11

Swedish Men and Women s Mobility Patterns: Issues of Social Equity and Ecological Sustainability

Merritt Polk

University of Gothenberg

SWEDISH MEN AND WOMEN S MOBILITY PATTERNS: ISSUES OF SOCIAL EQUITY AND ECOLOGICAL SUSTAINABILITY

Present day systems of mass mobility contribute to the degradation of the natural and social environments of Sweden through air pollution, death and injury from accidents, and urban congestion. In response to the social and environmental problems connected to automobility, it is often claimed that certain changes in present mobility patterns and the supporting infrastructure will be necessary to attain a more sustainable transportation system. While the car is often seen as the most flexible form of private transportation, this flexibility depends on the infrastructures which have been built to fulfil the needs of automobility at a cost of other investments in transportation facilities. These investments and their resultant use, takes place within a complex social context where all individuals do not have the same resources, financial and temporal, to use for transportation. The distribution of both access and the resulting 'bads' and 'goods' connected to automobility therefore, directly or indirectly mirror power relationships within a society. If it is assumed that all individuals in Sweden are socially and legally equal and that this results in similar mobility needs in order to fulfil the demands of modern lifestyles, then similar travel patterns between men and women should be implied. However, in travel studies and studies about automobility from the US, Scandinavia, and England the car is explicitly or strongly implicitly discussed as a *male* form of transportation[1, 2, 3].

If the car is seen as a necessity because it is the most versatile form of private transportation which can best fulfil current mobility needs, then a marginalization of certain groups results in limits which have direct social, as well as indirect ecological implications. Some categories of individuals in Sweden use the car disproportionately more than other groups. In different studies, these were loosely identified as well-educated men with a higher than average income[4, 5]. The first aim of this paper is, therefore, to describe some of the differences between men and women's use of the car in Sweden and secondly, to explore how these differences can be understood, and discussed in terms of social equity and ecological sustainability.

Any discussion naming 'sustainable' mobility does so because the use of the car results in the degradation of local, regional and global environments through air pollution, the use of arable land for road infrastructure, oil spills and car production and disposal. Because the complexity of the myriad of other factors relating to sustainable transportation systems are outside of the scope of this paper, sustainability here will only refer to the effects of air pollution from energy production for transportation. In Sweden, approximately one fourth to one-fifth of carbon dioxide, nitrous oxides, and hydrocarbon emissions come from the private use of the automobile[6, p. 21]. It is for these reasons that ecological sustainability is judged to be a necessary part of any discussion of travel patterns in Sweden.

Men and women's mobility patterns will be presented by first describing travel patterns in terms of kilometers driven, overall mode use and purpose. Secondly, possible explanations for men and women's differing use of the car will be explored. Can sex be identified as an important determining factor of car use or are other variables such as income, household composition and/or age of equal or more interest? In conclusion, mode use will be looked at in terms of its impact on the natural environment through the energy intensity that this entails. Can women's travel patterns be judged more environmentally benign than men's? Do men or women have travel patterns which can be seen to be more adaptable to a sustainable transportation system?

THE 1994 SWEDISH TRAVEL PATTERN SURVEY

National travel surveys (RVU) have been conducted in Sweden by Statistics Sweden (SCB) in 1978, 1984/85 and one is currently being conducted which started in 1994 and will run until 1998. The RVU are commissioned by the Delegation for Forecast and Development, under the Transportation Sector of the Department of Communications. The 1994-1998 RVU is being conducted in order to forecast future transportation needs of the country, to establish concrete material to be used as a basis for transportation policy, and to approximate the safety risks involved within the transportation sector for the population in Sweden[7]. The material used in this paper is from the first year of the 1994 national travel survey and covers the quarters included within April 1, 1994 to March 31, 1995, but will be referred to as the 1994 study.

In the first complete year of the 1994 survey, 10,439 individuals between the ages of 6 to 84 years of age were interviewed by telephone. One week before the interview, the respondent received a letter presenting the study and informing them that the interview would take place. The respondents also received a diary and were encouraged to fill in all trips occurring on a designated study day in order to better remember them for the interview. The interview occurred on the day following the designated study day or, when this was not possible, within a week after this date. For seasonal variations, the designated travel study day was spread out over the entire year. The random sample was taken from the Swedish Register of the Population. Children between the ages of 6-14 were indirectly interviewed through a parent. The response rate for the first year was 78%.

Some problems with the Riks-RVU 94 have been pointed out in studies where a comparison of travel patterns were made with earlier travel surveys in Sweden[8, 9]. The main methodological problem which affects this work is the likelihood that short trips have been significantly underestimated in the 1994 survey. There has been a systematic decrease in the frequency of trips for all modes, purpose, sex and age groups. This type of trend does not seem to follow real developments. The earlier surveys used personal interviews and the 1994 survey used telephone interviews. The possible reason for the underestimation of short trips is that respondents did not report all their trips in order to shorten the telephone interview. A thorough analysis of the method problems connected to the reporting of short trips is given in Krantz and Vilhelmson[8].

