 1960 and 1990, as shown in Table 2.4.

In general, studies are finding that working women retain more of the household responsibilities than their husbands (Firestone and Shelton, 1988), leaving less leisure time for working women with children (7% of a day vs. 12% for their male counterparts) (Fox, 1985). The combination of work, household and childcare duties places a premium on commute time. Existing studies do not indicate to what degree the shorter commute times for women (Fox, 1985) are due to the use of proximity as a factor in job choice, the use of job location as a factor in residential choice, or the occupational distribution of women in the work force.

Using data from the 1988 National Survey of Families and Households, Blair and Lichter (1991) found a complex relationship between a woman's employment and earnings relative to that of her spouse or partner and to the degree of gender segregation in household tasks and the relative number of hours men and women devote to housework each week. A woman's education, employment and earnings increase the man's share of total family labor and decrease the gender segregation of household tasks. A woman's hours of participation in the labor force and the relative difference in both education and earnings between partners are significantly related to task segregation and the proportion of housework done by the man. Blair and Lichter found that employed women who equal or exceed their partner in education and income spend less time in household tasks than unemployed women. The presence and number of children were found to exert pressures in the opposite direction.

2.2 Social Trends and Travel Behavior

Social trends identified in this report include: an increase in the percentage of married couple households in which the wife works outside the home; an increase in the percentage of single parent (predominantly female) families; and increases in both single person households and non-family households. All of these changes can be expected to have an impact on the transportation needs and habits of individuals and households.

Some of the effects of these trends on individual and household behavior have been studied by earlier researchers. In particular the impacts relating to and affecting women in the workforce, and women as

Table 2.3: MARRIED WOMEN WITH CHILDREN AS PERCENT OF TOTAL LABOR FORCE

	1970	1980	1990	1991
Married Women with Children	10.20	13.70	16.50	16.60

Source: Statistical Abstract Table 620 "Women in Labor Force by Marital Status and Presence of Children" based on U.S. Division of Labor Statistics, Bulletin 2307; and unpublished data.

Table 2.4: PROPORTION OF WOMEN IN THE LABOR FORCE BY MARITAL STATUS AND PRESENCE OF CHILDREN

	1960	1970	1980	1990
Married Without Children	30.50	40.80	50.10	58.20
Married With Children	27.60	39.70	54.10	66.30
Single, with & without	44.10	53.00	61.50	66.40
Other	40.00	39.10	44.00	46.80

Source: Statistical Abstract Table 620 "Women in Labor Force by Marital Status and Presence of Children" based on U.S. Division of Labor Statistics, Bulletin 2307; and unpublished data.

making increased steadily with age of the oldest child. However, two parent families generated roughly 50% more trips than single parent families.

Notwithstanding the attractiveness of the lifecycle approach to trip prediction, Zimmerman points out that divergent views exist on appropriate lifecycle categories for transportation. She calls for "Better theoretical justification for the selection of life-cycle stage in travel research than have been made to date" (p55).

In recent work involving household structure and trip chaining, Strathman et al (1992) have defined household types on the basis of work status, presence and age of children, and age of adults for zero worker households only. These household types are shown with their frequency distribution in Table 2.5.

This comprehensive set of household types leaves out only non-family households (unrelated adults) and unmarried related adult households. And, as with lifecycle, several other variables important for analyzing travel behavior are confounded.

Household Type	Percent of Sample
Zero workers, all persons aged 60+	15
Zero workers, some under age 60	14
Single working person	8
Single working person w/child < 6 years	1
Single working person w/child > 5	2
Traditional Couple	16
Traditional Family w/child < 6 years	11
Traditional Family w/child > 5 years	10
Dual income, no children	12
Dual income w/child < 6 years	3
Dual income w/child > 5 years	7
Multiple adult workers	2

Source: Strathman, et al. 1992

2.3 Measuring Travel Behavior

Travel patterns have traditionally been identified in terms of trips that are home-based or non home-based, without regard to relationships between successive trips. However, researchers have found considerable evidence that trip makers frequently chain trips together to accomplish their daily activities. For example, Clark et al (1981) found that 44 to 71 percent of journeys were single stop and the remaining 29 to 56 percent involved some trip chaining.

O'Kelly and Miller (1984) studied the characteristics of multi-stop and multi-purpose non-work travel based on two week travel diaries prepared by residents of Hamilton, Ontario. They compared trip lengths for single stop and multi-stop "tours." Tours were defined as a series of trips starting and ending at home. A single stop tour might be home to grocery shopping to home; a multi stop tour could be home to grocery shopping to grocery shopping (at another location) to home, or home to non-grocery shopping to social/recreational/other to home. They demonstrated that travel times of multi-purpose tours for grocery shopping were typically 40 percent longer than travel times of single stop grocery tours and concluded that "ignoring multi-stop tours will result in serious underestimation of total travel as well as provide a poor conceptual starting point for behavioral modeling efforts."

Kostyniuk and Kitamura (1984) studied urban travel patterns using 1965 and 1980 data from south-east Michigan. They found that travel patterns had changed considerably over this time period but were able to conclude that obligatory and less flexible activities tended to be pursued earlier in the day and before flexible activities. The 1980 data also showed that individuals who made many trips per day were more likely to organize trips into trip chains.

Nishii et al. (1988) looked specifically at trip chaining in the home to work and work to home commute. They hypothesized that the likelihood of undertaking a separate home based trip (or trip chain) to accomplish non-work activities will increase with speed of travel and will decrease with increases in commuting distance, travel cost, and density of opportunities. The analysis was confined to workers who engaged in a single discretionary trip in addition to their work trips. They defined sequences of trips as paths subdivided into multi-chain paths in which the additional activity is pursued in a separate home-based trip chain, and single-chain paths in which the activity is linked to a commuting trip. Data for 1980 from Osaka and Kyoto, Japan, showed that 36.2 percent and 38.7 percent, respectively, of the discretionary trips were attached to the morning or evening commute, 53.5 percent and 42.5 percent were made during work, while 10.3 percent and 18.8 percent were undertaken as a separate home based trip chain. The data used for this study included trips by each household member over five years of age. Commute trip data were not broken down by gender.

In 1989 Goulias et al. developed a method for estimation of trip generation, taking trip chaining into account. Using data from Detroit, they developed regression models in which mandatory trips are a function of income, household structure, and other variables and discretionary trips are a function of mandatory trips and other variables. They found that trip chaining was associated mostly with work, shopping, and personal business trips and very little with school and social/recreational trips.

Using data from an NCHRP project investigating travel characteristics at large scale suburban activity centers in Dallas, Washington, DC and Minneapolis, Chang and Lin (1992) looked for clusters in the travel data. They clustered the data based on the frequency of stops in the commute trip and found that trip chaining on the commute trip is higher in large households with a large number of children and in households with a low number of available vehicles; but a very short or very long commute diminishes the degree to which trips are chained. Small households living very close to work and small suburban households with a short commute exhibited a low propensity for trip chaining on the commute.

Using two week diaries of commuters in Austin, Texas, Hatcher and Mahmassani (1992) investigated the variability in the evening commute. They compared "day-to-day" patterns with patterns which "deviate from normal." They found that about 39 percent of evening commute trips included at least one intermediate stop and 11 percent had two or more stops. Only about 5 percent of commuters made stops in their evening commute every day. At the other extreme, 14 percent did not stop on any of the days in the survey. The researchers separated stops into routine and non routine, defining routine as stops at the same location made at least 3 times per week. Using this definition they found that 15.9 percent of the stops were routine. 9.7 percent of the commuters had at least one routine stop. 62.6 percent of the routine stops were to serve passengers.

In 1992 Strathman et al. conducted a study of the effect of travel conditions and household structure on trip chaining, using data for weekday travel in Portland, Oregon. Trip making was described by simple and complex chains. All chains began and ended at home; data which did not fit into this category were discarded. A simple chain was a home to home circuit with one stop coded by purpose (work, school, shop, social/recreational, personal business, serve passenger, other). A complex chain had two or more stops, each coded by purpose as listed above. The sample of 2718 households consisted of 3443 persons aged 5 and older. In the 24 hour period of the survey, 19112 trips were made, organized into 7,967 chains starting and ending at home. Simple chains made up 76.1 percent of the total and complex chains 23.9 percent. Work chains constituted about one third of all chains; about 80 percent of work chains were simple chains. The number of daily trip chains per household ranged from 0.5 (for single working persons) to 2.5 for persons living in multiple adult worker households.

In their analysis Strathman et al. examined the propensity for trip chaining and the tendency to incorporate non-work trips into the commute trip chain or into separate non-work trip chains. They found that single working adults with preschool children had the highest propensity to form complex commute trip

chains. This group was followed (but not closely) by single persons, single persons with school-age children, dual income couples and dual income couples with preschoolers. At the low end in propensity to form complex commute chains were traditional couples, multiple workers, traditional couples with preschoolers, and dual income families with school age children.

The traditional couple and traditional couple with preschoolers tended to incorporate non-work trips into complex non-work chains, while dual income couples with preschoolers and people living in multiple worker households incorporated more of these trips into complex work commutes. Single persons, single persons with children, and dual income couples incorporated these trips into both complex commute chains and complex non-work chains; however single persons and dual income couples favored the complex commute chain. Dual income couples with school age children incorporated few trips into complex chains.

In addition to the effects of household structure on trip chaining, Strathman *et al.* investigated the effects of driving alone to work, living in the suburbs, working in the CBD, working in the suburbs, number of vehicles in the household, distance to work, congestion, total number of non-work trips, high income and low income on the tendency to incorporate non-work trips into complex work chains or into complex non-work chains. Driving alone to work was the only variable with effects of the same order of magnitude as household structure and, as expected, this encouraged incorporation of more trips into complex commute chains than into complex non-work chains. The researchers concluded that household structure has an important influence on the formation of complex commute chains and that the rapid growth of households of the type which tend to form complex commute chains has contributed to the high rate of growth of peak period traffic.

2.4 Summary

The literature reviewed above suggests that structural concepts for categorizing travelers and for measuring travel behavior are receiving a lot of attention. Attempts to develop and apply a structural method for analyzing travel behavior have been undertaken for many of the same reasons expressed in this report. However, development of structural concepts and measures are still at an early stage in their development. In particular, categories of traveler are less fully developed and utilized than are measures of travel behavior based on trip chain concepts. Clearly, there is a recognized need to continue this line of research.

Methodology

3.1 Descriptors of Travelers

Travel surveyed in the 1990 NPTS is examined at the household level and at the person level in this report. Household level travel is described for different household structures, and person level travel is described for persons' roles within households. Altogether, travel behavior for 12 household structures and 12 person roles is described.

Several special terms are used in this report. A "reference person" is either the homeowner or the person who pays the rent. One reference person is identified for each household. Other terms include "independent adult" and "dependent." Status as an independent or dependent adult depends on whether a person has a significant degree of economic independence relative to other persons in the household. All persons under 18 years of age were classified as dependents, as were all children of the reference person up to 35 years of age. Most persons classified as independent were those who were reportedly in the labor force (working or looking for work) or retired. All reference persons were also classified as independent, regardless of age. Reference persons may not be working and may derive income from welfare, a working spouse, or some other source. However, the fact that they "pay the rent" suggests that they enjoy some degree of independence within the household. Independent adults were further subdivided by relationship to other household members and presence of dependent persons in the household. Classification of household members into dependent or independent status is shown in Table 3.1.

Table 3.1: CLASSIFICATION OF DEPENDENT AND INDEPENDENT PERSONS

Relationship	Age				
	0-15 years	16-17 years	18-21 years	22-35 years	36 or older
Reference Person	Independent	Independent	Independent	Independent	Independent
Child of Reference Person	Dependent	Dependent	Dependent	Dependent	Mixed*
Spouse of Reference Person	Dependent	Mixed*	Mixed*	Mixed*	Mixed*
Other Relative of Reference Person	Dependent	Mixed*	Mixed*	Mixed*	Mixed*
No Relation to Reference Person	Dependent	Mixed*	Mixed*	Mixed*	Mixed*

* Classified as independent only if main occupation was reported as working, looking for work, or retired.

Household Level

Household structures were defined by the relationship of household members to the reference person and the absence or presence of other independent adults or dependents. The twelve household structure types capture the "traditional" married couple and the traditional nuclear family, as well as household types that have proliferated in recent decades. Other household types include two income married couples, two income families, single person households, single parent families, non family households with two independent adults (with and without children or other dependents), and households with 3 or more independent adults (with and without children or other dependents). Two unmarried independent adult households have been further subdivided into related and unrelated individuals. Households with three or more independent adults may or may not be related, and may or may not include a married couple. (Table 3.2)

Table 3.2: HOUSEHOLD STRUCTURE DEFINITIONS

*Household with no dependent persons***

Single adult	A single person
Two unrelated adults	Two independent persons*, not related to each other.
Two related adults	Two independent persons, related to each other.
Two independent adult married couple	Two independent persons, married to each other, no other persons in the household
Single independent adult married couple	Two independent persons, married to each other, no other persons in the household
More than two adults	Three or more independent persons irrespective of their relationships.

Households with dependents

Single adult	A single person with children and/or dependent adult(s)
Two unrelated adults	Two independent adults, not related to each other, with children and/or dependent adults, and no other independent adult(s)
Two related adults	Two independent adults, related to each other, with children and/or dependent adult(s)
Two independent adult married couple	Two independent persons, married to each other, with children and/or dependent adults, and no other independent adult(s).
Single independent adult married couple	Two independent persons, married to each other, with children and/or dependent adults, and no other independent adult(s).
More than two adults	Three or more independent adults irrespective of their relationship and with/without children and/or dependent adult(s)

* "Independent persons" include:

1. All household reference persons regardless of age
2. All adults (not children) unrelated to the reference person
3. Adults *** who answered yes to the worker question or who answered the question what were you doing most of last week by: working; looking for work; retired; or with job but unable to work.

** "Dependent persons" include:

1. Adults*** do not fit the independent status as defined above: i.e. answered no to the worker question and who answered the question what were you doing most of last week by: keeping house, unable to work, going to school
2. Children aged 0 to 17

*** "Adults" are:

1. All persons over 35
2. Persons over 21 who are not the child of the reference person
3. Persons 18 or over who are not related in any way to the reference person

Person Level

Person roles defined for the person level analysis were also determined with respect to the relationship of household members to the reference person and the absence or presence of other independent adults or dependents. Role specification was constrained to some degree by the data set. In the data file, a person's relationship to the household reference person is given, but relationships among other members of the household cannot always be inferred from this data. For example, if an independent adult is the spouse, sister, brother, or child of a household member other than the reference person, they are classified as an unrelated adult (see Appendix D). The person roles are defined in Table 3.3.

3.2 Travel Descriptors

Travel descriptors include conventional variables and new variables based on trip chaining concepts. Both conventional and new travel variables are derived from the concept of trip, which is defined as uninterrupted travel from one place to another by any transportation mode. All travel variables are daily mean values. Because of the large number of variables in this study, conventional travel variables are restricted to person trips, person miles of travel, and average person trip distance. Conventional variables used are:

Household Level

Mean number of household person trips

Mean household travel distance

Mean distance per person trip

Person Level

Mean number of person trips

Mean travel distance per person

Mean distance per person trip

Trip chains and loops are defined in this report to reflect trip chaining concepts. A trip chain is a sequence of trips which begin and end at a travel anchor. Travel anchors are trip origins or destinations that are relatively fixed in terms of where they are located and when travel between them must be taken. Home, school, and work have been designated as travel anchors; trips to and from school and work are generally constrained to specific days and times of day; home is included as an anchor because daily travel typically begins and ends at home. A loop is defined as a sequence of trips which begin and end at home. Loops may consist of two or more chains. Chains are subdivided into simple and complex chains. A simple chain may contain one or two trips. Simple chains between home and school or work contain one trip; simple chains between home and home, between school and school, or between work and work contain two trips. Complex chains between home and work or school contain two or more trips, complex chains between home and home, school and school, or work and work contain three or more trips. Some examples of loops and chains are:

Loops

- Home - work - home
- Home - work - shop - home
- Home - dinner - shop - home
- Home - personal business - lunch - shop - home

Simple Chains

- Home - work
- School - work
- School - home
- Home - shop - home
- Work - lunch - work
- Work - work related business - work

Complex Chains

- Home - shop - personal business - home
- Home - personal business - school
- Home - serve passengers - personal business - work
- Work - social - personal business - work

The new travel descriptors used in this study are:

Household Level

- Mean number of household person loops
- Mean number of trips per loop
- Mean number of complex chains per loop

Person Level

- Mean number of person loops
- Mean number of trips per loop
- Mean number of complex chains per loop

Analysis of loops and chains was done on a subset of the data used for analysis with conventional trip making variables. The subset consists of 12,982 households and 29,213 persons and includes only those households in which there were no incomplete loops. Further information about the construction of travel pattern descriptor variables can be found in Appendix E.

Table 3.3: PERSON ROLE DEFINITIONS

Dependents

Child 5-15	Any child aged 5-15 (regardless of relationship to reference person).
Child 16-21	Any child aged 16 or 17; a 18 to 21 year old dependent person** or child of reference person.
Adult 22-35	A 22-35 year old dependent person** or child of reference person.
Adult > 35	A dependent person over 35.

Adults with no Dependents

Single	An independent person* living alone.
Unrelated	One or more independent persons in a household where no one is related to the reference person.
Related	One or more independent persons in a household where others are related but not married to the reference person.
Married	An independent married person, living with spouse.

Adults with Dependents

Single	An independent person living with related dependents.
Unrelated	One or more independent persons, in a household with dependents where no independent person is related to the reference person.
Related	One or more independent persons in a household with dependents where other independent persons are related but not married to the reference person.
Married	An independent married person, living with spouse and dependents.

* "Independent persons" include:

1. All household reference persons regardless of age
2. All adults (not children) unrelated to the reference person
3. Adults *** who answered yes to the worker question or who answered the question what were you doing most of last week by: working; looking for work; retired; or with job but unable to work.

** "Dependent persons" include:

1. Adults*** who do not fit the independent status as defined above i.e. those who answered no to the worker question and who answered the question what were you doing most of last week by: keeping house, unable to work, going to school
2. Children aged 0 to 17.

*** "Adults" are:

1. All persons over 35
2. Persons over 21 who are not the child of the reference person
3. Persons 18 or over who are not related in any way to the reference person

Results

Figures and tables in this Section are based on statistical information presented in Appendix F. Complete data are included in Appendix F. In the cross tabulations some cells have very low frequencies. These data have not been used in the analysis. For the household structure and person role groups the lowest frequencies are 144 and 526 respectively and occur for related households with dependents and independent persons living in unrelated households with dependents.

Household structures are identified in figures and tables using the following symbols:

Households with no dependents

- H1 Single independent adult
- H2 Two unrelated independent adults
- H3 Two related independent adults
- H4 Two independent married adults
- H5 One independent adult married couple
- H6 Three or more independent adults

Households with dependents

- H7 Single independent adult
- H8 Two unrelated independent adults
- H9 Two related independent adults
- H10 Two independent married adults
- H11 One independent adult married couple
- H12 Three or more independent adults

Person roles are identified as follows:

Dependents

- D1 Child ages 5 to 15
- D2 Dependent person aged 16 to 21
- D3 Dependent adult aged 22 to 35
- D4 Dependent adult over 35 years of age

Independent adults without dependents

- A1 Single independent adult
- A2 Independent adult living with an unrelated independent adult
- A3 Independent adult living with a related independent adult
- A4 Married Independent adult living with spouse

Independent adults living with dependents

- AD1 Single independent adult
- AD2 Independent adult living with an unrelated independent adult
- AD3 Independent adult living with a related independent adult
- AD4 Married independent adult living with spouse

Some of the persons classified as dependents are working. This occurs in group D2 and D3 because all persons under 18 years and all children of the reference person to age 35 years are classified as dependents, regardless of their work status. Furthermore, some independent adults do not have a “worker,” “looking for work,” or “retired” work status. This may happen when the reference person, who is always an independent adult, has another work status, such as “student” or “keeping house.” For example, a one independent adult married household could contain no “workers” or “homemakers” if the reference person’s work status is “student” and the other adult has a dependent status. And a two independent adult married household there might have only one “worker,” and there may or may not be a “homemaker” in the household.

4.1 Household Structure and Person Role: Distributions and Profiles

As seen in Table 4.1.1, the single adult household without dependents is the largest category (25% of households), followed by the two independent adult married couple with dependents (23%) and the two independent adult married couple without dependents (19%). The single adult household with dependents is the next largest group (9%), and the one independent adult married couple with dependents is about the same size (8%). The remaining seven household categories each constitute 1% to 5% of the total number of households in the data set.

The distribution of persons in households (Figure 4.1.1) shows that more persons live in two independent adult married couple households with dependents (33% of all persons), followed by persons living in two independent adult married couple households without dependents (16%), persons living in one independent adult married couple households with dependents (12%), single persons without dependents (11%), and persons living in single adult households with dependents (9%). Persons living in each of the remaining 7 household categories make up 1% to 4% of all persons in the data set.