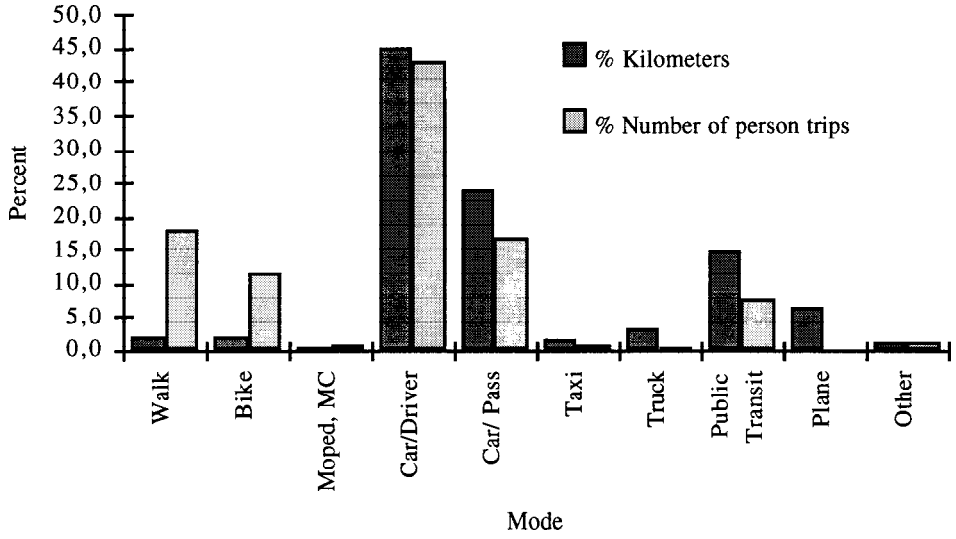
A DESCRIPTION OF MEN AND WOMEN S TRAVEL PATTERNS IN SWEDEN

In the study year of 1994, the Swedish population between the ages of 6-84 is estimated to have travelled a total of approximately 116 billion kilometers in Sweden. Of these total kilometers travelled, 80 billion kilometers were made in an automobile. 17 billion kilometers occurred using public transportation which includes: commuter trains, trams, subway, buses and regular trains. 6.5 billion kilometers were travelled by plane, 2 billion by walking, and 2 billion kilometers by bike.

The majority of person trips and kilometers travelled in Sweden were made in a car. Of the total kilometers travelled, 69% were made in a car, which represents 60% of the total person trips. Of the total kilometers travelled, 15% occurred using public transportation, which was 8% of the total person trips, and 2.0% of the kilometers were travelled by walking and biking, which stand for 17.8% and 11.4% of the person trips respectively.

A clearer picture of mode use can be seen in Figure 1 where the kilometers travelled and the number of trips are given in the percent in which they are used by the Swedish population. As can be seen in Figure 1, despite the predominance of car use by individuals in Sweden, walking and biking and public transportation still make up 40% of the total trips travelled. The presentation of travel patterns given here describes the overall average use of mode by an idealized 'average' Swedish population, but to what extent do women and men share these patterns?

Figure 1
The Share of Total Numbers of Trips and Total Number of Kilometers Travelled Respectively by Transportation Mode, for the Swedish Population, ages 6-84, in 1994.



SOURCE: Calculated from the 1994 Swedish Travel Survey.

In order to describe the mobility patterns of individuals in Sweden, the number of kilometers travelled during a day and the number of trips made will be interpreted as spatial measures of how individuals relate to their surroundings. One of the most striking differences between men and women's overall travel patterns is the total number of kilometers travelled in Sweden. Men travelled approximately 71 billion kilometers in 1994 which is 61% of the total kilometers travelled. Women travelled 45 billion kilometers or the remaining 39%. In Table 1 below, women are travelling on average 19 kilometers less per day than men.

Table 1
Domestic Kilometers and Person Trips
by Swedish Men and Women, Ages 6-84, in 1984.

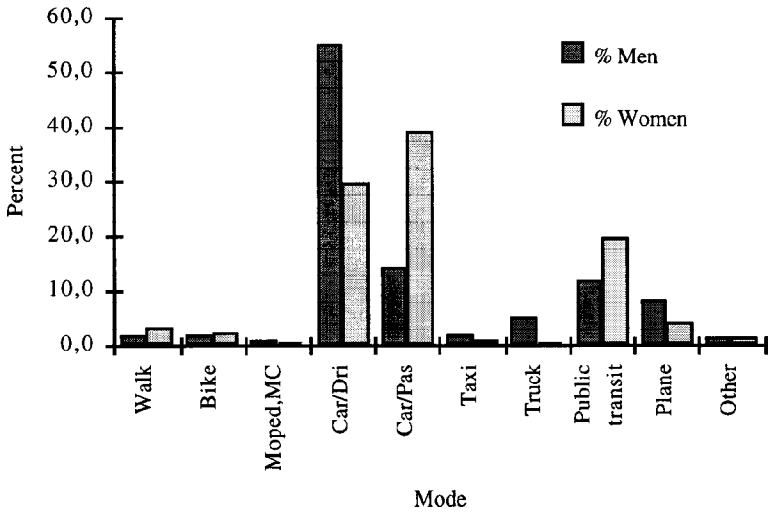
	km (10^9)	% km	Number of Person Trips (10^9)	% Person Trips	Average kilometers per day (km/day)	Per capita trips per day
Men	71	61%	4.4	52%	50	3.0
Women	45	39%	4.0	48%	31	2.8
Total Pop.	116	100%	8.4	100%	40	2.9

SOURCE: Calculated from the 1994 Swedish Travel Survey.

Overall kilometers travelled is one measure of mobility. Another measure is the trips taken per person. In the number of person trips per capita and day, there are small differences between men and women. On this general level, the differences between men and women's travel patterns are predominantly in the extent of travel as measured in kilometers per capita, and less so in the number of trips per day.

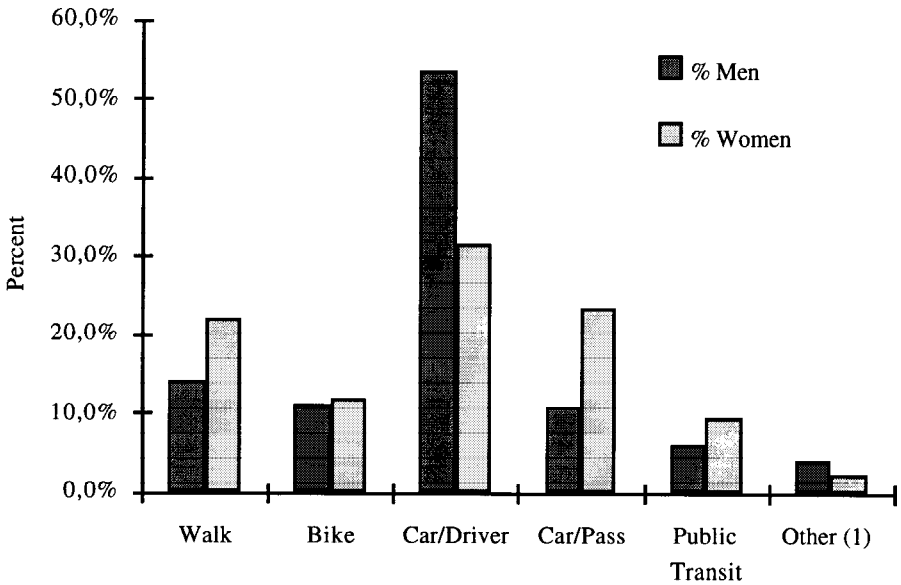
A comparison of the kilometers travelled and the trips per mode can also be used to describe the variety of mode use within the Swedish population in 1994. Women and men are travelling an almost equal share of their total kilometers in a car. This is approximately 69% of their total kilometers travelled. In the number of person trips, women make 54%, and men 64% of their person trips by car. While the total use of the car is very similar in terms of the percent of kilometers travelled, there are striking differences in who drives the car. The study material was collected in terms of who was the driver and who was a passenger. As can be seen in Figure 2, men are travelling 55% of their kilometers as the driver of a car, and 14% as a passenger. Women are travelling 30% of their kilometers as a driver, and approximately 40% as a passenger.

Figure 2
The Distribution of Domestic Kilometers Travelled by Mode,
by Swedish Men and Women, Ages 6-84, in 1994, Percent.



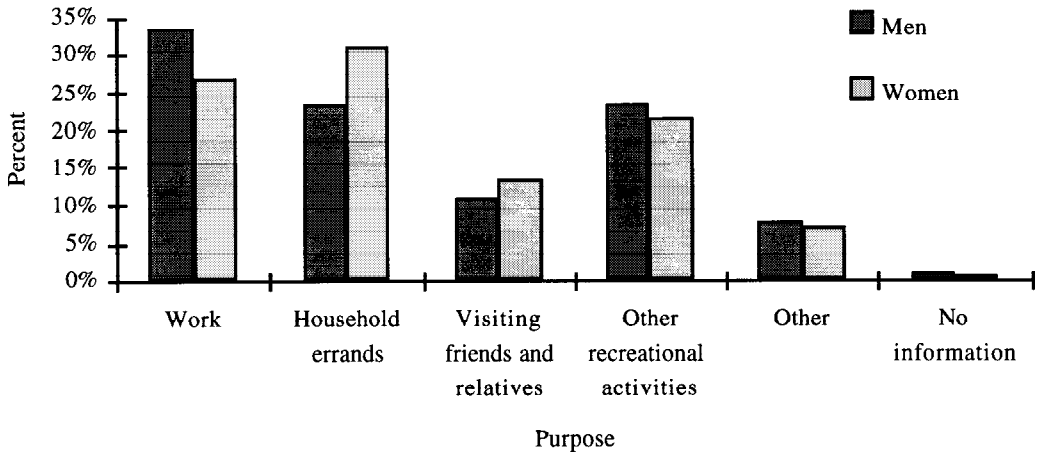
In Figure 3**,** the frequency of men and women's use of the different modes can be compared. The three most frequently used modes by both men and women are car, bike and public transit. Men and women are, furthermore, each making their largest number of domestic person trips as the driver of a car. Despite these similarities, the distribution of mode use by men and women is slightly different. Women are making more trips by walking and public transportation. Men's dominant use of the automobile overshadows the use of the other modes. The only mode where the percent of men and women's person trips by mode used is almost identical is biking.