Distribution of persons by person role is presented in Figure 4.1.2. As seen in this figure, 37.6% of persons are dependents, including 19.6% under the age of 16. Of the independent adults, 21.3% are found in married couple households with dependents, and 17% are in married couple households without dependents. Single independent adults with and without dependents constitute 3.4% and 9.8%, respectively, of independent adults. The remaining four independent adult person roles each constitute less than 4% of independent persons.

In the following summaries, key findings are discussed for household structure groups in the following order:

- Single Adult Households without Dependents (H1)
- One and Two Independent Adult Married Households without Dependents (H5 and H4)
- One and Two Independent Adult Married Households with Dependents (H11 and H10)
- Single Adults with Dependents (H7)
- Households with two Related Person, with and without Dependents (H9 and H3)
- Households with two Unrelated Person, with and without Dependents (H8 and H2)
- Households with three or more Independent Adults, with and without Dependents (H12 and H6)

Single Adult Households without Dependents (H1)

For this household category, which constitutes 25% of all households and contains 10.6% of all persons, person role and household structure are synonymous. This group consists mostly of lower income households, as expected for a household size of one. Figure 4.1.3 shows that fifty four percent (54%) of these households have incomes less than \$20,000 and only 12.7% have income over \$40,000. Automobile

Table 4.1.1: HOUSEHOLD STRUCTURE DISTRIBUTION FOR NPTS SAMPLE

Household Structure	Households (percent)	Persons in Households (percent)	Mean Household Size
Households with no dependents			
Single adult (H1)	25.0	10.6	1.00
Two unrelated adults (H2)	3.2	2.8	2.00
Two related adults (H3)	1.8	1.6	2.00
Two independent married couple (H4)	19.4	16.4	2.00
One independent married couple (H5)	4.7	4.0	2.00
More than two adults (H6)	2.1	2.8	3.15
Households with dependents			
Single adult (H7)	8.6	9.1	2.50
Two unrelated adults (H8)	1.3	1.9	3.31
Two related adults (H9)	1.0	1.6	3.59
Two independent married couple (H10)	22.6	33.1	3.45
One independent married couple (H11)	8.2	12.0	3.47
More than two adults (H12)	2.0	4.2	4.83
	<u>100.0</u>	<u>100.0</u>	<u>2.36</u>
Study Totals	17203	40536	

ownership in these households is low, (Figure 4.1.4) with 22.3% having no vehicle. Not surprisingly, this category had the highest percentage (12.1%) making none of their trips by private vehicle (Table 4.1.2.). As seen in Figure 4.1.5, persons living in this household category are predominantly female (62.2%). Figure 4.1.6 shows that although the largest proportion of persons in this group are working (47.5%), a large proportion are retired (34.6%).

One and Two Independent Adult Married Households without Dependents (H5 & H4)

Married households without dependents consist only of two adults. These household categories make up 4.7% and 19.4% of all households, respectively. Together they account for 20.4% of all persons. Income levels are distributed across the spectrum (but weighted towards the high end for two independent adult married couples). Of these households, 33.1 % and 20.9% have incomes below \$20,000, and 32.5% and 43.4% have incomes over \$40,000 (Figure 4.1.3). Automobile ownership in these households is high, with 67.3% and 75.0%, respectively, having two or more vehicles (Figure 4.1.4). As seen in Figure 4.1.7, a high percentage (33.9%) of the independent adults in these households are retired, while a very small percentage (less than 1%) are students or student/workers.

Figure 4.1.1 Distribution of Households and Persons

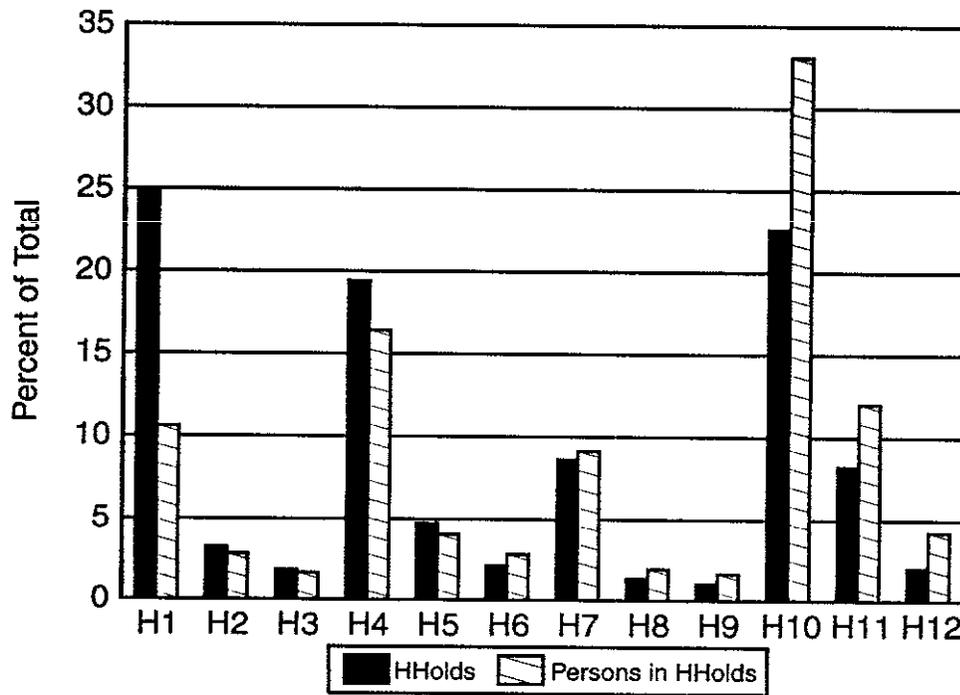


Figure 4.1.2 Distribution of Person Roles

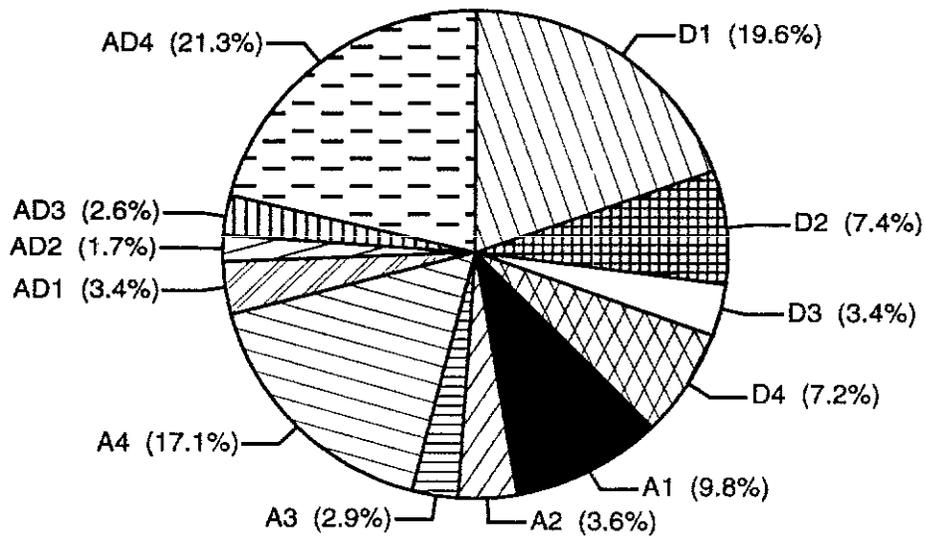


Figure 4.1.3 Distribution of Households by Income

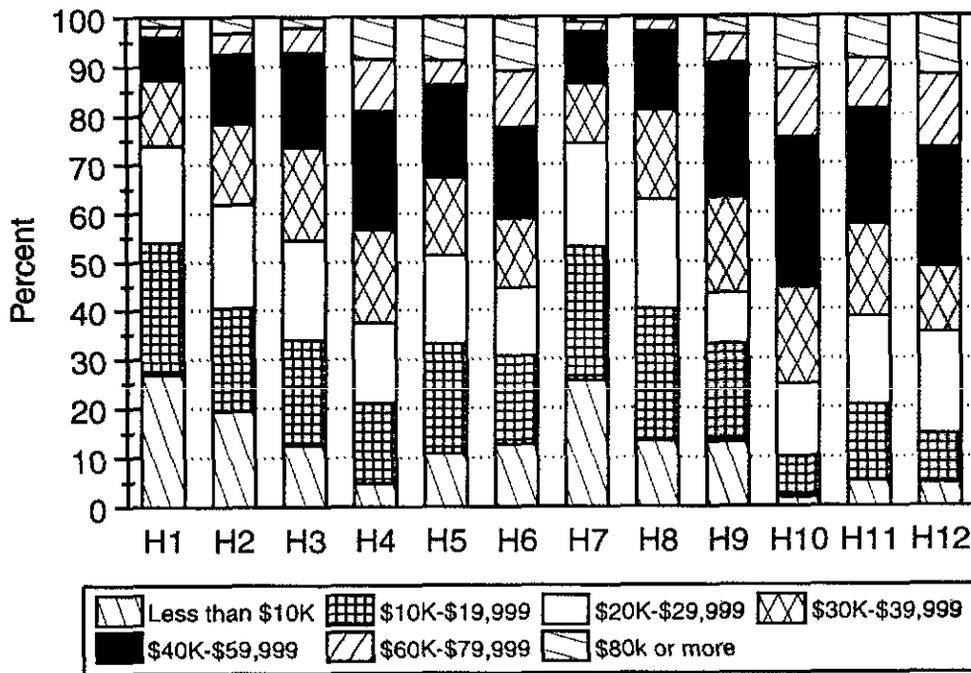


Figure 4.1.4 Distribution of Households by Number of Vehicles Owned

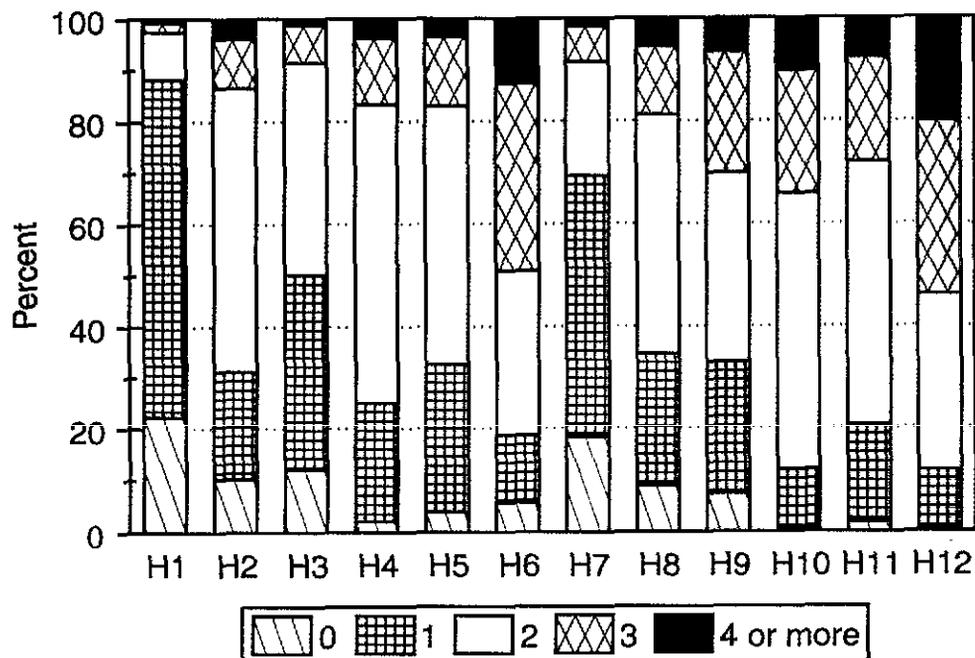


Table 4.1.2: RELIANCE ON PRIVATE VEHICLE MODE BY HOUSEHOLD TYPE

Share of Trips	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12
None	12.1	7.1	8.8	2.4	3.9	4.9	11.0	5.5	12.1	1.4	2.7	2.6
Some	3.8	7.1	5.1	2.1	2.9	6.1	11.6	7.8	8.7	6.2	7.2	10.5
Most	4.5	12.9	7.3	7.6	7.2	16.0	21.7	28.6	22.5	30.6	26.5	34.5
All	79.6	72.9	78.8	87.9	86.0	73.0	55.7	58.1	56.6	61.7	63.6	52.3

One and Two Independent Adult Married Households with Dependents (H11 & H10)

These married households with dependents make up 30.8% of all households (8.2% and 22.6%, respectively), and together account for 45.1% of all persons. These households consist of two adults with dependents of various ages. Average household size is 3.47 and 3.45 persons, respectively (see Table 4.1.1). Income levels are high, with only 20.5% and 10.2% having incomes below \$20,000, and 55.4% and 42.4% having incomes over \$40,000 (Figure 4.1.3). As seen in Figure 4.1.4, 79.8% and 88.1% of these households have two or more vehicles.

Figure 4.1.17 shows that 71.2% of all persons in the one independent adult household category are dependents (29.4% are non working spouses). In the two independent adult households, 42.1% of persons are dependents (Figure 4.1.18). Respectively, 29.1% and 28.6% of the persons in these households are under 16 years of age. Less than 1% of the dependents are over 35 years of age. Children aged 16 to 21 make up 8.3% and 9.3% of persons, respectively, and dependent adults aged 22 to 35 are only 4.3% and 3.7% of persons in these households.

As seen in Figure 4.1.8, workers make up 87.6% of the independent adults in married households with dependents. Only 3.1% of the independent adults in these households are retired, less than 1% are students or student workers, and 6.2% are homemakers.

Single Adults with Dependents (H7)

This household category makes up 8.6% of all households and accounts for 9.1% of all persons (Figure 4.1.1). As seen in Figure 4.1.3, income is relatively low, with 53.05% of these households having income below \$20,000 and only 13.4% having income over \$40,000. Of the households in this category, 18.3% do not own a vehicle (Figure 4.1.4). Consequently, 11% of the respondents made none of their trips by private vehicle and only 55.7% of respondents made all their trips by private vehicle, one of the lowest rates for all households (Table 4.1.2). As seen in Figure 4.1.5, independent adults living in these households (role AD1) are predominantly female (84.7%).

Figure 4.1.19 shows that dependents make up 60% of the persons living in these households. Of the persons in these households, 33.1% are under 16 years of age and 3.6% are over 35 years old. Children aged 16 to 21 make up 14.1% of the persons in these households. This group has the largest percentage of young adults, aged 21 to 35, (9.1%).

As seen in Figure 4.1.9, workers make up 68.8% of the independent adults in this category, 5.6% are retired, 3.5% are students or student workers, and 16.5% are homemakers. These homemakers have been classified as independent because they are the household reference persons.

Figure 4.1.5 Gender Distribution by Person Role

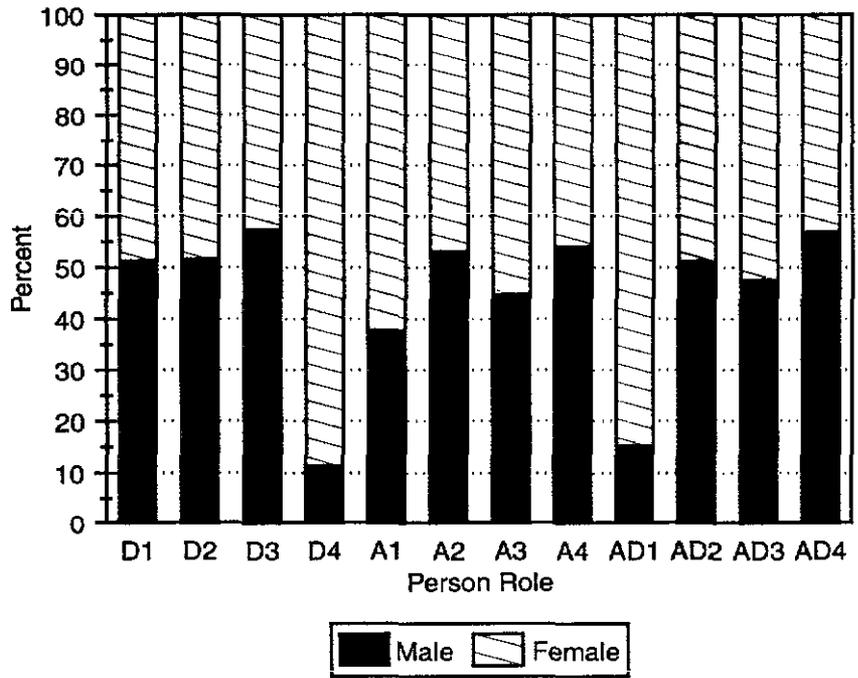
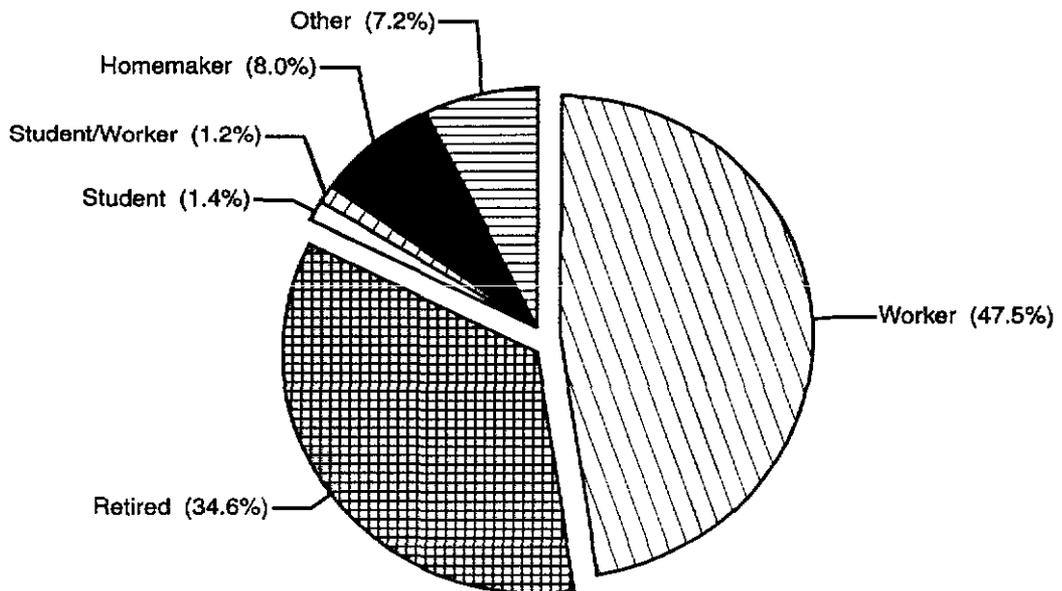


Figure 4.1.6 Work Status of Single Adult Households without Dependents



Households of Two Independent Related Adults, with and without Dependents (H9 & H3)

Related adult households with or without dependents together make up only 3.1% of all households and account for only 3.5% of all persons (Figure 4.1.1). Incomes are distributed across the spectrum with 33.0% and 34.0%, respectively, having household income below \$20,000, and 36.9% and 26.5% have incomes greater than \$40,000 (Figure 4.1.3). Mean household size is two persons for these households without dependents; for these households with dependents the mean is 3.59, slightly larger than married couple households with dependents (Table 4.1.1). As seen in figure 4.1.5, over 50% of the independent persons in these households (role A3 and AD3) are female (52.5% and 55.2% respectively).

As seen in Figure 4.1.20, 44.2% of persons in related person households with dependents are dependents. This is a little higher than the corresponding percentage for married households. Only 18.2% of persons in these households are 5 to 15 years of age, and 10% (the highest for all household groups) are over 35 years of age. Dependents aged 16 to 21 make up 12% of all persons, and 4% are young adults 22 to 35 years old. Independent adults make up 55.8% of the persons in this household category.

The work status profile for two related adults with dependents (shown in Figure 4.1.10) is unlike that of married couple households with dependents. Of persons in related adult roles, 17.6% are retired, 69.2% are working, 3.8% are students or student workers, and 4.4% are homemakers. Both retirees and students are more highly represented in related adult households than in married households.

Figure 4.1.11 shows work status for independent adults in these households without dependents. The percentage of retirees is large (33.2%) and similar to the percentage of retirees in married person households without dependents. Workers make up 57.1% of persons in this household group. The work status profile is similar to that of married persons without dependents except for larger percentages of students (1.2%) and student/workers (1.4%).

Households of Two Independent Unrelated Adults, with and without Dependents (H8 & H2)

Unrelated adult households collectively make up 4.5% of all households and account for 4.7% of all persons (Figure 4.1.1). Incomes are distributed across the spectrum but weighted toward the lower end. Of these households, 40.2% with dependents and 40.5% without dependents have household income below \$20,000 and 18.9% and 21.5%, respectively, have incomes greater than \$40,000 (Figure 4.1.3). Mean household size for households without dependents is 2; for these households with dependents mean size is 3.31, which is slightly smaller than households of married couples with dependents (Table 4.1.1). Among independent adults in these households (AD2 and A2), the percentage of females is 48.9% and 46.8% (Figure 4.1.5), respectively, in contrast with percentages above 50% for the comparable related person households.