Figure 3
The Distribution of Domestic Person Trips by Mode
for Swedish Men and Women, Ages 6-84, in 1994, Percent.



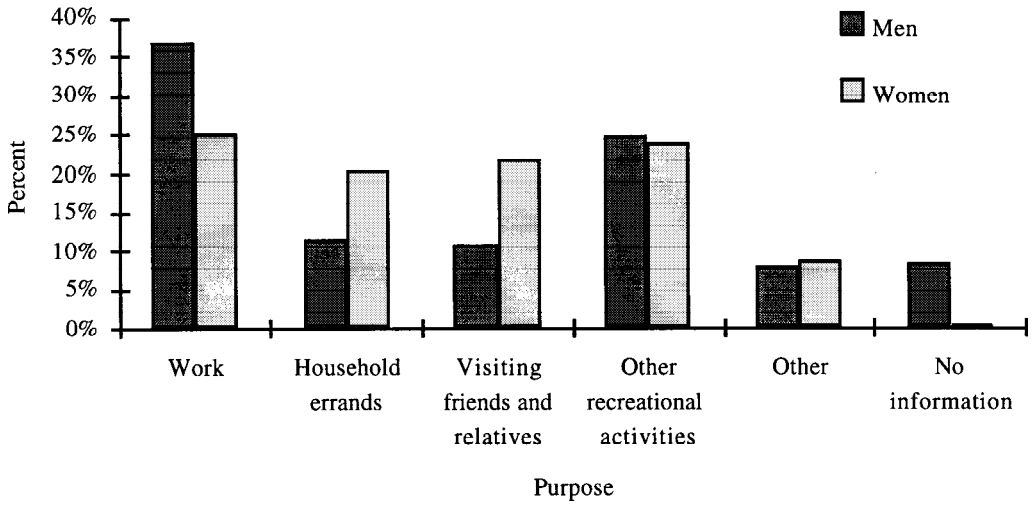
Another important measure of mobility patterns is the purpose for which the trips are taken. Any reduction of the use of the car must concretely take place within an individuals' daily activity patterns. Are some trips more bound in time and space than others? Do all trips need the flexibility that the car offers? The work trip (which includes business trips and the trip to school) while not flexible in time and space, is usually a routine trip with one purpose. Household errands (which include service, health and child care, and shopping trips) are also judged to be routine but not to the same extent as the work trip as they are not as bound to a specific time and place. Trips for visiting friends and relatives and recreational activities are judged to be the most dependent upon individual preferences, and while possibly routine, they are not as externally determined as the work trip. In the survey data, men and women seem to have very similar purposes for their trips. Figure 4 shows that women are making the largest number of their person trips for household errands and second largest to work, while men travel most often to work, and secondly to recreational activities and household errands. The largest differences between men and women are in the number of trips to work and for household errands. As was expected, women are making more trips for household errands. For the entire population, the single largest purpose is the work trip, with household errands with recreational following respectively.

Figure 4
The Distribution of Domestic Person Trips by Purpose,
for Swedish Men and Women, Ages 6-84, in 1994.



The differences in men and women's trip purpose is more pronounced when looking at the kilometers travelled for the different purposes which is presented in Figure 5. Women are travelling an almost equal number of kilometers (from 20-25%) for all of the purposes shown, while men's work trip dominates (37%), followed by household and visiting trips at 11% and 11% respectively. Women and men are travelling and making an almost equal number of trips for recreational purposes.

Figure 5
The Distribution of Kilometers Travelled by Purpose,
for Swedish Men and Women, Ages 6-84, in 1994.



SOCIOECONOMIC VARIABLES : WHY DO MEN AND WOMEN USE THE CAR IN DIFFERENT WAYS?

As has been seen, men and women have similar travel patterns in terms of the overall kilometers travelled by car. Since the previous section has described mobility patterns by grouping men and women as homogeneous groups, this section will deepen the discussion by showing how other factors affect the travel patterns of individuals in Sweden. Since this study of mobility patterns is interested in elucidating the environmental impact of transportation technologies and because the majority of kilometers and person trips are made by car, the following analysis will be limited to kilometers travelled per day by car. While this study will not attempt to unravel the complexities which make up the theoretical discourses surrounding issues of gender, it will attempt to pinpoint the different background variables which can be seen to be connected to mobility patterns. The most important determinant of car use is, of course, access to a car and a driver's license. Driver's licensing rates and access to the car will be presented first. Following this, other background factors which are of interest here will be divided up into those relating to employment status, personal background, life cycle and economic status. The main question to be answered in this section is: Do other background factors besides sex better explain how much men and women use a car on a daily basis?

ACCESS: THE BASIC REQUIREMENTS OF CAR USE

Due to the legal requirement of being 18 or over to attain a driver's license in Sweden, only individuals 18 and older are included in the following presentation concerning access. As can be seen from Table 2, a majority of individuals in 1994, both men and women were licensed to drive in Sweden. For the population between 18-84 years old, 80% had a driver's license. A closer look, however, shows that three-fourths of the unlicensed persons are women and only one-fourth are men.