As seen in Figure 4.1.21, in unrelated person households with dependents, dependents make up 39.6% of persons. Only 1.1% are dependent adults over 35 years, in contrast with 10% for related households with dependents. This household category has a large percentage of persons 5 to 15 years of age (28.6%), and, except for a smaller percentage of dependent adults aged 22 to 35 (1.9%), resembles the comparable two independent adult married couple households.

Figure 4.1.21 shows that 60.3% of the persons in the unrelated adult with dependents household category are independent adults. Of these independent adults, 4.3% are retired, 74.7% are working, 3.3% are students or student workers, and 12.2% are homemakers (Figure 4.1.22). The work status profile for adults in these households is closer to that of married couples with dependents than the households of related adults with dependents.

As seen in Figure 4.1.13, the percentage of retirees in unrelated adult households without dependents is also very small (4.1%), while the percentage of students and student workers is relatively large (15.5%). This gives unrelated households without dependents a work status profile unlike any of the other household categories without dependents.

Households with Three or more Independent Adults, with and without Dependents (H12 & H6)

These households respectively make up 2.0% and 2.1% of all households and account for 4.2% and 2.8% of all persons. The mean household sizes are 4.83 and 3.15 persons (Table 4.1.1). Household incomes are high, with 14.6% and 30.7% below \$20,000 and 51.4% and 41.2% above \$40,000 (Figure 4.1.3). Respectively, 88.3% and 81.4% of these households own 2 or more vehicles (Figure 4.1.4).

As seen in Figure 4.1.22, dependents make up 38.3% of persons in 3+ independent adult households with dependents. Dependents under 16 years of age make up 17.9% of all persons. Dependents over 35 years are a large group in this household category (7%); another 9.6% are 16 to 21 years old, and 3.7% are dependent adults ages 22 to 35. Of persons in these households with dependents, 61.7% are independent adults (Figure 4.1.19); 44.5% of the persons in these households are related adults, while 17.2% are unrelated adults.

Profile of Dependents

Dependents make up 37.6% of all persons in the data base; the largest group of dependents are those under 16 years of age (Figure 4.1.2). Figure 4.1.5 shows the gender distribution of dependents. Of dependents up to the age of 15, slightly more than 50% are male. Dependents between 16 and 21 years of age are 51.6% males, and 57.4% of dependent adults aged 21 to 35 are males. However, only 11.5% of the dependent adults over 35 are male. Dependent adults over 35 include spouses who are not in the labor force or retired, which significantly increases the percentage of females in this group.

Figures 4.1.14 to 4.1.16 show the work status distribution for dependents 16 to 35 years of age. Persons ages 16 to 35 who were identified as children of the reference person have been classified as dependents regardless of their work status. Thus some of these dependents are workers. For the 16 to 21 year old age group, 36.2% are workers, 32.5% are students, and 16.1% are student workers; a small percentage identified themselves as homemakers (5.9%). Of dependents in the 22 to 35 age group, 75% are workers, 9.1% are students or student/workers, and 6.6% are homemakers. Of the dependent adults over 35 years old, most (76.8%) are homemakers, 4.2% are students, and a large percentage have an unidentified work-status (19%).

Gender Differences

As data in Figure 4.1.5 show, 84.7% of the independent single adults with dependents (AD1) are female, while 62.2% of single adults without dependents (A1) are female. Nearly 90% of the dependents over 35 years of age are female, which is not surprising given the large proportion of homemakers in this role. Closely associated with the disproportionate distribution of females into the D4 role is the distribution 54.1% and 56.9% of males into the independent married adults with and without dependents (A4 and AD4). The respective percentages for related independent adults, with and without dependents (AD3 and A3) are 55.2% and 52.5% female. Unrelated independent adult roles (A2 and AD2) have only slightly more males than females.

Work Status Differences

A high percentage of persons living in households with no dependents were found to be retired persons. As seen earlier, the percentage of retired persons ranged from 33.2% in households of related adults (Figure 4.1.11), to 33.9% for married households (Figure 4.1.7), to 34.6% in single adult households (Figure 4.1.6). However, Figure 4.1.13 shows there is a very small percentage of retired persons (4.1%) in households consisting of unrelated adults. In general, a low percentage of independent adults living in households with dependents were found to be retired persons. For single persons (Figure 4.1.19), unrelated adults (Figure 4.1.21), and married adults with dependents (Figure 4.1.18), the percentage ranges from 3.1% to 5.6%. But in households of related adults with dependents, 17.6% of the independent persons are retired persons (Figure 4.1.10).

Differences in Age of Youngest Child

Data for age of youngest child for households with dependents are found in Table 4.1.3. Married adult households and households with two unrelated adults have the largest percentages for youngest child under 5 years of age (36.2% to 44.4%); two related adult households have the lowest percentage (16.2%). One and two independent married adult households and two unrelated adult households are similar in that 18 to 20% of these households have the youngest dependent aged 16 or more years; and less than 1.5% have youngest dependent over 35. On the other hand, 33.4% of single adult households have the youngest dependent aged 16 or more years and 5.2% have youngest dependent over 35. In two related adult households the corresponding percentages are 48% and 20.1%. Thus a smaller percentage of single adult households and related adult households have children who may be dependent on adults for transportation because of their age.

Table 4.1.3: DISTRIBUTION OF YOUNGEST DEPENDENT BY HOUSEHOLD TYPE

AGE	H7	H8	H9	H10	H11	H12
0-4 yrs	23.9	41.2	16.2	36.2	44.4	27.7
5-15 yrs	42.8	40.8	35.8	43.8	37.3	40.3
16-21 yrs	16.1	13.6	22.3	12.9	10.0	18.0
22-35 yrs	12.1	3.1	5.6	6.6	7.5	8.9
36+ yrs	5.2	1.3	20.1	0.5	0.9	5.1

Figure 4.1.7 Work Status of Married Adult Households without Dependents

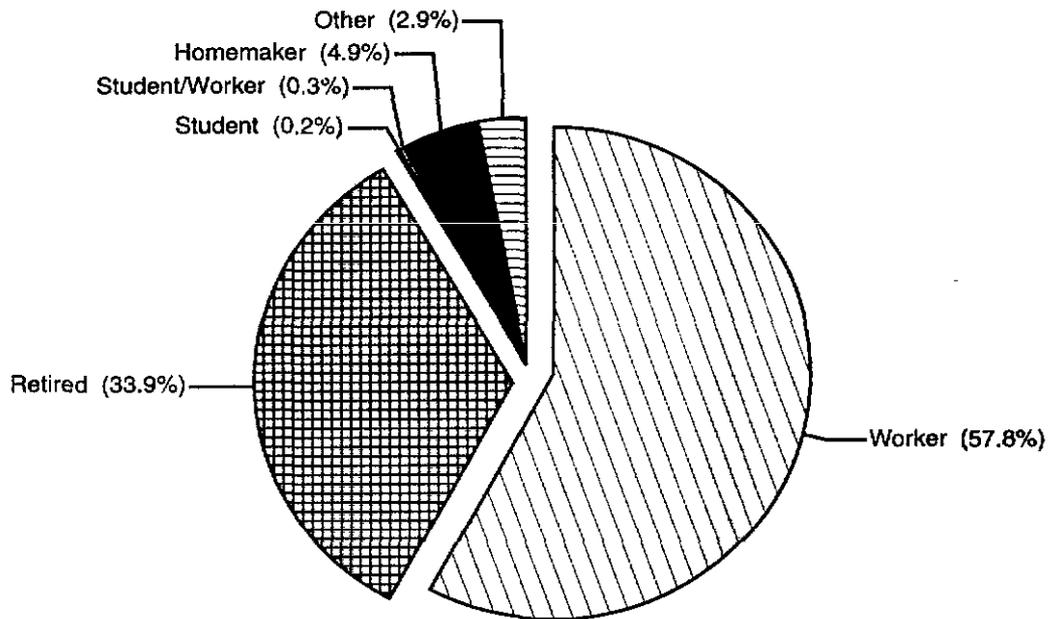


Figure 4.1.8 Work Status of Married Adult Households with Dependents

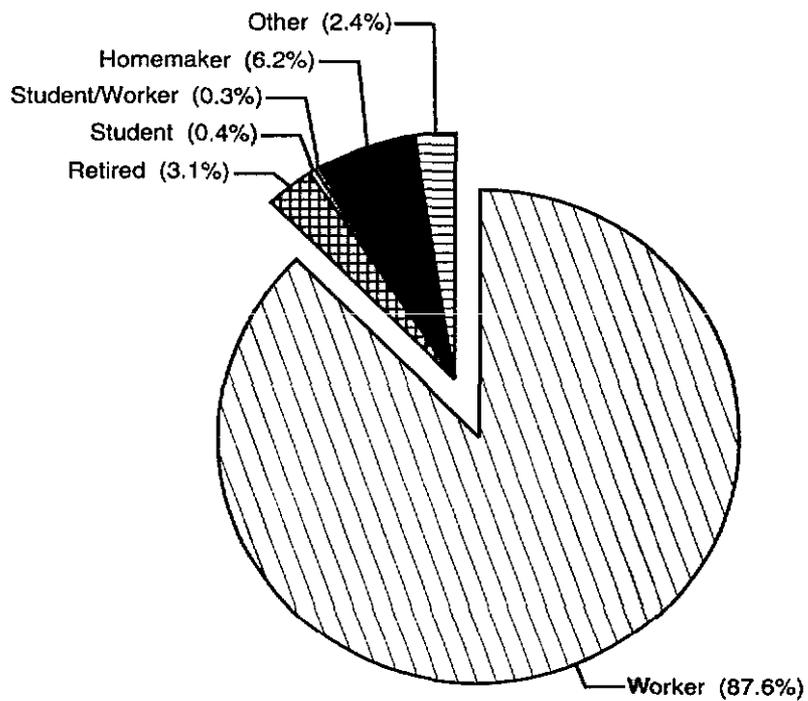


Figure 4.1.9 Work Status of Single Adult Households with Dependents

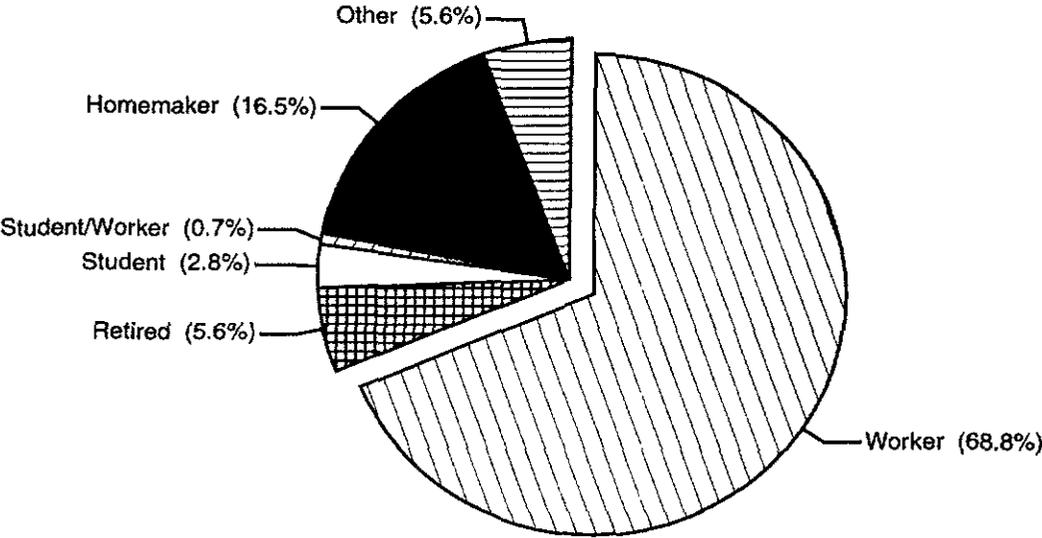


Figure 4.1.10 Work Status of Related Adult Households with Dependents

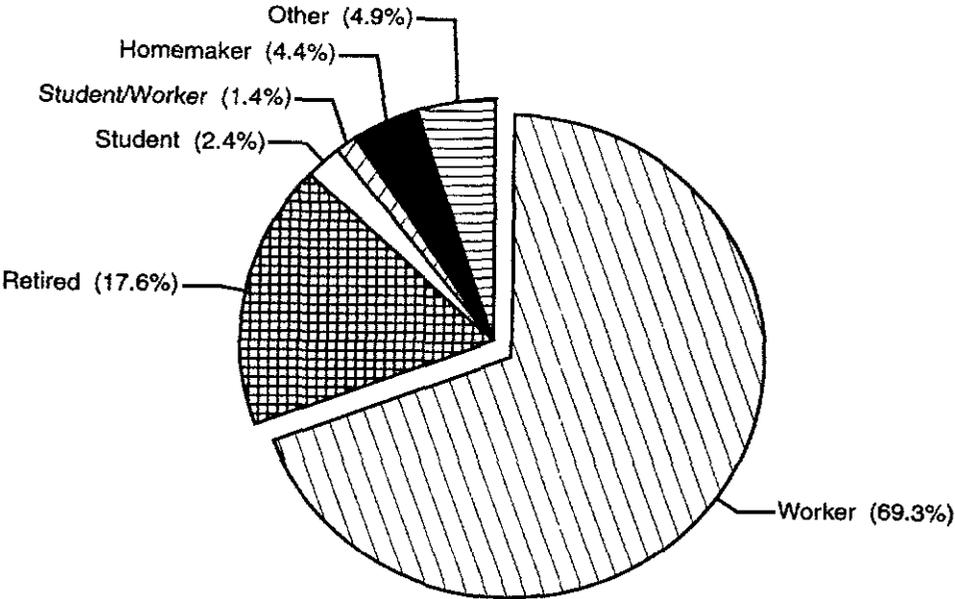


Figure 4.1.11 Work Status of Related Adult Households without Dependents

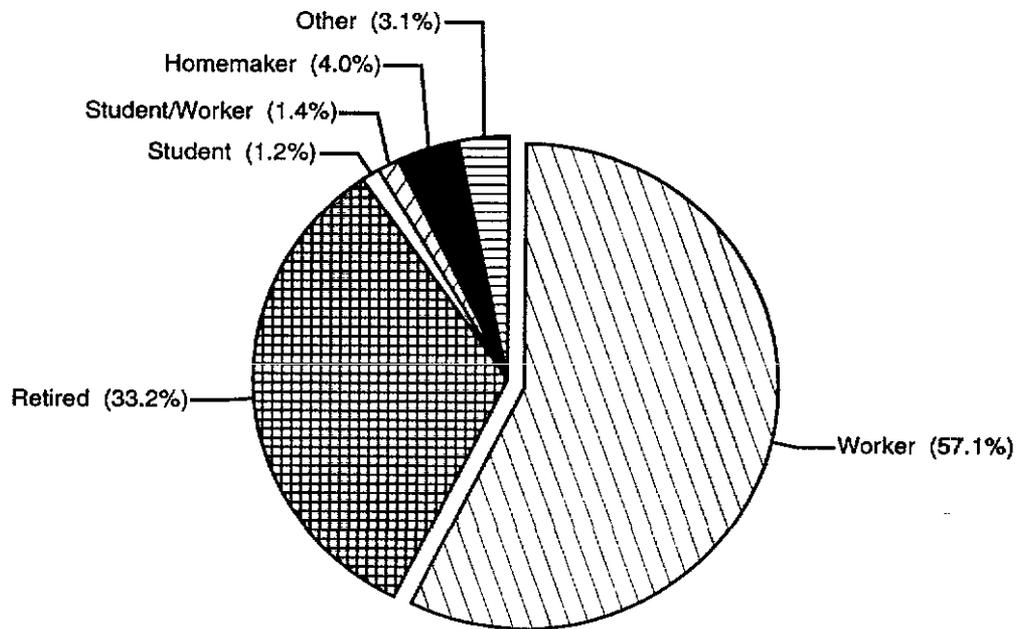


Figure 4.1.12 Work Status of Unrelated Adult Households with Dependents

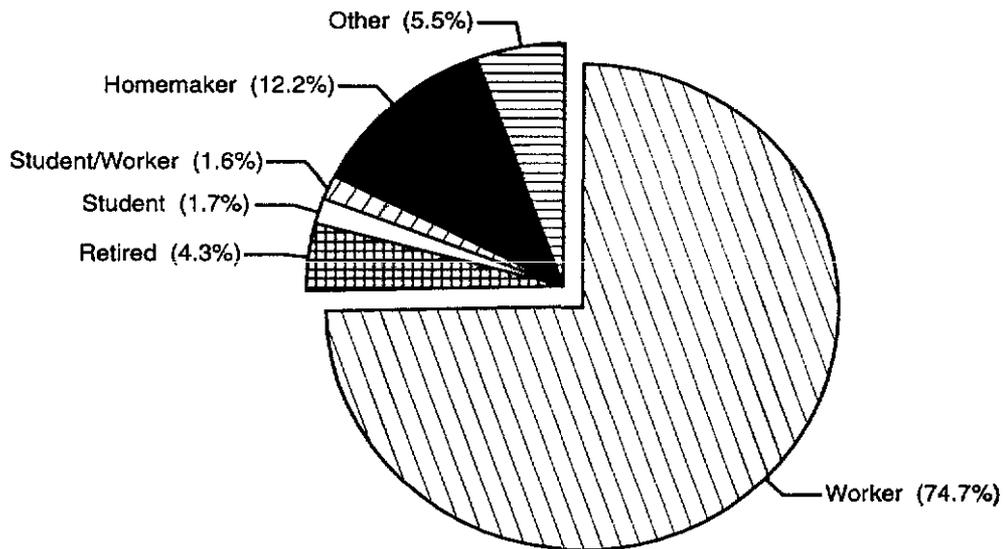


Figure 4.1.13 Work Status of Unrelated Adult Households without Dependents

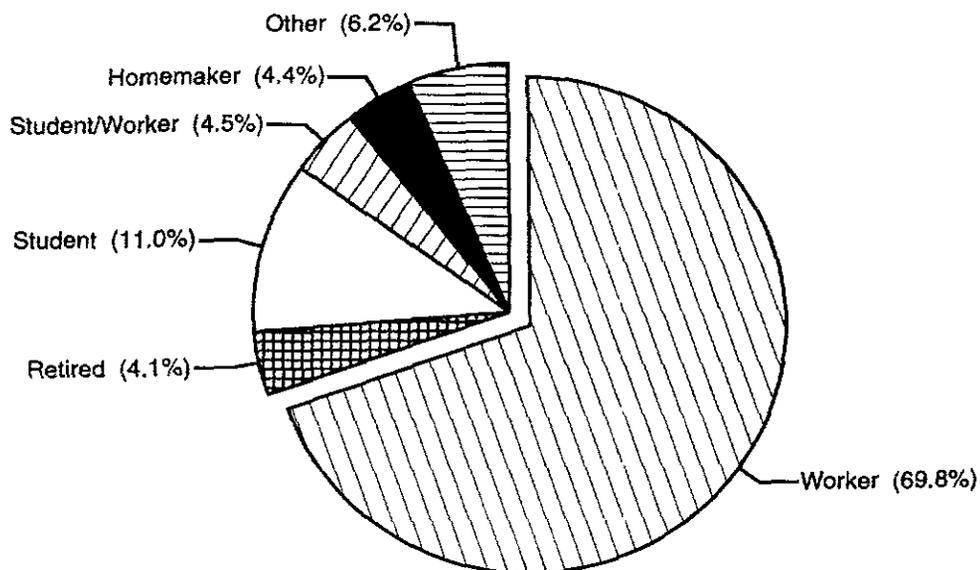


Figure 4.1.14 Work Status of Children Age 16-21

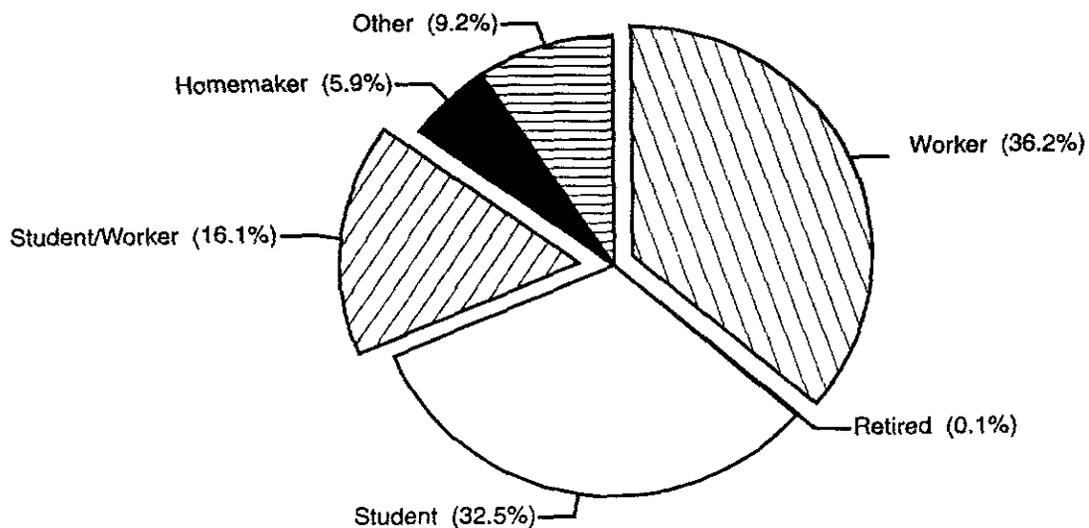


Figure 4.1.15 Work Status of Dependent Adults Age 22-35

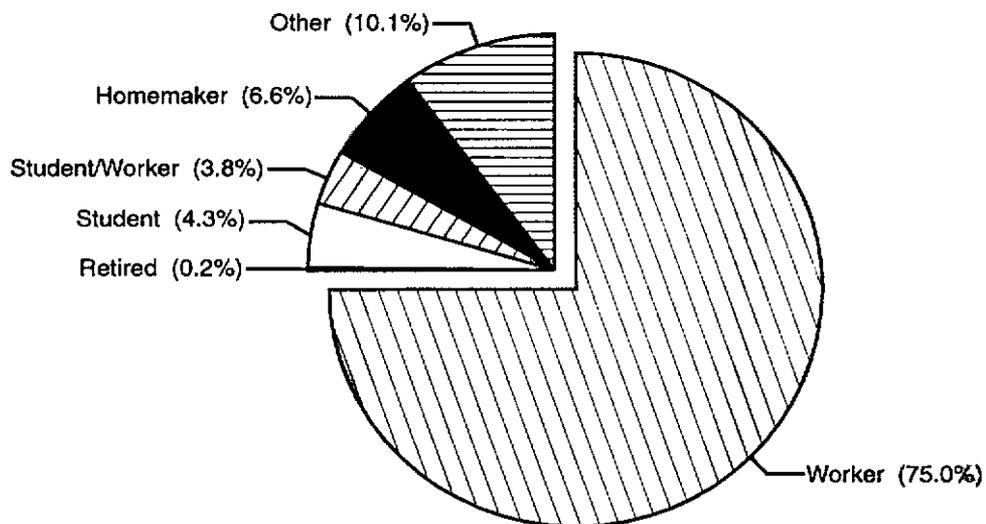


Figure 4.1.16 Work Status of Dependent Adults Over 35 Years of Age

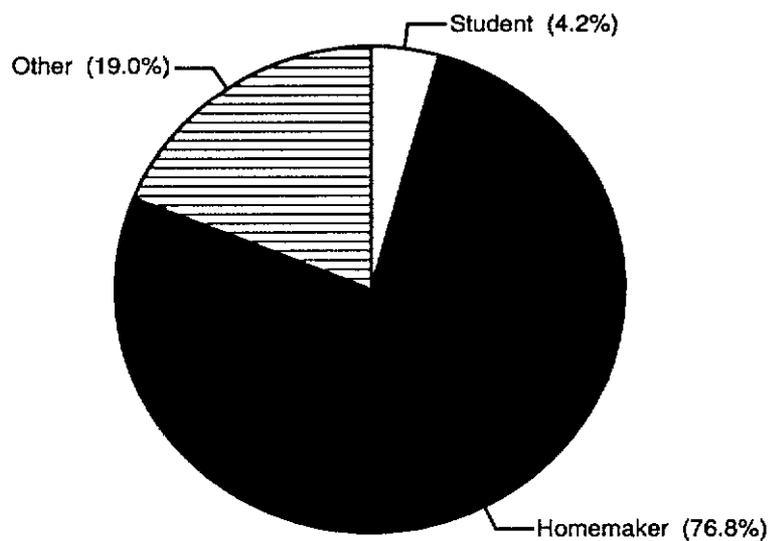


Figure 4.1.17 Role Distribution of Married Adult Households with Dependents

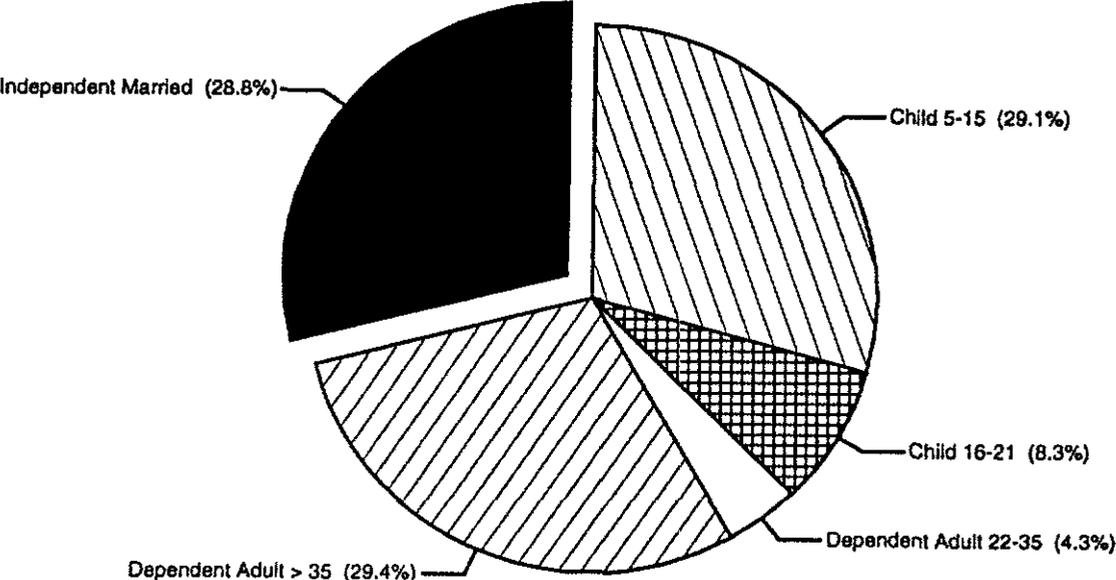


Figure 4.1.18 Role Distribution of Married Adult Households without Dependents

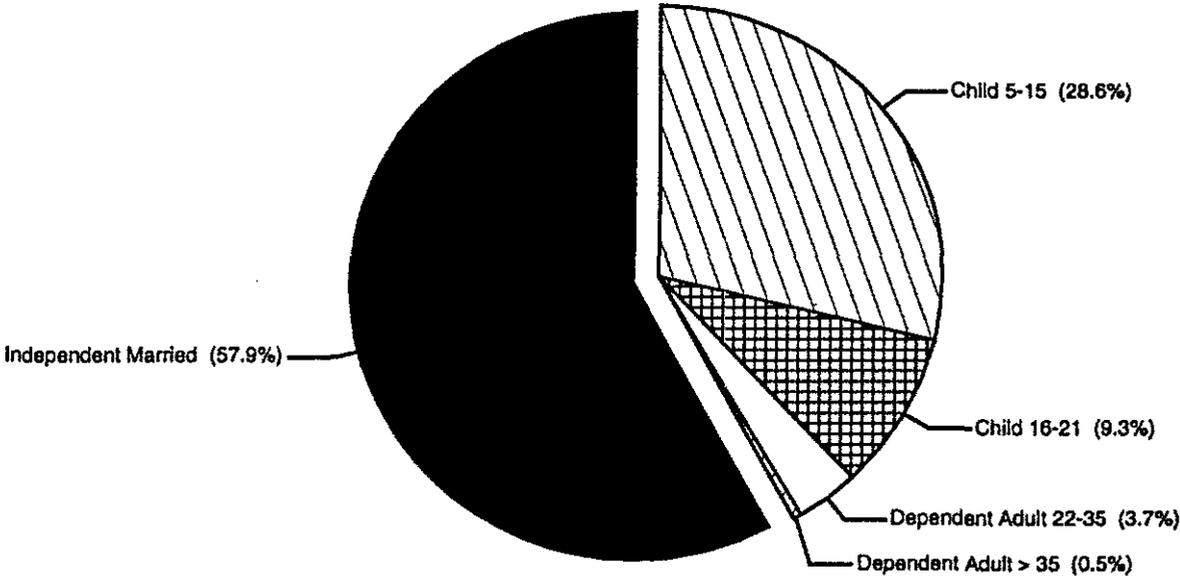


Figure 4.1.19 Role Distribution of Single Adult Households with Dependents

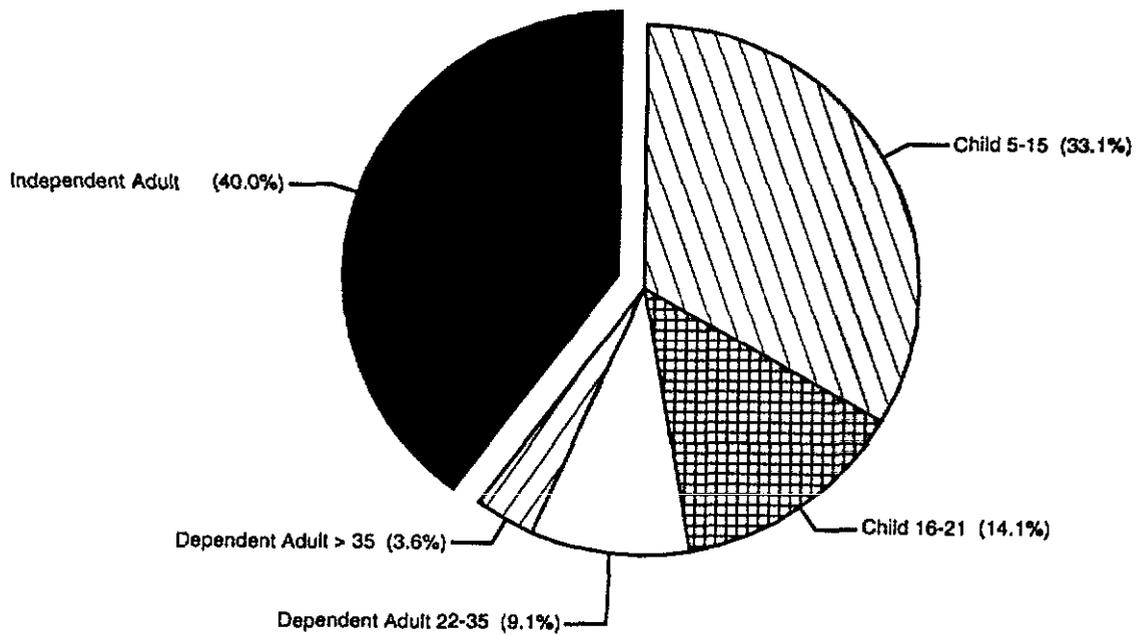


Figure 4.1.20 Role Distribution of Related Adult Households with Dependents

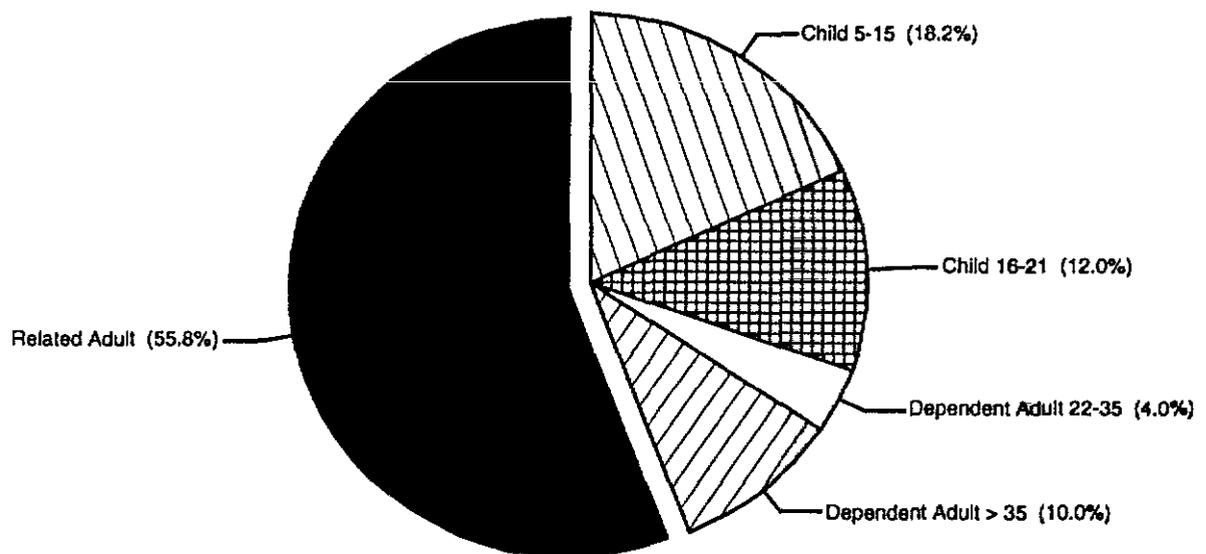


Figure 4.1.21 Role Distribution of Unrelated Adult Households with Dependents

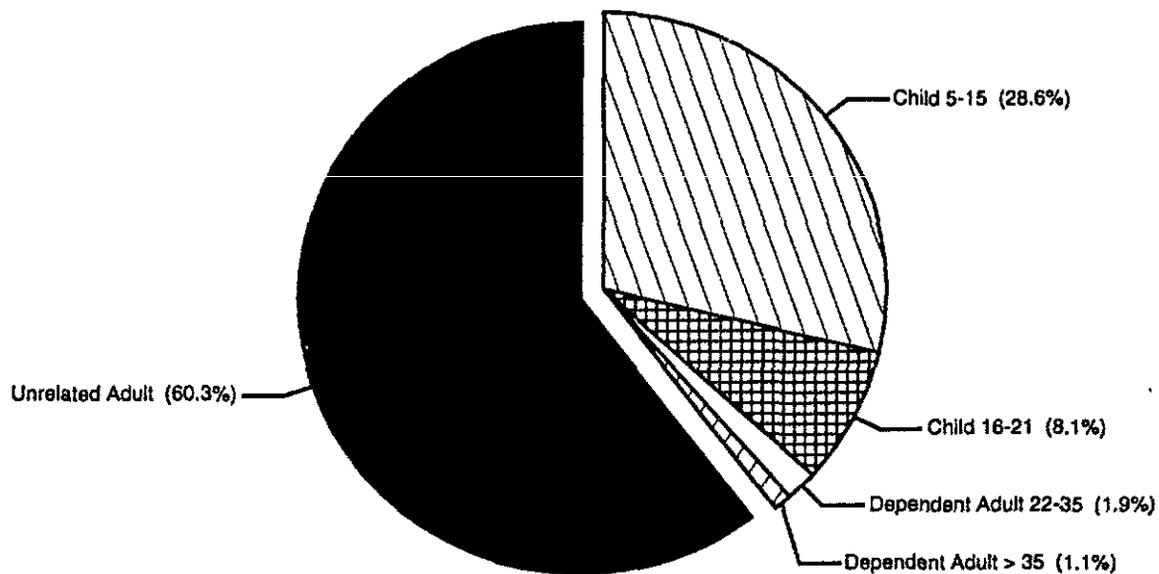
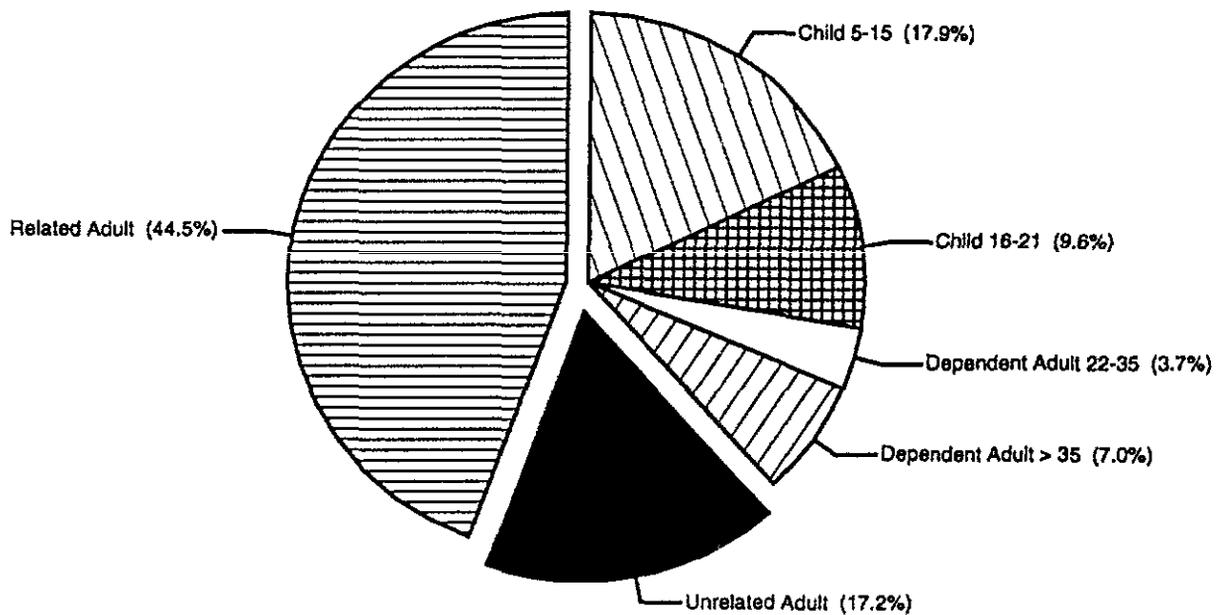


Figure 4.1.22 Role Distribution of 3+ Adult Households with Dependents



4.2 Household Structure, Person Role, and Travel Behavior

In this section travel behavior is described for household types and person Roles. The analysis follows the same order as in Section 4.1. Travel variables and their means for the data set are shown in Table 4.2.1.

As defined earlier, a trip is uninterrupted travel from one place to another by any transportation mode. A loop is a journey of two or more trips which begins and ends at home. A complex chain is a sequence of two or more trips between origin and destination anchors. Anchors are defined as home, work, or school trip origins or destinations.

Table 4.2.1: MEAN HOUSEHOLD AND PERSON TRAVEL

	Households	Person
Mean number of person trips per day	7.23 trips	3.07 trips
Mean travel distance per day	66.98 miles	28.71 miles
Mean distance per person trip*	11.23 miles	11.68 miles
Mean number of person-loops per day	3.01 loops	1.49 loops
Mean number of trips per loop*	2.66 trips/loop	2.65 trips/loop
Mean number of complex chains per loop*	0.26 complex chains/loop	0.24 complex chains/loop

* Slight differences in these variables measured at the household level and the person level are due to the different sizes of the data set for each case (see Appendix F).

Single Adults without Dependents

The households of single adults without dependent (H1) and the single independent adult without dependents role (A1) are the same. As seen in Table 4.2.1 and Figures 4.2.1, 4.2.2, and 4.2.3, these independent adults make slightly fewer trips per day (2.91) than the average person, the total travel distance (24.88 miles) is considerably below average, and their mean trip length is the lowest for all independent person roles (9.92 miles per trip). Figures 4.2.4, 4.2.5, and 4.2.6 and Table 4.2.1 show that these person-households make about the average number of person loops per day (1.46), but have the second highest number of person trips per loop (2.79 trips per loop) and a high number of complex chains per loop (0.32 complex chains per loop). The average level of trip making exhibited by this group (trips per day and loops per day) is believed to be influenced by the relatively lower incomes and rates of vehicle ownership of members of this group.

The most striking travel behaviors of this group are their tendency to make short trips and to organize their trips into more complex loops and chains. Since their travel is not tied to the schedules and travel needs of other household members, these individuals may have more freedom to select origins and destinations closer to each other and to organize their travel into complex travel patterns.

Married Households without Dependents

Independent adults in these household groups (A4) make just above average (2.90) trips per day (Table 4.2.1 and Figure 4.2.1). Their daily travel distance is also somewhat above average (32.36 miles, Figure 4.2.2) and they have one of the longest mean trip distances (13.90 miles per trip, Figure 4.2.3). Persons in these groups make slightly less than the average number of loops per day (1.45, Figure 4.2.4), make an average number of trips per loop (2.61, Figure 4.2.5) and have just above the average number of complex chains per loop (0.26, Figure 4.2.6). Except for mean trip distance, the travel behavior of

independent adults in these household groups are close to the average. The longer trip distance may be associated with the high percentage of workers and higher incomes of persons in these roles.

There are also interesting differences between the one and two independent married adult households without dependents. Although these two household types are the same size (2.0 persons) the mean number of trips per household, travel distance per household, and travel distance per trip was different in each case. As seen in Figures 4.2.7, 4.2.8, and 4.2.9, the two independent adult households have 0.68 more trips per day (13%) and travel 11.60 (22%) more miles per day than the one independent adult households, **but** have mean trip lengths that are 0.41 miles (3%) **shorter**. Trip and travel distance differences may in part be attributed to the relatively lower income of the one independent adult households; the shorter average trip length for the one independent adult households could be the result of a higher proportion of adults whose travel is unconstrained by work trips, and who are not required to coordinate their travel with the travel needs of dependents. Consequently, while one independent adult households take fewer trips and travel fewer total miles, they may have the time and flexibility to take longer trips when they do travel.

The relatively greater number of trips per day for the two independent adult households is also reflected in a greater number of loops per day for two independent adult households (2.52 versus 2.31, Figure 4.2.10). However, it appears that there is little difference in the complexity of travel between these household types; the number of trips per loop is only slightly higher for two independent adult households (2.59 versus 2.53, Figure 4.2.11), and there is no difference in the number of complex chains per loop (0.25, Figure 4.2.12).