Table 2
Automobile Licensing Rates of Swedish Men and Women Ages 18 and over in 1994

	License			No license		
	Number (millions)	% (men and women)	% of total	Number (millions)	% (men and women)	% of total
Men	2.9	55	89%	0.3	26	9%
Women	2.4	45	71%	0.9	74	27%
Total Pop.		(100)			(100)	
over 18	5.3		80%	1.2		19%

SOURCE: Calculated from the 1994 Swedish Travel Survey.

Licensing rates of women are dependent upon the age cohort to which they belong. The older female age groups have progressively lower licensing rates, than the younger. Of the 1.2 million unlicensed individuals shown above, half of these are elderly women. Those remaining are divided between all the age groups, though in every age category there are more women without a license than men. Women's licensing rates begin to decrease in the age groups 54 and over while men's only decrease a substantial amount in the over 75 age group.

While fewer new cars were being bought in the late 1980s to the early 1990s due to an economic recession, the number of cars on Swedish roads has still increased. From earlier national travel studies in Sweden it can be seen that the percent of households with access to a car has grown from 74% in 1978, to 77% in 1984/85, and to 80% in 1994[8, p. 20]. The number of households with more than one car has also increased. In 1978, 17% of the representative population had access to more than one car in their household. In 1984/5 and 1994, this number had increased to 20% and 26% respectively[8]. There were 2.9, 2.7, and 2.5 individuals per car, respectively, in Sweden in the study years noted above[8, p. 20].

Since there has been a clear increase in the number of individuals who have access to a car, it can be assumed that both men and women in some way share this increase in access to the automobile. While this is the case on a general level, when age is also taken into account, there has not been an increase in car disposition for all age groups. In Tables 3 and 4, these differences can be seen in both the different age groups and in the total population.

Table 3
Percent of Different Age Groups Who Had a Driver's License and Access to a Car in the Household, 1979, 1984/5, and 1994.

Percent of individuals with driver's license and access to a car

Age	Sex	1978	1984/5	1994
18-24 years	Men	72	73	58
	Women	46	57	46
25-64	Men	84	87	87
	Women	60	69	75
64-84	Men	43	58	77
	Women	7	16	34

Source: Krantz and Vilhelmson, 1996a, p. 21.

In Table 3, it can be seen that for individuals between the ages of 18 and 24, car disposition had decreased for both men and women from 1984/5 to 1994. The reasons for this can be due to the high unemployment rates of this group and the financial limitations which this results in[8]. It is interesting to speculate on what impact this decrease in licensing in the younger age group will have in the future. Will these individuals obtain a license and car as soon as they are financially able, to the same extent as has been the case previously? In the other age groups the differences between men and women is similar to what was noted in the licensing rates. While there has been a decrease in the number of younger individuals who obtain a driver's license, there has been an increase in car disposition in the other age categories. What is interesting to note is that the increases in car disposition of women between 1978 and 1994, while substantial in the older age groups, has still not reached the same level as men. Age cohort effects are more strongly seen in women's access to a car and driver licensing rates than in men's.

In the Swedish population in 1994, 80% of the individuals had access to one or more cars in their household. The percent of individuals with access to a car differs by age, sex and household composition. For all age groups, including children, 77% of the women and 86% of the men had one or more cars. As can be seen from Table 4, 19% of the men and 38% of the women between the ages of 18 and 84 did *not* have access to both a car and a driver's license in 1994. In all age groups, there were more women than men who did not have a car in their household. From Table 3, these differences were noted as being age dependent. However, even with regard to age, women are still not only licensed to a lesser extent than men, they also have less access to a car in comparison to men.

Table 4
Car Disposition for Swedish Men and Women, Ages 18-84,
in 1994, Percent of Total and Percent Men and Women.

	No car access				**Car access**					
	No License		License		No License		License		**Total**	
		total		total		total		total		total
Men	30	7	44	8	23	4	57	82	50	100%
Women	70	16	56	9	77	13	43	62	50	100%
Total	100%	11	100%	9	100%	8	100%	72	100%	100%

Car access can also be analyzed with regard to household type. A majority of households in Sweden are composed of cohabiting couples. Of the Swedish population in 1994, 28% were living in single adult households, and the remaining 72% were living in cohabiting adult households. The largest group of individuals live in cohabiting households with children. This group makes up 39% of the population. The second largest group is cohabiting individuals without children which make up 33%. Of the single households mentioned already, 6% have children. The majority of these are headed by women. As can be seen from Table 5, higher car access is correlated to cohabitation, and to the presence of children. This can be due to the expense of buying and using a car in Sweden and the obvious fact that cohabitation results in an increased income for the household, as well as the fact that children tend to increase the mobility needs of family life. From this study, it is obvious that while the Swedish population is more or less motorized, there are still a large number of individuals who do not have access to a car. Of these, a substantially higher percentage are women.

Table 5
Percent Men and Women in Sweden in 1994,
Ages 6-84, Who Had Access to One or More Cars, by Household Type.

	Single		Cohabiting	
	No Children, %	Children, %	No children, %	Children, %
Men	62	74	92	96
Women	34	60	90	96

SOURCE: Calculated from the 1994 Swedish Travel Survey.