One and Two Independent Adult Married Households with Dependents

Independent adults in these households (role AD4) have the highest trip making rate (3.63 trips per day, Figure 4.2.1) of all person roles. They also have the highest travel distance (38.03 miles per day, Figure 4.2.2) and one of the longest mean trip distances (13.62 miles per trip, Figure 4.2.3). These independent adults make an above average number of loops per day (1.56 loops per day, Figure 4.2.4), combine a higher than average number of trips into each loop (2.74 trips per loop, Figure 4.2.5), and have a slightly above average number of complex chains per loop (0.25 complex chains per loop, Figure 4.2.6). This could be the result of relatively high income levels and high percentages of workers in these households, as well as a greater ability for multiple adults in the same household to serve the transportation needs of dependents.

Although the average size of these two household types is nearly the same (3.45 and 3.47 persons), mean number of trips per household, travel distance per household, and travel distance per trip for the two independent adult married households were different from the one independent adult households. As seen in Figures 4.2.7, 4.2.8, and 4.2.9, the two independent adult households have one more trip per day (9%), travel 13.77 (15%) more miles per day, and have mean trip lengths 1.36 miles (13%) **longer** than the one independent adult households. As with the comparable households without dependents, income differences may account for trip number and total travel distance differences. However, shorter rather than longer mean trip length for one independent households with dependents may be the result of the limiting influence of dependents on the travel of adult household members who are not otherwise constrained by a work trip.

Two independent adult households also had a greater number of loops per day than the one independent adult households (4.38 versus 4.15, Figure 4.2.10). Although the number of trips per loop is slightly higher for two independent adult households (2.64 versus 2.57, Figure 4.2.11), the number of complex chains per loop is lower (0.22 versus 0.25, Figure 4.2.12). This suggests that members of one independent adult married households with dependents structure the complexity of their travel differently from the two independent adult married households.

It is also interesting to note that the number of complex chains per loop, the same for one and two independent adult married couples without dependents, was equal to one independent adult married couples