Access to a car can explain the difference in men and women's use of the car in the number of trips which are taken by car as compared to other forms of transportation. It is more difficult to use access to explain the differences in the length of men's travel in comparison to women's. For all households with two or more cars it can be assumed that, in a traditional household, both adult individuals have access to one car. As noted earlier, such households made up approximately one-fourth of the population in 1994. How is car access for the remaining three-fourths of the population? Of the cohabiting households, 60% had one car, 35% had two or more cars, and 6% had no car. It is within the cohabiting households with one car where access to the car is of interest. How is this shown in the length of men and women's daily car travel?

In Figures 6 and 7, household categories for single and cohabiting individuals are given in terms of the average daily travel length by car, and in terms of the number of cars per household. Kilometers travelled per day were calculated from total kilometers travelled by car including both as the driver and as the passenger. Since men are the dominant driver's in Sweden, these figures are different when calculated only for kilometers driven. Because this paper is concerned with the environmental impact of car use, driver or passenger status is not distinguished. For single men and women with one car men are travelling 15 kilometers more per day than women. Though 60% of cohabiting individuals have access to one car, their daily travel lengths by car, show a difference in the extent to which the car is used by men and women. For both single and cohabiting households with one car, men are travelling 50% more than women travel per day by car. As can be expected, cohabiting women in two car households are travelling more than both single women with a car and more than cohabiting women with one car. Cohabiting women with one car are also travelling approximately 10 kilometers more than single women with one car. An interesting difference to note here is the difference in daily travel lengths by car of cohabiting individuals with two cars. Even though women can be assumed here to have equal access to a car, men are still travelling, 15 kilometers more per day by car than women. For households with three or more cars it can be assumed that neither access nor financial pressures limit travel patterns. It is only here, in a group which represents only 5% of the population, that men and women's daily use of the car is very similar.

Figure 6 Average Kilometers Travelled Daily by Car and Number of Cars in Household, by Single Men and Women in Sweden in 1994.

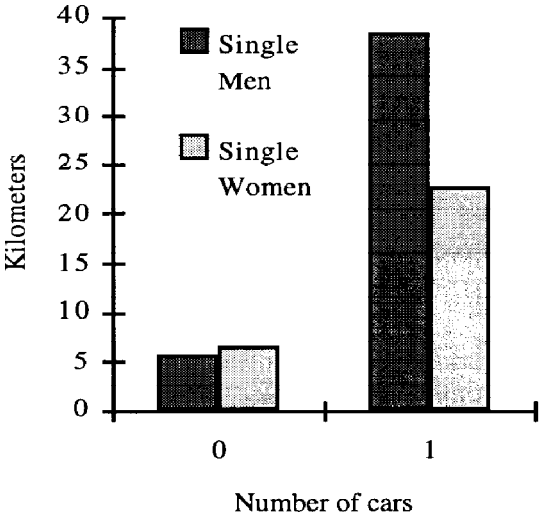
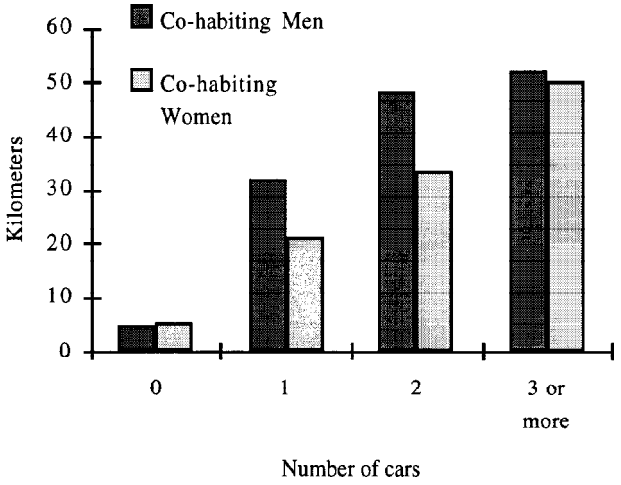


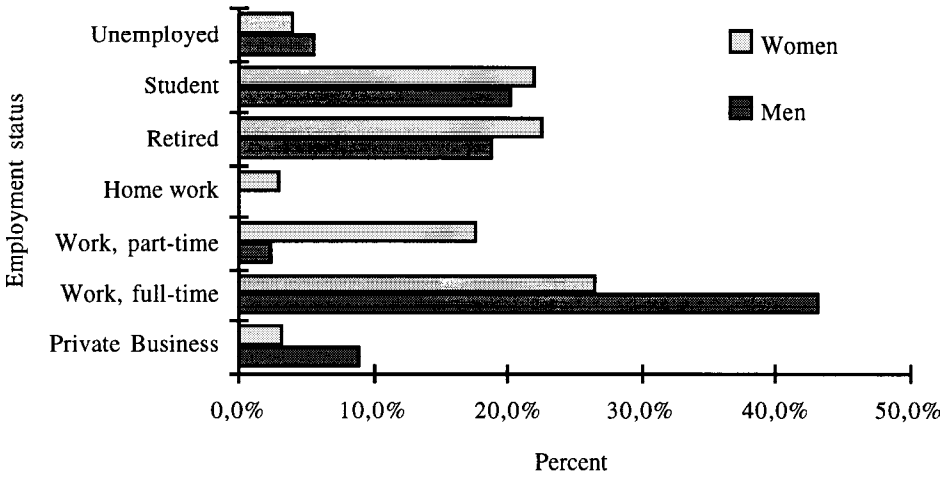
Figure 7 Average Kilometers Travelled Daily by Car and Number of Cars in Household, by Cohabiting Men and Women in Sweden in 1994.