Figure 4.2.1 Person Trips by Role

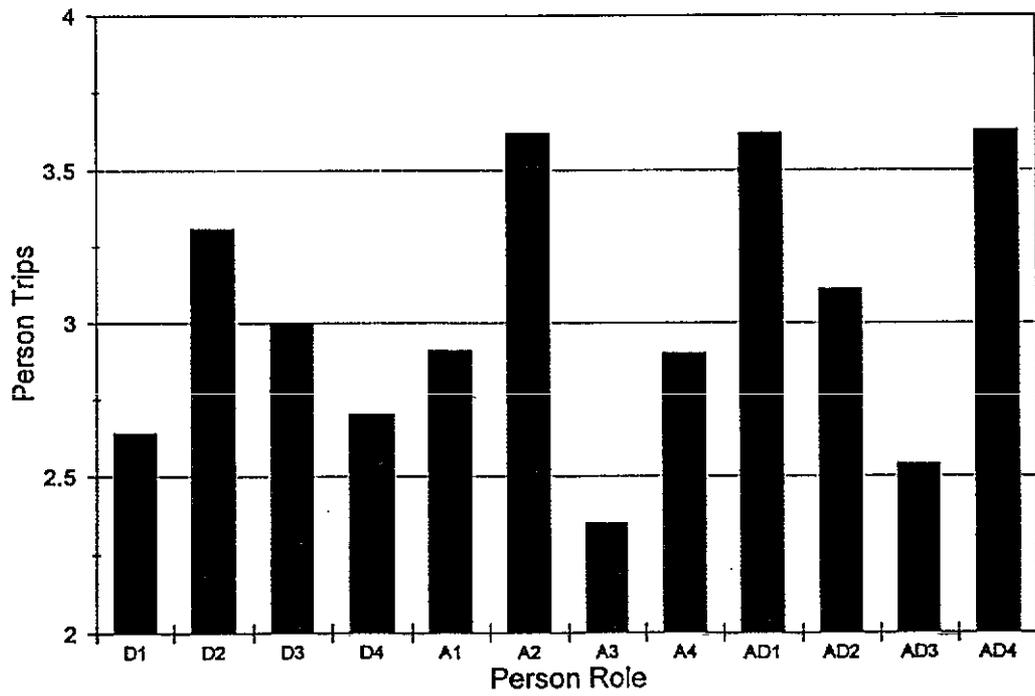


Figure 4.2.2 Travel Distance by Role

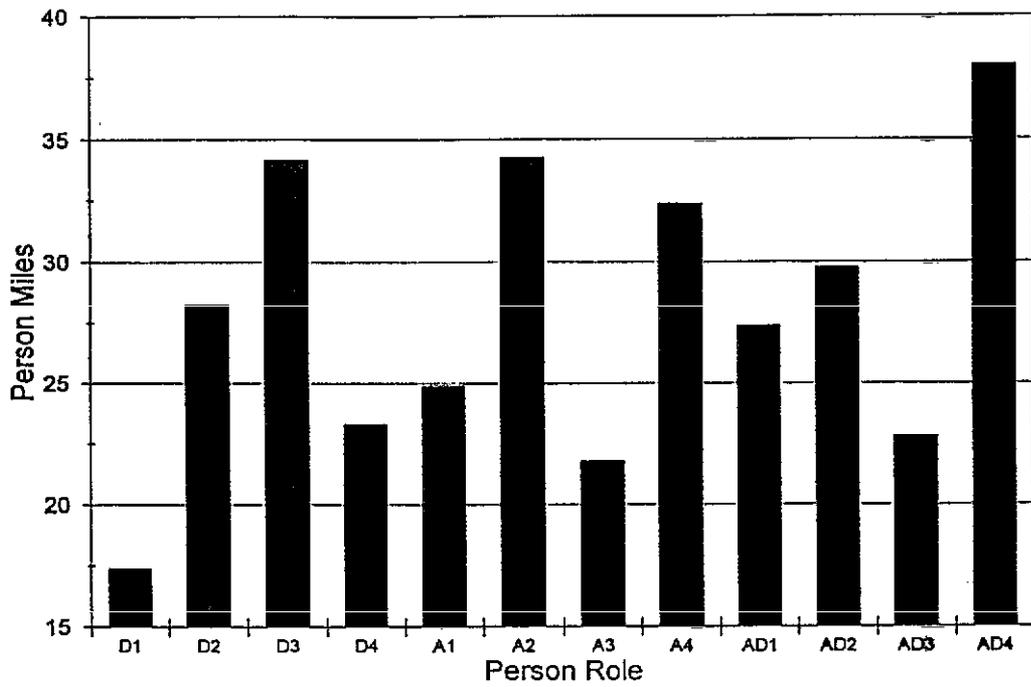


Figure 4.2.3 Miles per Person Trip by Role

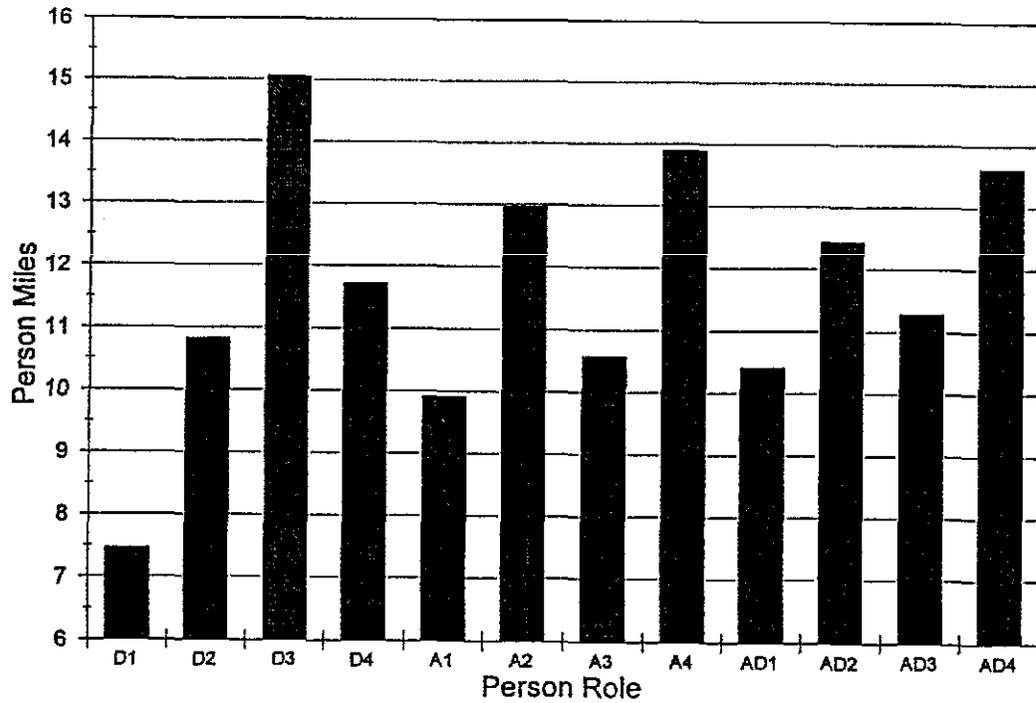


Figure 4.2.4 Person Loops by Person Role

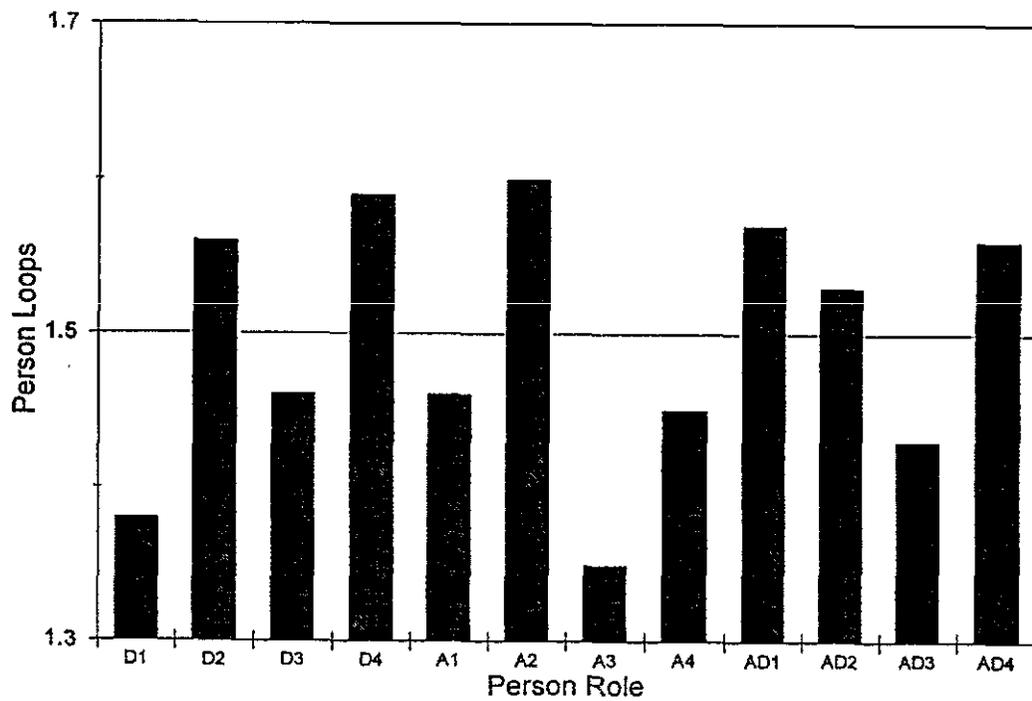


Figure 4.2.5 Person Trips per Loop by Role

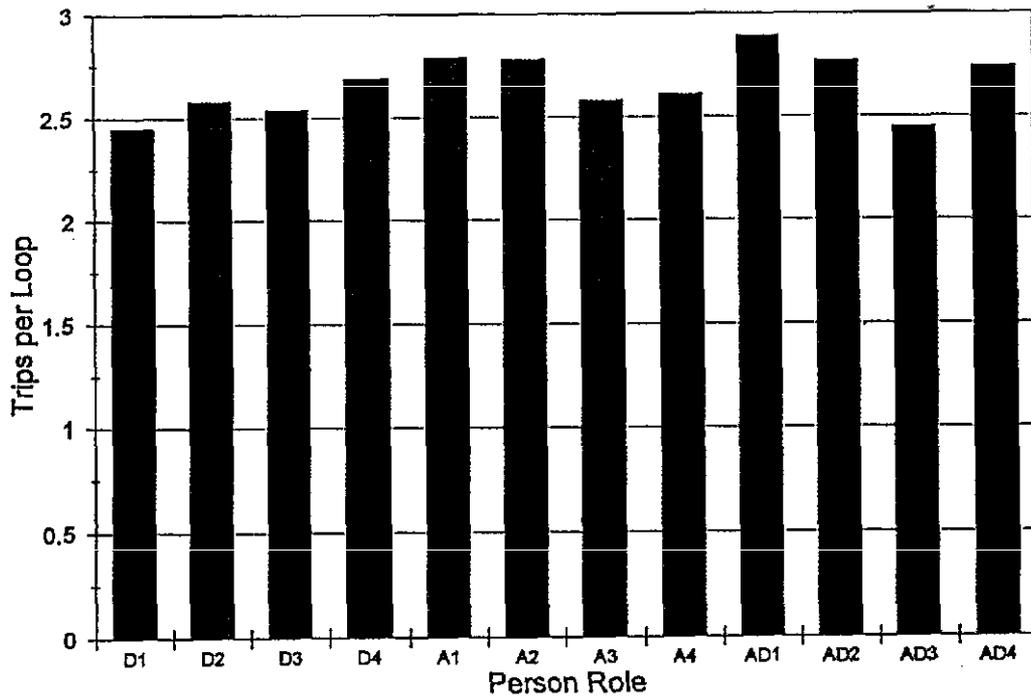


Figure 4.2.6 Complex Chains per Loop by Role

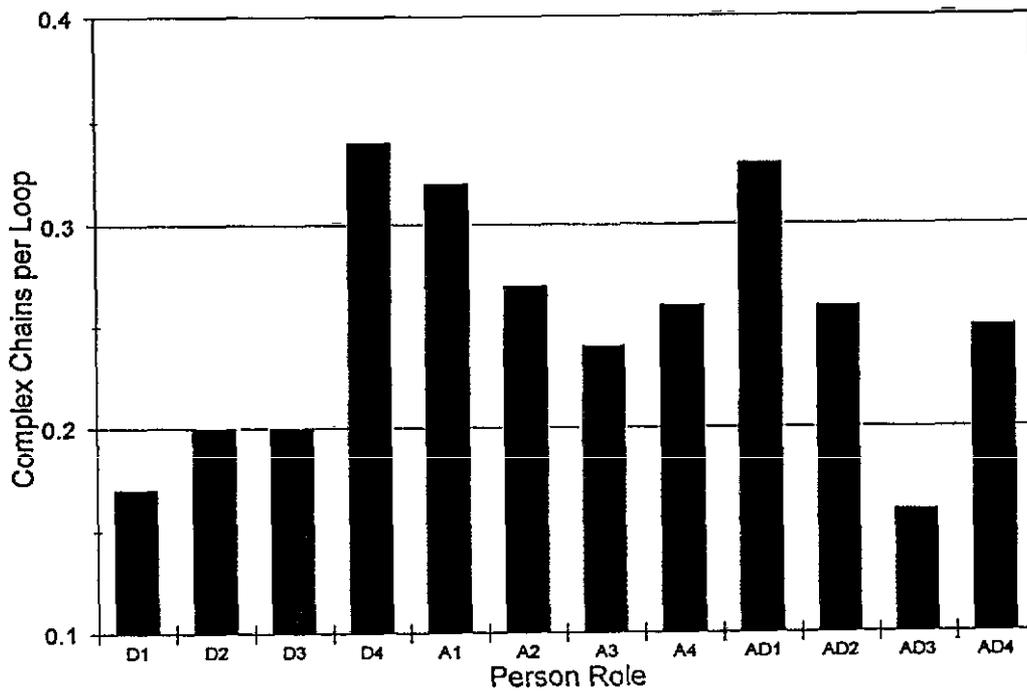


Figure 4.2.7 Person Trips per Household by Household Type

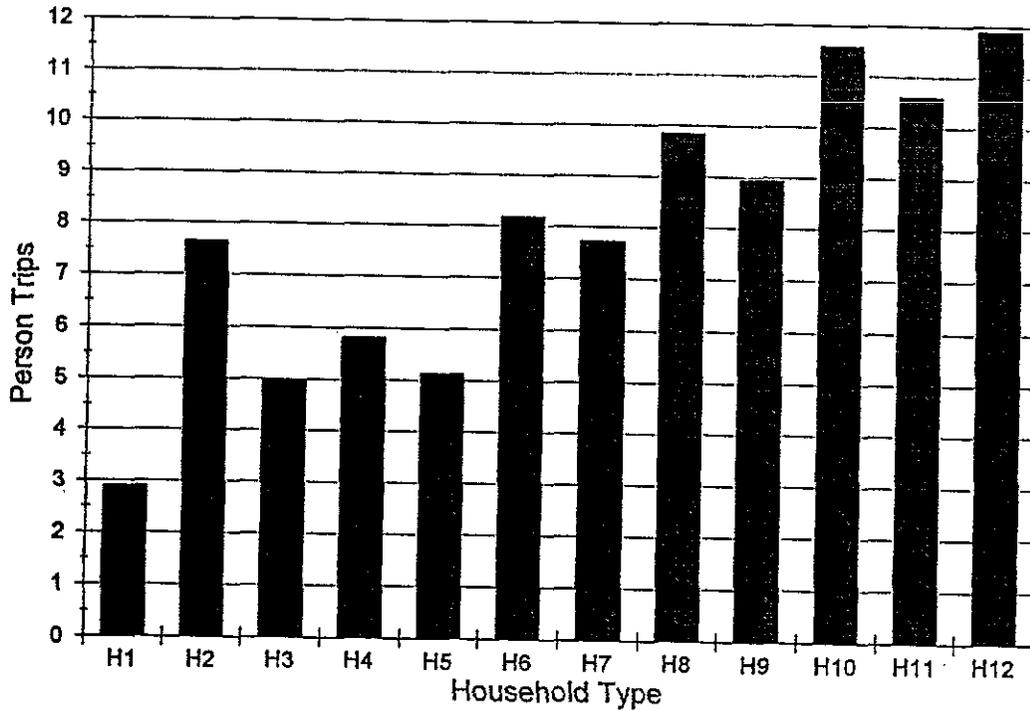


Figure 4.2.8 Person Miles per Household by Household Type

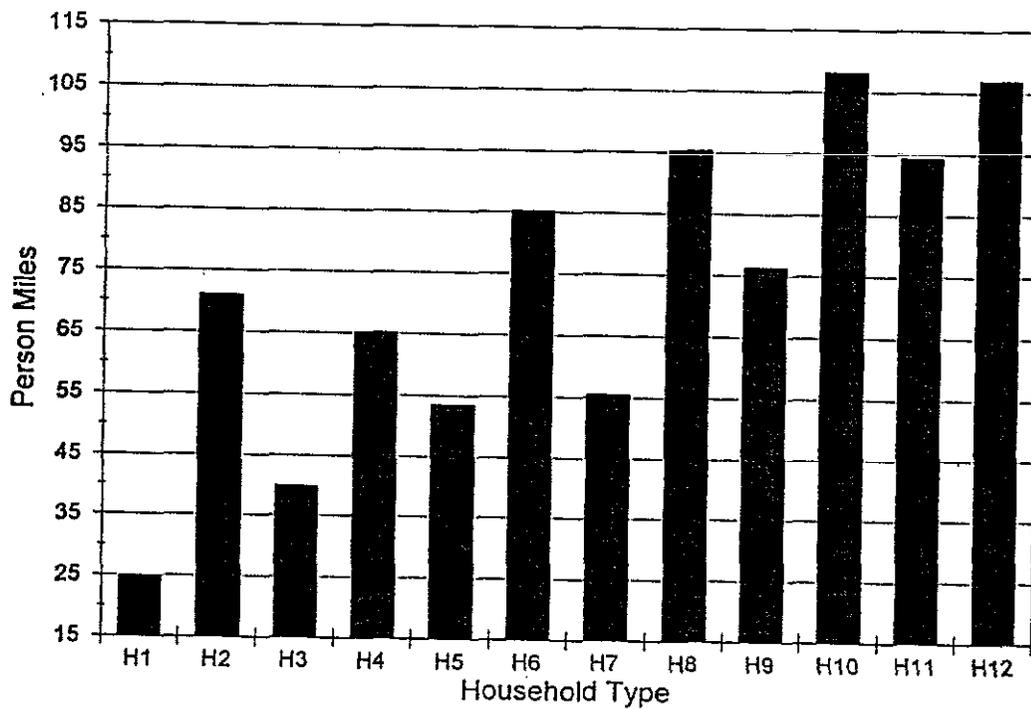


Figure 4.2.9 Person Miles per Trip by Household Type

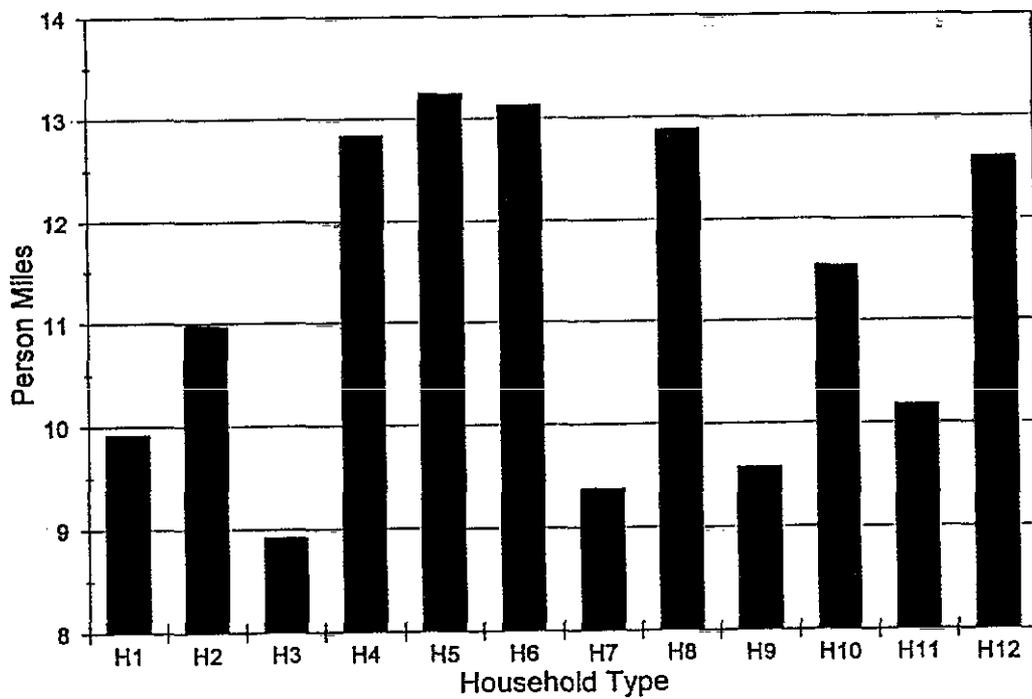


Figure 4.2.10 Person Loops per Household by Household Type

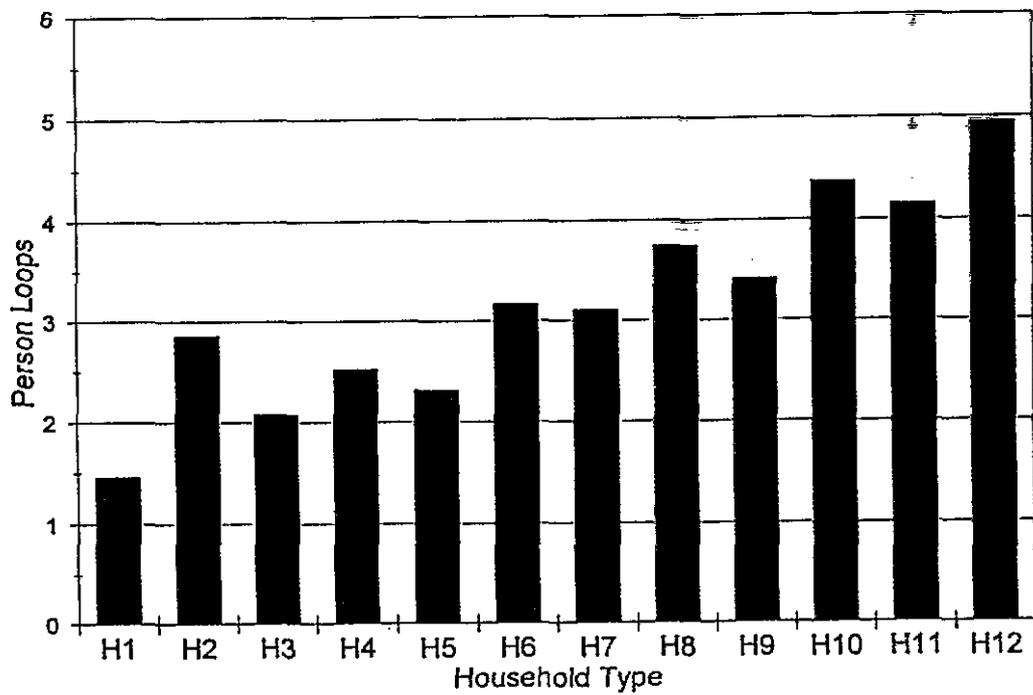


Figure 4.2.11 Trips per Person Loop by Household Type

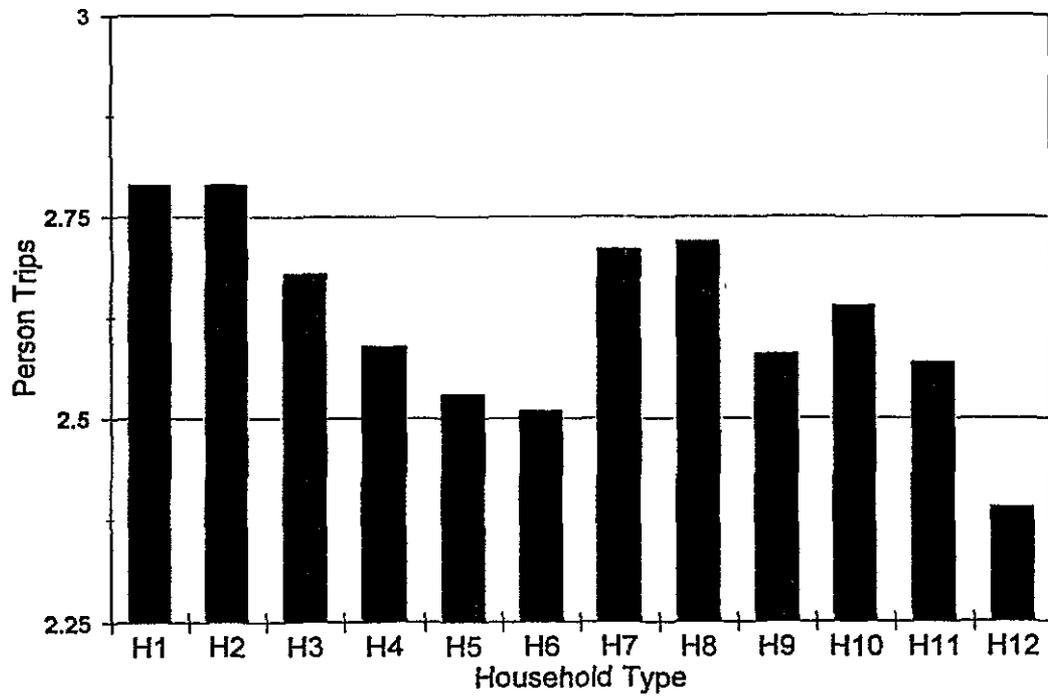
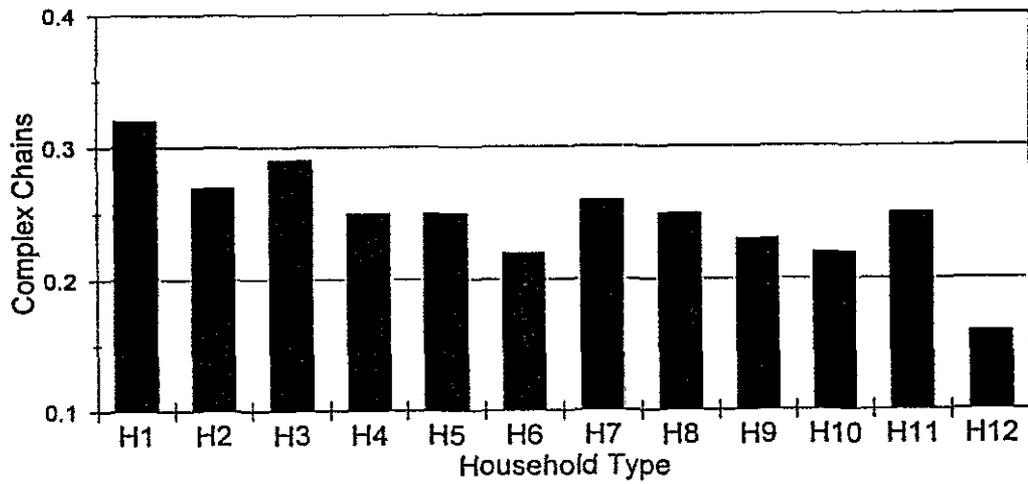


Figure 4.2.12 Complex Chains per Loop by Household Type



with dependents (0.25); only two independent adult married households with dependents were lower (0.22). The lower propensity to form complex chains may be because working adults have relatively less time for travel and less scheduling flexibility, and so are less able to serve the travel needs of dependents. In this case, household members might merge their travel less frequently and fewer chains would contain multiple trips. Dependents may then become more likely to travel alone or forgo some travel altogether.

Single Adults with Dependents

Independent adults in this household category (role AD1) have one of the highest trip rates (3.62 trips per day, Figure 4.2.1), but have a mean travel distance a little below average (27.39 miles per day, Figure 4.2.2) and one of the lowest average distances per trip (10.41 miles per trip, Figure 4.2.3). These independent adults also have a high mean number of loops per day (1.57, Figure 4.2.4), high mean number of trips per loop (2.89, Figure 4.2.5) and high mean number of complex chains per loop (0.33, Figure 4.2.6).

The high trip making rate of independent adults in this household group seems surprising (because of the low income level, low rates of vehicle ownership, and high percentage of independent adult females) until one considers that there is only one independent adult to meet the travel needs of dependents. Single adult households have an average of 1.5 dependents, compared with 1.45 and 1.47 dependents, respectively, in the one and two independent adult married couple households with dependents. The presence of these dependents adds 4.82 trips per day to the 2.9 trips per day made by a single adult household without dependents. This is comparable to the married households with dependents where 5.78 and 5.46 trips per day are added to the 5.82 and 5.14 trips per day made by the married couple households without dependents.

The relatively high level of trip chaining exhibited by this group could be due to the much lower proportion of workers than in married adult households (68.8% and 87.6% respectively, Figures 4.1.12 and 4.1.10) combined with the much smaller proportion of adults available to accompany dependents on trips. As a result, the independent adults in these households may have more time and flexibility to serve dependents' travel needs, while lacking the opportunity to share this necessity with another adult.

Households with two Independent Related Adults, with and without Dependents

Independent adults in related households with and without dependents (roles AD3 and A3) have, respectively, the lowest trip making rates (2.54 and 2.35 trips per person, Figure 4.2.1), the shortest travel distances (22.81 and 21.83 miles per day, Figure 4.2.3), and below average trip lengths (11.28 and 10.57 miles per trip, Figure 4.2.3). The respective number of loops per day (1.43 and 1.35, Figure 4.2.4) and number of trips per loop (2.45 and 2.56, Figure 4.2.5) for independent adults in these households are also below average. The number of complex chains per loop is extremely low (0.16, Figure 4.2.6) for these households with dependents, and average (0.24, Figure 4.2.6) for households without dependents. The low level of trip making and short trip distances is not surprising for this group because of the low income levels and high percentages of retirees. Although both students and retired persons are more highly represented in related adult households, it is not yet clear why the propensity to form complex chains is so low.

Households with two Independent Unrelated Adults, with and without Dependents

In contrast with households of related adults, independent adults in unrelated adult households with and without dependents (role AD2 and A2) have relatively high trip making rates (3.11 and 3.62, Figure 4.2.1), travel distances (29.77 and 34.25, Figure 4.2.2) and trip lengths (12.43 and 12.96, Figure 4.2.3). The mean values for unrelated adults with dependents are only slightly lower than those for married households with dependents. This may be accounted for by their similar work status profiles and because the presence of dependents implies a strong possibility that adults in these households interact in ways similar to married adults. Trip making rates and total travel distance for unrelated individuals without dependents, however, are higher than for independent adults in other household groups without dependents. This may be due to the small proportion of retirees in this group and the high percentage of students and student workers.

Average trip distance for independent adults in unrelated households without dependents is exceeded only by those in married adult households with or without dependents.

For these households, with and without dependents respectively, the number of loops per day (1.53 and 1.60, Figure 4.2.4) and the number of trips per loop (2.77 and 2.78, Figure 4.2.5) are all considerably above average, while the number of complex chains per loop (0.26 and 0.27, Figure 4.2.6) are just above average.

Households with Three or more Independent Adults, with and without Dependents

These categories of households contain a mixture of related and unrelated independent adults. Comments here pertain only to data for household level trip making. These households have an average size of 4.83 and 3.15, respectively (Table 4.1.1). The number of trips per household are 11.9 and 8.19 (Figure 4.2.7) or an average of 2.46 and 2.60 trips per person. This is considerably below the overall average for all persons in the data set of 3.07 trips per person. The mean person miles for these households are 106.90 miles and 85.21 miles per day (Figure 4.2.8), or a daily average of 22.13 miles and 27.05 miles per person. These are also below the per person average for the data set. However, mean distance per trip is 13.13 and 12.61 miles respectively (Figure 4.2.9), which is well above average.

The mean number of person loops per household for these households is 4.95 and 3.17 respectively (Figure 4.2.10). This is an average of 1.02 and 1.01 loops per person, well below the average for the entire data set. The average number of person trips per loop is 2.39 and 2.51 (Figure 4.2.11), the lowest for all household structure categories. Finally, the number of complex chains per loop, 0.16 and 0.22 (Figure 4.2.12), are the lowest for all household types. These low levels of trip chaining may partially be attributed to the effects of the larger household sizes in this group. As the number of persons in a household increases, so does the number of competing schedules and destinations. As the number of competing travel needs increases, it probably becomes more difficult for household members to travel together.

Dependents

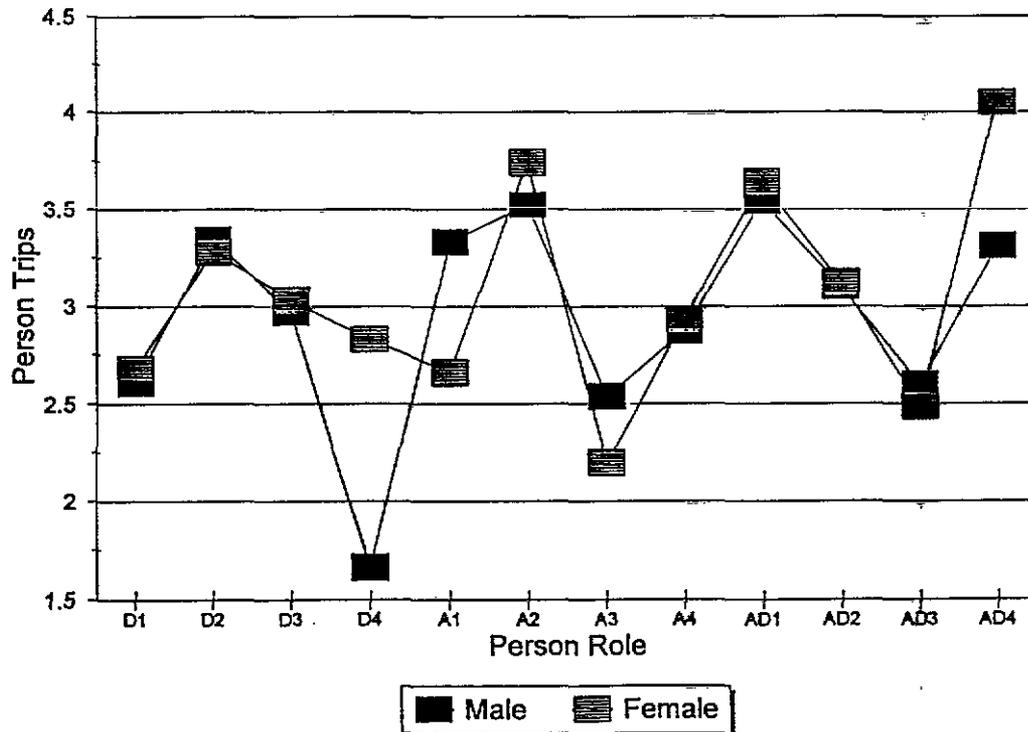
Trip making rates for dependents range above and below the mean for the data set (2.64 to 3.31 trips per person per day, Figure 4.2.1). Only those aged 16 to 21 exceed the mean. Trip distances are short for dependents under 21 years of age (7.47 to 10.82 miles per trip, Figure 4.2.3). However, young adults have a very high mean trip distance (15.06 miles per trip, Figure 4.2.3), and adults over 35 are close to the mean (11.7 miles per trip, Figure 4.2.3). Total travel distances are very low for dependents under 16 years of age (17.38 miles per trip, Figure 4.2.2) and very high for young adults aged 22 to 35 (34.15 miles per trip, Figure 4.2.2).

Children under 16 years old have well below average rates of person loops per day (1.38, Figure 4.2.4), trips per loop (2.45, Figure 4.2.5) and the second lowest number of complex chains per loop (0.17, Figure 4.2.6). Children aged 16 to 21 have among the highest number of loops per day (1.56, Figure 4.2.4), but have below average rates of trips per loop (2.58, Figure 4.2.5) and rates of forming complex chains per loop (0.20, Figure 4.2.6). Dependents aged 22 to 35 have a similar pattern, except that they have fewer loops per day (1.46, Figure 4.2.4). Not surprisingly, dependent adults older than 35, primarily comprised of homemakers, have one of the highest number of loops per day (1.59, Figure 4.2.4) and the highest number of complex chains per loop (0.34, Figure 4.2.6).

Gender Effects

Gender alone does not have a large influence on number of trips per person for the data base as a whole (3.02 trips per day for males and 3.11 trips per day for females). However, larger differences become apparent when person role and household structure are taken into account. As seen in Figure 4.2.13, differences in number of person trips are largest for dependent adults over 35 years of age (males make 41% fewer trips per day than females - 1.66 trips compared with 2.83 trips). Similarly independent male

Figure 4.2.13 Person Trips by Role and Gender



members of married households with dependents make 18% fewer trips than their female counterparts (3.31 trips compared with 4.05 trips per day). On the other hand single males without dependents make 25% more trips per day than their female counterparts (3.33 trips per day compared with 2.66).

Data presented in Figure 4.2.13 suggest that trip making by independent females may be more greatly influenced by person role than it is for independent males. The range of the number of trips per day for females is 2.20 (related adults, no dependents) to 4.05 (married adults, with dependents) while the range for males is 2.54 (related adults, no dependents) to 3.52 (single with dependents).

As seen in Figure 4.2.14, total person miles of travel are strongly influenced by gender for the data base as a whole and for each person role. In general, males travel more miles than females; the only exception is for dependent adults over 35 years old, which includes a high proportion of homemakers. Travel distance for males and females is very close for unrelated adults without dependents.

Mean trip lengths (Figure 4.2.15) are also longer for males, with the exception of unrelated independent adults without dependents in which trip length for females is slightly higher than for males. Trip length for females is also very close to that of males for single persons without dependents.

The number of loops per day are very close for males and females in many roles (Figure 4.2.16); this is consistent with the role-gender influence on number of trips per day. The data show number of trips per loop and number of complex chains per loop (Figures 4.2.17 and 4.2.18) are generally higher for females than for males.

Figure 4.2.14 Person Miles by Role and Gender

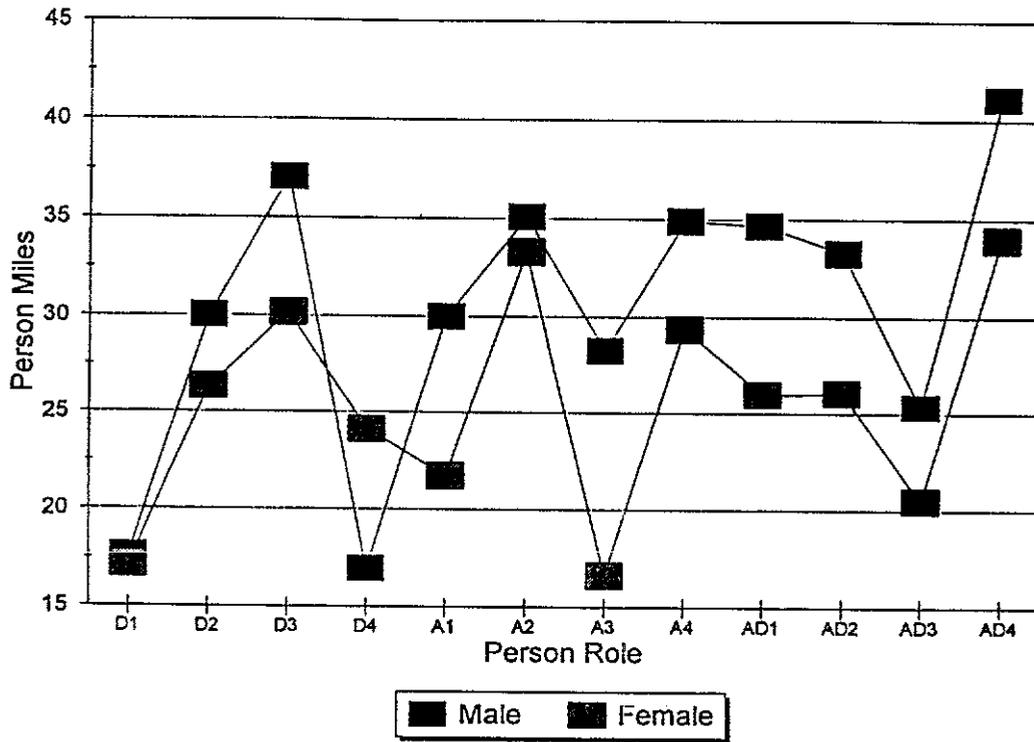


Figure 4.2.15 Mean Trip Length by Role and Gender

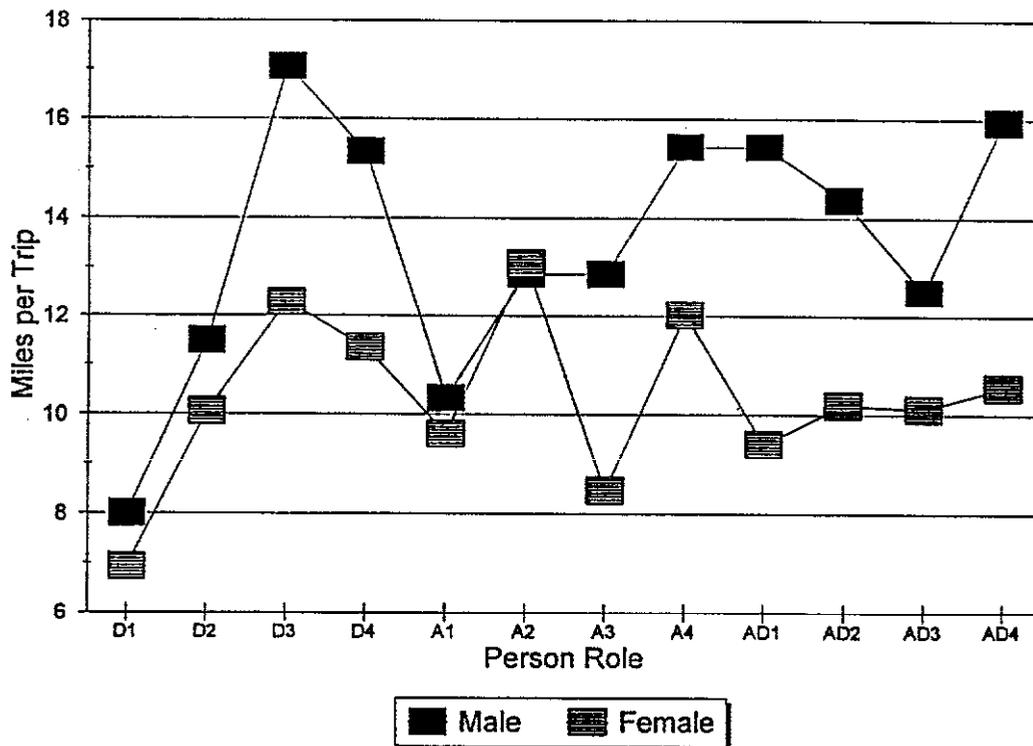


Figure 4.2.16 Person Loops by Role and Gender

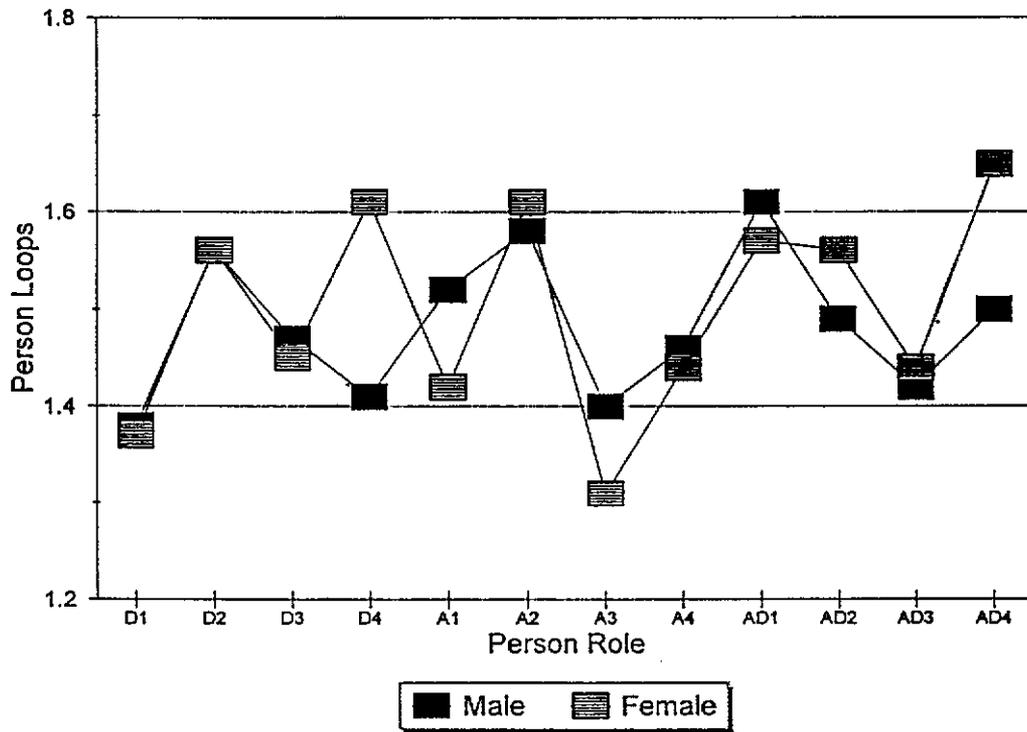


Figure 4.2.17 Trips per Loop by Role and Gender

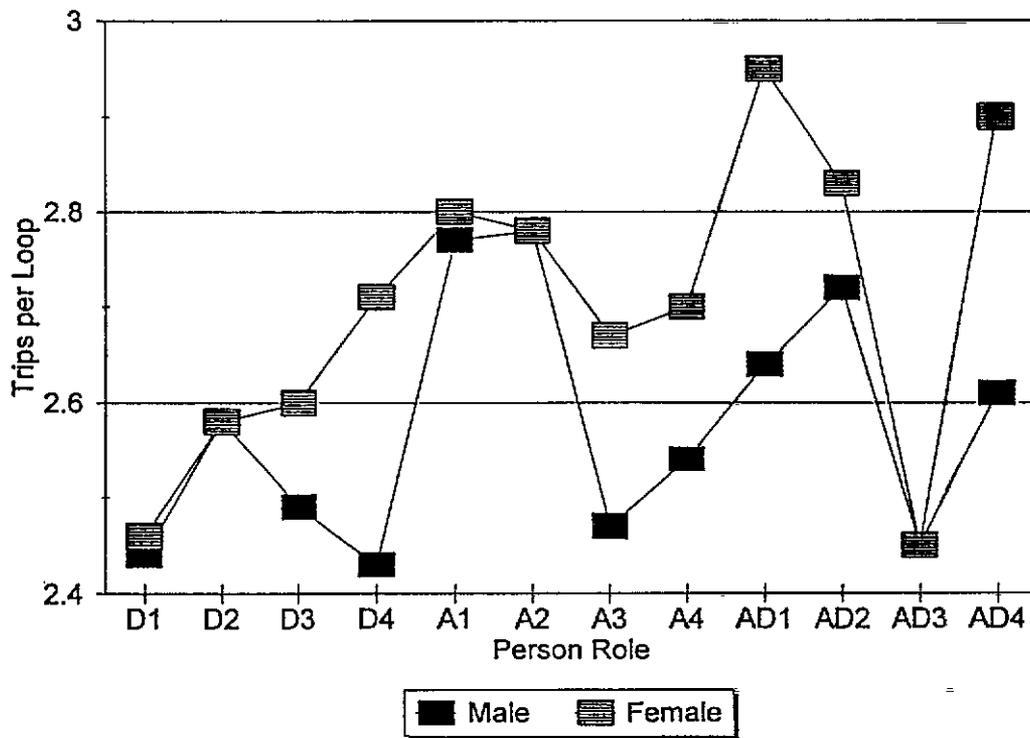
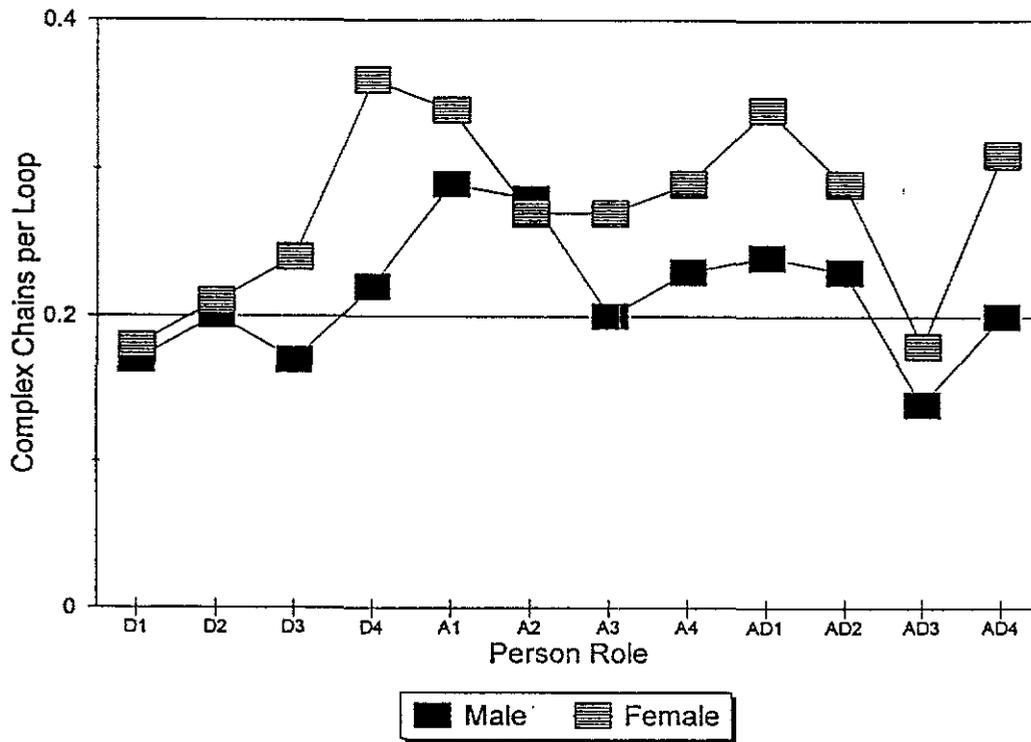


Figure 4.2.18 Complex Chains per Loop by Role and Gender



Work Status Effects

The effect of work status on trip making, shown in Tables 4.2.1 to 4.2.6, is consistent across all person roles. Student/workers, workers, and students have the highest number of trips per day and the highest mean travel distance per day. Workers also have the highest mean distance per person trip but students and student workers have a mean distance per trip close to the average for the data set. Student/workers exhibit the highest number of loops per day. Workers and students have only slightly above average number of loops per day. Students and student/workers exhibit a very low propensity to form complex chains, shown by a low number of complex chains per loop, while workers have an average number of complex chains per loop.

Retired persons and homemakers exhibit quite different trip making characteristics in comparison with workers, student/workers, and students. The number of trips per day is very low for retired persons and a little higher for homemakers, but still below the average. These groups also have the lowest mean travel distance per day compared with the average. The mean distance per trip is close to the average for homemakers, but much higher for retired persons.

Effect of Ages of Dependents

At the household level the age of the youngest child in the household has a strong effect on the number of trips per day, mean travel distance per day, and mean distance per person trip (see Table 4.2.7). The mean number of person trips is highest for households with youngest child aged 5 to 15, but total person miles of travel is highest for households with youngest child aged 16 to 21; and mean trip length is longest for households with youngest dependent aged 22 to 35. These differences are largely due to the travel behavior of the dependents.

Table 4.2.2: MEAN PERSON TRIPS BY ROLE AND WORK STATUS

Role	Worker	Retired	Student	Student/ Worker	Home- making	Other
D1 (Child 5-15)	—	—	2.64**	—	—	—
D2 (Child 16-21)	3.51	—	3.00	4.31	2.50	2.45
D3 (Dependent Adult 22-35)	3.18	—	2.24*	3.27*	2.07	2.47
D4 (Dependent Adult >35)	—	—	3.26	—	2.83	2.04
A1 (Single Adult; No DPTS)	3.81	1.96	3.48	4.75	2.07	2.09
A2 (Unrelated; No DPTS)	3.82	1.66	3.49	5.03	2.14	2.96
A3 (Related; No DPTS)	2.93	1.34	2.60*	3.28*	2.31	2.05*
A4 (Married; No DPTS)	3.36	2.18	2.89*	4.16*	2.41	2.80
AD1 (Single Adult; w/DPTS)	4.01	1.94	4.34*	5.64*	2.57	2.98
AD2 (Unrelated; w/DPTS)	3.37	1.00*	2.69*	3.58*	2.70	2.15*
AD3 (Related; w/DPTS)	2.87	1.13	3.56*	4.44*	2.63*	1.83
AD4 (Married; w/DPTS)	3.68	2.51	4.18*	4.09	3.63	3.03

* Groups with less than 50 cases

** Shown in data as "other," assumed to be students

Table 4.2.3: MEAN PERSON MILES BY ROLE AND WORK STATUS

Role	Worker	Retired	Student	Student/ Worker	Home- making	Other
D1 (Child 5-15)	—	—	17.39**	—	—	—
D2 (Child 16-21)	35.10	—	23.78	28.31	19.95	22.17
D3 (Dependent Adult 22-35)	37.06	—	24.02*	49.64*	17.19	22.74
D4 (Dependent Adult >35)	—	—	34.99	—	21.78	26.91
A1 (Single Adult; No DPTS)	37.61	12.62	19.96	52.31	10.41	12.04
A2 (Unrelated; No DPTS)	35.77	50.73	33.03*	27.73*	17.83	24.11
A3 (Related; No DPTS)	30.97	8.00	18.80*	16.56*	19.47*	13.78*
A4 (Married; No DPTS)	40.63	19.40	43.83*	38.29*	19.40	39.97
AD1 (Single Adult; w/DPTS)	32.65	13.29	18.93	26.36	14.72	19.42
AD2 (Unrelated; w/DPTS)	33.23	18.84*	11.75*	39.80*	16.00	24.80
AD3 (Related; w/DPTS)	27.00	5.65	27.84*	46.50*	20.33*	19.07
AD4 (Married; w/DPTS)	39.27	21.84	32.19*	32.75*	28.86	39.47

* Groups with less than 50 cases

** Shown in data as "other," assumed to be students

TABLE 4.2.4: MEAN TRIP LENGTH BY ROLE AND WORK STATUS

Role	Worker	Retired	Student	Student/ Worker	Home- making	Other
D1 (Child 5-15)	—	—	7.47**	—	—	—
D2 (Child 16-21)	13.02	—	9.78	7.01	8.45	14.74
D3 (Dependent Adult 22-35)	15.16	—	12.18*	18.27*	16.70*	13.19
D4 (Dependent Adult >35)	—	—	13.06	—	9.97	20.52
A1 (Single Adult; No DPTS)	11.83	7.32	7.93*	11.77*	5.83	7.02
A2 (Unrelated; No DPTS)	11.41	72.79*	13.19	8.10	8.50*	7.70
A3 (Related; No DPTS)	12.12	7.23	8.15*	4.72*	9.07*	6.15*
A4 (Married; No DPTS)	15.11	11.42	16.85*	14.30*	8.68	17.68
AD1 (Single Adult; w/DPTS)	11.12	8.03*	4.00*	4.49*	7.33	14.91*
AD2 (Unrelated; w/DPTS)	11.84	45.33*	5.26*	9.54*	6.99	24.37*
AD3 (Related; w/DPTS)	11.70	5.39	9.80*	9.61*	12.31*	17.47*
AD4 (Married; w/DPTS)	13.77	12.74	9.36*	9.43*	11.04	16.53

* Groups with less than 50 cases

** Shown in data as "other," assumed to be students

Table 4.2.5: MEAN PERSON LOOPS BY ROLE AND WORK STATUS

Role	Worker	Retired	Student	Student/ Worker	Home- making	Other
D1 (Child 5-15)	—	—	1.38**	—	—	—
D2 (Child 16-21)	1.57	—	1.49	1.72	1.48	1.47
D3 (Dependent Adult 22-35)	1.46	—	1.39*	1.50*	1.55*	1.43
D4 (Dependent Adult >35)	—	—	1.60	—	1.60	1.49
A1 (Single Adult; No DPTS)	1.49	1.38	1.81*	2.17*	1.36	1.47
A2 (Unrelated; No DPTS)	1.56	1.30*	1.78	1.91	1.59*	1.57
A3 (Related; No DPTS)	1.34	1.33	1.23*	1.64*	1.57*	1.43*
A4 (Married; No DPTS)	1.45	1.44	1.33*	1.90*	1.43	1.52
AD1 (Single Adult; w/DPTS)	1.59	1.40*	1.79*	2.11*	1.45	1.52*
AD2 (Unrelated; w/DPTS)	1.53	1.67*	1.30*	1.40*	1.56	1.48*
AD3 (Related; w/DPTS)	1.41	1.39	1.36*	2.07*	1.56*	1.56*
AD4 (Married; w/DPTS)	1.55	1.52	2.00*	1.78*	1.76	1.69

* Groups with less than 50 cases

** Shown in data as "other," assumed to be students

Table 4.2.6: MEAN PERSON TRIPS PER LOOP BY ROLE AND WORK STATUS

Role	Worker	Retired	Student	Student/ Worker	Home- making	Other
D1 (Child 5-15)	—	—	2.45**	—	—	—
D2 (Child 16-21)	2.61	—	2.48	2.69	2.55	2.65
D3 (Dependent Adult 22-35)	2.54	—	2.33*	2.88*	2.47*	2.55
D4 (Dependent Adult >35)	—	—	2.66	—	2.70	2.63
A1 (Single Adult; No DPTS)	2.96	2.53	2.44*	2.63*	2.65	2.65
A2 (Unrelated; No DPTS)	2.86	2.44*	2.47	2.60	2.43*	2.90
A3 (Related; No DPTS)	2.65	2.36	2.42*	2.33*	2.61*	2.55*
A4 (Married; No DPTS)	2.68	2.46	2.45*	2.37*	2.59	2.77
AD1 (Single Adult; w/DPTS)	2.95	2.57*	2.90*	2.91*	2.70	2.93*
AD2 (Unrelated; w/DPTS)	2.76	2.11*	2.57*	3.30*	3.06	2.54*
AD3 (Related; w/DPTS)	2.46	2.30	2.65*	2.39*	2.67*	2.25*
AD4 (Married; w/DPTS)	2.74	2.50	2.68*	2.64*	2.80	2.62

* Groups with less than 50 cases

** Shown in data as "other," assumed to be students

Table 4.2.7: MEAN COMPLEX CHAINS PER LOOP BY ROLE AND WORK STATUS

Role	Worker	Retired	Student	Student/ Worker	Home- making	Other
D1 (Child 5-15)	—	—	0.17**	—	—	—
D2 (Child 16-21)	0.21	—	0.16	0.19	0.29	0.33
D3 (Dependent Adult 22-35)	0.18	—	0.09*	0.21*	0.31*	0.32
D4 (Dependent Adult >35)	—	—	0.20	—	0.36	0.28
A1 (Single Adult; No DPTS)	0.32	0.31	0.18*	0.21*	0.35	0.32
A2 (Unrelated; No DPTS)	0.29	0.29*	0.16	0.19	0.29*	0.36
A3 (Related; No DPTS)	0.23	0.25	0.19*	0.20*	0.31*	0.40*
A4 (Married; No DPTS)	0.24	0.26	0.18*	0.15*	0.34	0.35
AD1 (Single Adult; w/DPTS)	0.32	0.31*	0.42*	0.37*	0.36	0.35*
AD2 (Unrelated; w/DPTS)	0.24	0.11*	0.27*	0.10*	0.41	0.33*
AD3 (Related; w/DPTS)	0.15	0.21	0.27*	0.08*	0.39*	0.15*
AD4 (Married; w/DPTS)	0.24	0.27	0.25*	0.20*	0.37	0.25

* Groups with less than 50 cases

** Shown in data as "other," assumed to be students

All three conventional measures of trip making are lowest for households with youngest dependent over 35 years of age. This reflects the lower trip making rates and travel distances of dependents over 35 years of age, and that independent adults in these households are likely to be older than those in households with younger dependents and therefore likely to have lower trip making rates and distances. The trip making measures are also low for households with youngest child aged 0 to 4 years. This is partly due to the fact that trips for children under 5 years of age are not recorded in the data base, and due to some likely correlation of age of youngest dependent and household size.