Sweden, despite being considered one of the countries in the world which has the best equality between men and women, still exhibits gendered differences in occupational segregation, hours worked per week and wages. The main difference between men and women's employment is in the number of each who are employed, the type of employment, and the number of hours which are worked per week. In 1995, 80% of women between 20 and 64 were in the workforce, 45% worked full-time, 29% part-time, and 5% were unemployed[10, p. 40]. Though women's participation in the work force has increased greatly from 1970, the largest increase has been in part-time employment. Men's employment has changed most since 1990, with the largest increase in unemployment levels. In 1995 85% of men between 20 and 64 were in the workforce, 71% worked full-time, 7% part-time, and 7% were unemployed (10, p. 41).

As can be seen from these figures, while men and women do not differ greatly in the number who are active in the workforce, there are striking differences in the number of men and women who work part-time. Another important difference between men and women's employment is the job segregation which is still evident in most occupations. Of the 30 largest occupations in Sweden in 1990, *only 3* had 30% or more of the sex which was least represented[10, p. 44]. Traditional women occupations are secretarial, medical, educational and service oriented. Men dominate in most of the remaining occupations. Are these employment and occupational factors connected to the use of the car?

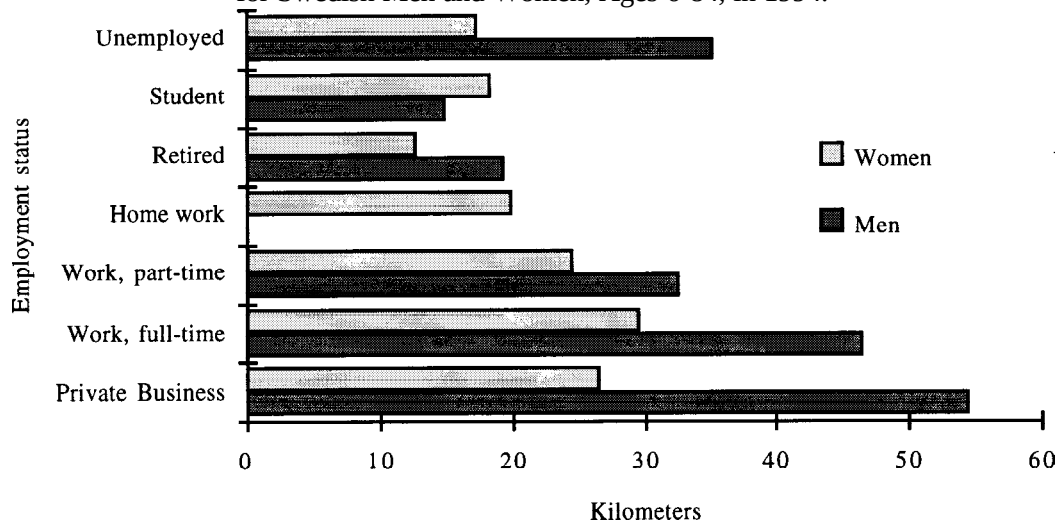
Figure 8
Distribution of Men and Women by Employment Categories in Sweden in 1994, Ages 6-84, Percent.



In the 1994 travel survey data, 54% of the individuals between 25 and 64 were working full-time. This represents 66% of the men and 42% of the women in these age groups. Of the comparative men and women who were working part-time there were 3% and 30%, respectively. The question to be raised, once again, concerns the differences between men and women. If part-time employment is seen as a reason for women's shorter travel lengths, does full-time employment increase it to the comparable lengths of men?

In Figure 9, the average travel lengths per day were calculated by employment status. From this figure, the extent of women's daily use of the car increases only slightly with full-time employment. There is a difference of 5 kilometers between the travel lengths of women working full-time and working part-time. Men working part-time travel, on average, 8 kilometers *more* by car than part-time employed women. The only category where women are making longer trips by car are for studying individuals. Unemployed and retired men are also making longer trips than their respective women, though these are the categories where travel by car is shorter.

Figure 9
Average Domestic Kilometers Travelled Daily by Car, by Employment Category, for Swedish Men and Women, Ages 6-84, in 1994.



An important aspect of women working full-time is the increase in salary that this entails. In Sweden in 1994 women were earning 78% of men's salary within the private sector, and 83% within the public sector[10, p. 55 and 57]. The difference in men and women's wages is often seen as being due to job segregation, where typically female employment, such as teaching, nursing and service jobs, are less paid than men's. Even women with college degrees do not earn as much as their representative men. Within the public sector in Sweden, college educated women earn between 85-89% of men's salary.[10, p.57] Increased hours worked per week does not put women on the same wage level as men, though women working full-time are, of course, earning more than part-time workers.