As seen in Table 4.2.8, the effect of the age of the youngest dependent on number of loops per day is similar to the effect on number of trips per day. The mean number of trips per loop and the number of complex chains per loop are both higher for households with youngest child aged 0 to 4 and for households with youngest dependent aged over 35. Thus the households with the lower level of trip making are also the households with the greater propensity to form more complex travel patterns. This again may be partly related to a smaller household size and to the presence of more homemakers and/or retirees in these households.

The effect of the age of youngest dependent on person level trip frequencies and trip lengths is shown in Table 4.2.9. The highest number of trips per person and travel distance per person occurs with youngest child aged 16 to 21, and the longest trip distance occurs with youngest dependent aged 21 to 35. Again these differences reflect the travel behavior of the dependents. But it is interesting to note that the effect is much less marked here, after adjusting for household size, than it is for household level travel. The effect of age of youngest dependent on mean number of person loops, trips per loop, and complex chains per loop (Table 4.2.10) is similar to that seen at the household level.

Table 4.2.8: CONVENTIONAL DESCRIPTORS OF HOUSEHOLD TRAVEL BY DEPENDENT AGE

	Youngest Child 0-4*	Youngest Child 5-15	Youngest Child 16-21	Youngest Child 22-35	Dependent Adult >35
Mean Person Trips	8.98	12.50	10.74	8.26	4.64
Mean Person Miles	81.88	102.74	108.38	91.45	46.73
Mean Person Miles per Trip	11.31	9.34	12.71	14.10	11.52

* Does not include travel by children aged 0 to 4 years

TABLE 4.2.9: STRUCTURAL DESCRIPTORS OF HOUSEHOLD TRAVEL BY DEPENDENT AGE

	Youngest Child 0-4*	Youngest Child 5-15	Youngest Child 16-21	Youngest Child 22-35	Dependent Adult >35
Mean Loops per Person	3.39	4.87	4.06	3.39	2.11
Mean Trips per Loop	2.75	2.56	2.60	2.53	2.67
Mean CMPX Chains per Loop	0.27	0.21	0.23	0.21	0.28

* Does not include travel by children aged 0 to 4 years

Table 4.2.10: CONVENTIONAL PERSONAL TRAVEL DESCRIPTORS BY DEPENDENT AGE

	Youngest Child 0-4*	Youngest Child 5-15	Youngest Child 16-21	Youngest Child 22-35	Dependent Adult >35
Mean Person Trips	3.22	3.21	3.25	2.82	2.87
Mean Person Miles	30.64	27.68	32.84	31.73	29.47
Mean Person Miles per Trip	13.53	12.14	14.78	17.56	14.88

* Does not include travel by children aged 0 to 4 years

Table 4.2.11: STRUCTURAL PERSONAL TRAVEL DESCRIPTORS BY DEPENDENT AGE

	Youngest Child 0-4*	Youngest Child 5-15	Youngest Child 16-21	Youngest Child 22-35	Dependent Adult >35
Mean Loops per Person	1.45	1.52	1.49	1.41	1.44
Mean Trips per Loop	2.73	2.58	2.59	2.53	2.66
Mean CMPX Chains per Loop	0.26	0.21	0.21	0.21	0.27

* Does not include travel by children aged 0 to 4 years

4.3 Comparison of Conventional Travel Variables with Household Structure and Person Role Variables

One purpose of this research was to evaluate the importance of household structure relative to the conventional demographic variables in differentiating the conventional travel descriptors: number of person trips, mean distance traveled per household, and mean distance per person trip. Table 4.3.1 shows the ratio of the highest to the lowest value of these travel descriptor variables for household structure, for person role, and for conventional demographic variables. Using the ratio of the highest to the lowest number of person trips, household structure provides more differentiation in number of person trips than all variables except number of persons in the household (4.09 vs. 5.33). The ratio generated by the extreme values of number of vehicles is a close third (4.04).

The same three variables are important in differentiating the mean distance per household, although the order is rearranged: number of vehicles has the greatest effect (a ratio of 9.55), while number of persons in the household is second (5.04) and household structure third (4.35). Travel mode and household income are the only other variables that are similar in their effect (ratios of 4.28 and 4.26 respectively).

The mean distances traveled per person are much less variable. The three most influential variables here are household income, number of vehicles, and person role — to be discussed in the next section of this report (with ratios of 2.36, 2.23 and 2.02 respectively).

In Table 4.3.2, similar ratios are presented for the travel pattern descriptors: number of person loops per day, number of person trips per loop, and number of complex chains per loop. Household structure remains among the most important factors influencing the newly developed travel pattern variables. It is

second in importance in its effect on the mean number of person loops per household (with a ratio of 3.39), behind the number of persons in the household (4.18) and ahead of travel mode (2.68). And it is tied for second with person role in affecting the mean number of complex chains per loop (with a ratio of 2.0), behind work status (2.06) and just ahead of travel mode (1.93).

The mean number of trips per loop is relatively constant across the values of all variables, varying between ratios of 1.06 and 1.18. Household structure and person role are at the high end of this limited range (1.17 and 1.18 respectively). Household size, income, and travel mode, and the individual's work status are intermediate in their effect, with ratios between 1.11 and 1.13.

Another goal of this study was to evaluate the importance of person role in differentiating the conventional travel descriptors and the new travel pattern variables. Although person role, by itself, has less

Table 4.3.1: RATIO OF HIGH TO LOW VALUES ON CONVENTIONAL TRAVEL DESCRIPTORS FOR HOUSEHOLD STRUCTURE, PERSON ROLE, AND THE TRADITIONAL DEMOGRAPHIC VARIABLES

	Mean Number of Person Trips per Household	Mean Distance Per Household per Trip	Mean Distance
Household			
Structure	4.09	4.35	1.49
Income	2.31	4.26	2.36
Number of vehicles	4.04	9.55	2.23
Number of persons	5.33	5.04	1.36
Age of dependents	2.69	2.31	1.51
Travel mode	3.06	4.28	1.28
Person			
Role	1.54	2.19	2.02
Gender	1.03	1.27	1.28
Work status	2.16	2.29	1.51

Table 4.3.2: RATIO OF HIGH TO LOW VALUES ON THE NEW TRAVEL PATTERN VARIABLES FOR HOUSEHOLD STRUCTURE, PERSON ROLE, AND THE TRADITIONAL DEMOGRAPHIC VARIABLES

	Mean Number of Person Loops per Household	Mean Number of Trips per Loop	Mean Number of Complex Chains Per Loop
Household			
Structure	3.39	1.17	2.00
Income	1.63	1.11	1.16
Number of vehicles	2.13	1.09	1.33
Number of persons	4.18	1.13	1.78
Age of dependents	2.31	1.09	1.33
Travel mode	2.68	1.12	1.93
Person			
Role	1.19	1.18	2.00
Gender	1.02	1.06	1.29
Work status	1.23	1.11	2.06

effect, relative to the conventional demographic variables, on the mean number of person trips and mean distance traveled per person, it is one of the three most influential variables affecting mean distance per trip (along with household income, and number of vehicles). And while it is among the least important in differentiating the mean number of person loops per person, it is among the most important in its affect on the mean number of trips per loop (first) and mean number of complex chains/loop (tied for second).

Controlling for gender increases the effect of person role on mean travel distance per person for men, while lowering it for women (a ratio of 2.42 for men, 1.98 for women, but 2.19 for role uncontrolled). However, gender does not markedly change the effect of role on mean distance per person trip.

In contrast, controlling for gender does not change the effect of person role on the new travel pattern variables: mean number of person loops per person, and mean number of trips and complex chains per loop. The effect of person role controlling for work status could not be properly evaluated since there were insufficient cell sizes for some roles in all but the worker status.

However, where the number of person trips is concerned, the effect of person role increases when controlling for gender. While the ratio of high to low number of person trips is 1.54 for role alone, it increases to 1.84 for women and 2.12 for men. Similarly, the effect of gender on some roles increases when role is introduced, from 1.03 for gender alone to 1.7 for dependent adults over 35. This reflects the interaction between gender and person role.

Implications

5.1 Mobility and Transportation Policy

Transportation research has come to rely on a limited number of conventional variables to measure and explain travel behavior. Conventional dependent variables, such as number of trips, trip length, and miles traveled, gained acceptance at a time when transportation planning and policy were mainly concerned with accommodating increasing personal vehicle travel and easing traffic congestion. Independent variables were chosen from individual and household characteristics readily available from existing data sources that correlate well with conventional dependent variables. Although conventional variables didn't provide accurate descriptions of travel behavior or comprehensive explanations for why people travel, they seemed to work reasonably well for analyzing one-dimensional traffic problems.

Over the past two decades increasing concern with a wide range of transportation-related problems has diminished the usefulness of traffic-specific methods. It is widely recognized that problems as diverse as energy security, air pollution, and community and regional development are affected by transportation policy and planning. It is also widely accepted that many transportation problems are interrelated, making it difficult to address one problem without aggravating others. Unfortunately, methods that are more oriented to analyzing traffic flows than actual travel behavior are not well suited for understanding complex transportation problems.

One legacy of the uncritical embrace of conventional methods is revealed by legislative mandates to address and resolve transportation problems. Government agencies responsible for transportation policy and planning are often directed by law to attain some reduction or minimization goal related to vehicle use, such as minimizing fuel consumption, hours of traffic delay, vehicle miles traveled, vehicle trips, or vehicle emissions. Clearly, vehicle use is minimized by simply eliminating it. But no one seriously advocates eliminating vehicle use; in most cases travelers have no realistic alternative. Instead, transportation planning is implicitly committed to maintaining personal mobility. In effect, preserving mobility has become another goal of an already complex planning process. But because mobility constraints are implicit, they are difficult to specify and the mobility impacts of various plans and policies are difficult to evaluate. Difficulties in analyzing contemporary transportation issues reflect the complexity of the social relationships that structure travel behavior. The inability to estimate travel needs and evaluate the mobility impacts of various policies and plans has become a serious drag on efforts to develop more effective, acceptable solutions to multi-objective transportation problems.

5.2 Mobility and Travel Strategies

Analysis of structured travel strategies is essential for understanding travel behavior and needs. People need to travel in order to access geographically dispersed activities. Activities with others are socially structured, and travel that links them together becomes integrated with those structures. Who travels, where they travel, when and with whom they travel is significantly affected by the relationships that structure activities. Travelers devise multi-dimensional travel strategies in order to integrate structured activities through travel.

A structural analysis of travel strategies requires two methodological elements to accurately measure and describe personal travel behavior and needs. First, travel behavior and needs should be understood in terms of the complex travel strategies that integrate structured activities. Second, it is essential to identify categories of travelers based on the way social structure affects individuals' travel behavior and needs.

Recognition that household structure is one of the more important structural influences on travel behavior is not new. Lifecycle methods have been the principal approach used to try to capture structural

influences and analyze travel behavior. However, lifecycle concepts are not pure structural variables. Lifecycle variables incorporate a number of disparate influences, such as household composition and size, age of household members, and work status. Combining many different kinds of influences into a single measure makes it impossible to distinguish structural influences from other variables that correlate well with travel behavior. Another drawback is that lifecycle concepts only apply to travel behavior at the household level. Although relatively good correlations may be estimated for household travel, lifecycle variables cannot be used to disaggregate household members' travel. Because structural influences are confounded with other influences, and because individual behavior cannot be analyzed through lifecycles, the effects of structural influences on individual travel behavior and needs cannot be accurately specified and measured. Although these weaknesses may not be debilitating for traffic flow analyses, they impede complex transportation problem solving.

Information developed in the preceding chapters of this study will be used to suggest how a structural analysis could enhance transportation planning and policy. The twelve household structure types are used to describe relative differences in household travel strategies. The twelve person roles presented in the preceding chapters of this report are used as categories of individual travelers whose travel behavior and needs are influenced by the household division of labor. However, because the results of this study are preliminary rather than exhaustive, the intent of this exploration is to guide further research on structural analyses rather than to draw definitive conclusions.

5.3 Dimensions of Travel Strategies

Four dimensions of travel strategies are derived from the six measures of travel behavior used in this report: travel frequency, travel complexity, dispersion of activities, and geographic reach. Travel times and total time traveled could also be incorporated into analyses of travel strategies. However, this information was not compiled for this report.

Travel frequency is estimated from number of person trips and person loops. Person trips can be thought of as activity links. The more activities a person needs to link together, the more trips they take. Person loops measure how frequently travelers leave home to link activities. Travel frequencies reflect the number of activities and the frequency with which travelers link activities from home.

Person trips per loop and complex chains per loop can be used to estimate the complexity of travel strategies. Trips per loop reflects travel complexity in terms of the number of activities linked together in the average excursion out of the house. Complex chains per loop suggests how concentrated travel complexity is by indicating the frequency with which complex travel is undertaken. Complexity is an important dimension of travel strategies because it can account for scheduling constraints of activities linked together, such as the necessity for adults to adapt travel strategies to accommodate the travel needs of children.

Average trip length is an indicator of the overall dispersion of activities that are linked through travel. More dispersed activities are associated with relatively longer average trip lengths than more centralized activities occurring near each other.

Finally, person miles traveled is a measure of the total distance covered in travel and reflects a traveler's overall geographic reach when linking activities together.

5.4 Structural Influences on Travel Strategies

Table 5.4.1 presents a summary of travel strategies by household type and Table 5.4.2 presents a summary of travel strategy by person role. The values presented in Tables 5.4.1 and 5.4.2 are subjective estimates based on the relative difference from mean values for all households or persons. While not an

objective, quantified measure of relative differences in travel strategies, these estimates can provide insight into differences in travel behavior and needs.

The household travel strategies summarized in Table 5.4.1 suggest several important relationships. First, when household travel frequency is analyzed by household type, the number of independent adults in a household appears to have little effect, but when dependents are present it increases substantially. It could be that adults substitute some activities within the household for outside activities when other adults are present but need to travel more frequently when dependents are present. Second, complexity of travel decreases as the number of independent adults increases and is greatest for households without dependents. This suggests that the number of schedules that need to be coordinated impede complex travel, and dependents' schedules may be particularly difficult to coordinate. Third, dispersion of linked activities increases with number of independent adults, but decreases when children are present. This may be because adults must serve many of dependents' travel needs, so everyone in the household restricts the dispersion of their activities in order to coordinate their travel according to the proportions of adults and dependents in the household. Finally, geographic reach shows the same pattern as travel frequency, ranging higher with the presence of dependents than with increasing numbers of independent adults. While only tentative, these findings suggest that household travel needs as reflected by household travel strategies are affected greatly by household structure.

The differences in travel strategies by person role presented in Table 5.4.2 are less straight forward. Frequency and reach are similar, but not as strong as for household travel strategies. Although there is a considerable amount of variation from one role to the next, readily apparent patterns are not so easily discerned. This is probably because additional structural and economic variables at the person level must be taken into account, which, unfortunately, is beyond the scope of this exploration.

Table 5.4.1: TRAVEL STRATEGY CHARACTERISTICS BY HOUSEHOLD TYPE

Households Without Dependents	Frequency ¹	Complexity ²	Dispersion ³	Reach ⁴
H1 (Single Adult)	LOW	HIGH	AVERAGE	LOW
H2 (Unrelated Adults)	AVERAGE	ABOVE AVERAGE	AVERAGE	AVERAGE
H3 (Related)	LOW	ABOVE AVERAGE	LOW	LOW
H4 (2 Independent, Married)	BELOW AVERAGE	AVERAGE	HIGH	AVERAGE
H5 (1 Independent, Married)	LOW	BELOW AVERAGE	HIGH	AVERAGE
H6 (3+ Adults)	AVERAGE	LOW	HIGH	AVERAGE
Households With Dependents	Frequency ¹	Complexity ²	Dispersion ³	Reach ⁴
H7 (Single Adult)	AVERAGE	AVERAGE	LOW	AVERAGE
H8 (Unrelated)	HIGH	AVERAGE	HIGH	HIGH
H9 (Related)	ABOVE AVERAGE	BELOW AVERAGE	LOW	AVERAGE
H10 (2 Independent, Married)	HIGH	BELOW AVERAGE	AVERAGE	HIGH
H11 (1 Independent, Married)	HIGH	AVERAGE	AVERAGE	HIGH
H12 (3+ Adults)	HIGH	LOW	AVERAGE	HIGH

1) person trip and person loop frequencies
4) daily person miles traveled

2) trips per loop and complex chains per loop

3) average trip length

Table 5.4.2: TRAVEL STRATEGY CHARACTERISTICS BY PERSON ROLE

Dependent Roles	Frequency ¹	Complexity ²	Dispersion ³	Reach ⁴
D1 (Child 5-15)	LOW	LOW	LOW	LOW
D2 (Child 16-21)	AVERAGE	BELOW AVERAGE	AVERAGE	AVERAGE
D3 (Dependent Adult 22-35)	AVERAGE	LOW	HIGH	HIGH
D4 (Dependent Adult >35)	BELOW AVERAGE	ABOVE AVERAGE	AVERAGE	LOW
Adult Roles w/o Dependents	Frequency ¹	Complexity ²	Dispersion ³	Reach ⁴
A1 (Single Adult; No DPTS)	AVERAGE	HIGH	LOW	LOW
A2 (Unrelated; No DPTS)	HIGH	ABOVE AVERAGE	AVERAGE	HIGH
A3 (Related; No DPTS)	LOW	AVERAGE	AVERAGE	LOW
A4 (Married; No DPTS)	AVERAGE	AVERAGE	HIGH	HIGH
Adult Roles with Dependents	Frequency ¹	Complexity ²	Dispersion ³	Reach ⁴
AD1 (Single Adult; w/DPTS)	ABOVE AVERAGE	HIGH	LOW	AVERAGE
AD2 (Unrelated; w/DPTS)	AVERAGE	ABOVE AVERAGE	AVERAGE	AVERAGE
AD3 (Related; w/DPTS)	BELOW AVERAGE	LOW	AVERAGE	LOW
AD4 (Married; w/DPTS)	ABOVE AVERAGE	AVERAGE	HIGH	HIGH

1) person trip and loop frequency

2) trips per loop and complex chains per loop

3) average trip length

4) daily person miles traveled

To take the comparative analysis a step further, we have taken the twelve person roles and grouped them under four headings: children, single adults, non-traditional roles, and traditional roles. Children and single adult roles are self-explanatory, and the reasons for separating them out is to control for some of the more important influences related to dependence, which isn't sufficiently developed in this study to analyze thoroughly, and household income, which also affects travel in important ways.

The traditional quality of a role was determined in comparison with the "typical" modern nuclear family composed of a married mom and dad with children. Research on changing family division of labor has established that household responsibilities do not necessarily change when a married mom enters the paid labor force, so working moms, working dads (AD4), and homemakers (D4) are included in the traditional category. Because the D4 category is overwhelmingly female and because most of the persons in D4 are homemakers, travel by men in this category is omitted. The non-traditional roles, broken down by gender, include married without children (A4), unrelated adult with and without children (A2 and AD2), and related adult with and without children (A3 and AD3).

As can be seen in Figures 4.4.13 and 14 (5.2.1&5.2.2), gender seems to effect the number of activities linked and the number of excursions out of the home for some roles but not for others. Children's roles are largely undifferentiated by gender; single adult roles are different by gender, but this may be a result of the income differences between men and women; non-traditional roles do not seem to differentiate frequency; but gender is clearly different for traditional roles. Traditional roles are a different matter; married dads come out higher than homemakers, but lower than working moms on these measures. This suggests that, although each role makes a difference, women in traditional roles generally have frequency needs different from men in the same roles.

Measures of travel complexity show a surprisingly different picture. Women's travel behavior presented in Figures 4.4.17 and 18 (Figures 5.2. 2&4) reflects greater overall and concentrated complex travel needs greater than men's, except for unrelated adults without dependents and related adults with dependents, where there is no difference. The lack of difference in the single adults is also surprising, suggesting that income and complexity are not closely related, and that the lack of household structural differences by gender translate into similar travel needs.

Dispersion of travel (Figure 4.4.15[5.2.5] shows a very similar pattern of travel behavior. It could be that women's restricted dispersion of activities is closely related to the complexity of their travel; where many activities and schedules must be integrated and coordinated, it seems likely that travel flexibility would be reduced and activity dispersion would reduced accordingly to accommodate the lack of flexibility. Closely related to dispersion is total reach (Figure 4.4.14[5.2.6]. The principal difference here is that single adults are different by gender, probably reflecting the income related differences by gender in number of activities and number of excursions from home.

In summary, it would seem that women in households with others do have special needs for more complex travel. However, only women in traditional roles differ substantially from men in the number of activities the need to link or the number of excursions they need to take away from home. Dispersion of activities is also a gender-based difference for most roles, probably constrained by women's greater travel complexity. This also translates into a more restricted reach in daily travel, also probably constrained by special complexity needs. It is also apparent that income can have a substantial effect on travel needs. But comparison with female single parent roles suggests that role can override income effects, at least in some circumstances.

- Traditional v Non and Class accounts for differentiation by gender for PT and PL.
- Gender accounts for differences for complexity.
- Complexity differences account for differences in trip length.
- Trip length differences account for differences in PMT.
- As more women move into non-traditional roles, their travel may look more like men's?
- Also as income gap narrows (men's incomes relatively declining?), men's will look more like women's?

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