As seen in the preceding section, access to the car is not adequate in explaining the differences between men and women's daily use of the automobile. Other approaches to this topic in the United States, where the largest amount of research concerning men and women's travel patterns has been conducted, have also analyzed the importance of how the location of home residence and work place affect women's travel pattern lengths. While any sort of direct comparison between Sweden and the United States is inadvisable because of the incomparability of the differences in urban planning and residential living evident in the two countries, an attempt will be made here to draw from research in the US and present what might be applicable to the Swedish case.

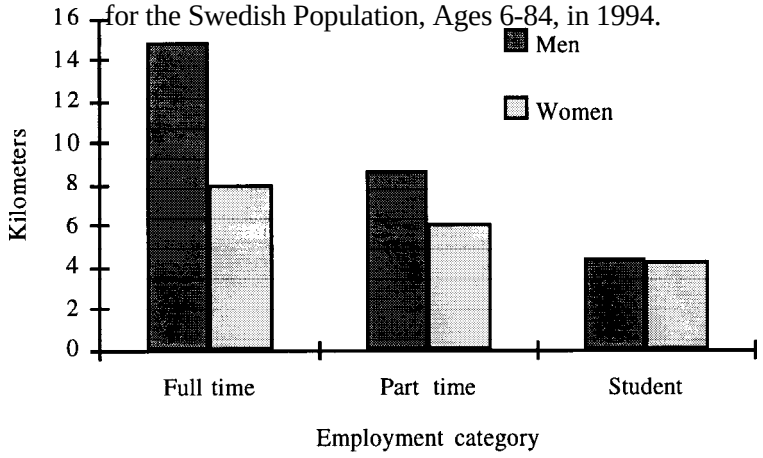
Studies concerning the importance of urban planning and employment locations on women and men's geographic mobility have been presented by researchers in various fields. Susan Hanson and Geraldine Pratt, for example, have shown how the geographical dimensions of sex segregated employment differ for men and women in a study done in Massachusetts[11, 12, 13]. Martin Wachs has discussed how men and women's lives in the US have developed within what he refers to as 'separate spheres'[14, 15]. The spatial location of jobs and the suburbanization of America are obviously important factors which structurally constrain women's travel patterns in ways that differ from the constraints that men experience. Hanson and Pratt in 1995 note, when discussing the development and the persistence of the separation of the private and public spheres in America, that:

> The same distance that would pose no problem to men would be an insuperable barrier for women and would suffice, therefore, to prevent their entry into the paid workforce. The urban/suburban-public/private dichotomy rests, then, on the assumption of a profound difference between women and men in their ability to overcome distance and on its corollary that women and men living in the same location are not likely to have access to the same set of opportunities[13, p. 95].

Though it is perfectly clear that women in the US in many ways have overcome the suburban isolation implied in the above quote, there are still significant differences between men and women's travel lengths as has been shown in numerous studies[13, 16]. Suburbanization is a topic which has not received much attention in Sweden because Swedish demographic patterns are instead distinguished by rural and urban living patterns. Approximately 80% of all Swedes live in urban areas. Another important difference between the two countries is the higher density of urban residential and apartment living in Sweden which would not, on initial inspection, lead to the same separation of household and work place which is so evident in the United States. Importantly though, the results of Hanson and Pratt show that: "Spatial fixedness is central to female labor // Geography is also the medium through which the gendering of the matching process between employers and employees occurs"[12, p. 396]. Even though a direct comparison is impossible to make, it is still interesting to suggest that since a large number of women are employed in predominantly female occupations and show shorter work trip lengths, that similar geographical patterns may be evident in Sweden. It is therefore possible to posit that the location of female and male dominated employment in Sweden follows patterns which result in different commuting lengths for men and women. In order to test such an assumption in Sweden, future work is needed to explore these dimensions.

To apply the previous discussion to the Swedish case, in Figure 10 the length of men and women's daily work trip is presented by employment category. The work trip has been defined to also include the trip to school for comparative purposes. As can be seen from this figure, women's worktrip lengths differ considerably from men's. Full time employed men have daily work trip travel lengths which are twice as long as their respective women. Part time employed men have a daily work trip length which is 40% longer than the travel lengths of women who work part time. The travel lengths of students show small differences between men and women.

Figure 10
Average Kilometers Travelled in the Work Trip, Per Person and Day, for the Swedish Population, Ages 6-84, in 1994.



It is clear from the material that men are travelling longer than women in almost all of the material presented thus far. The work trip was seen to make up 32% of all the kilometers travelled, and this difference has also been looked at in terms of employment. Though the differences in the work trip length are clear, is this enough to explain the differences between men and women's overall travel patterns?

LIFE CYCLE : AGE, HOUSEHOLD COMPOSITION, AND PRESENCE OF CHILDREN

In this section, life-cycle characteristics which include age, household composition, and presence and age of children, will be presented by kilometers travelled by car per person and day. It has already been noted that cohabitation and the presence of children increases car access and travel lengths per day. In the following, the average lengths of car trips per person and day, will be presented for single and cohabiting women and men, with and without children.

In Figures 11-15, the average kilometers travelled by car per person and day was tabulated, for ages of adults and children, and household composition. As can be seen in these figures, men have substantially longer average travel lengths in all categories besides single and cohabiting individuals with older children and for individuals over 65. As was noted in the section on access, cohabitation increases the number of kilometers travelled by car, but in different ways for men and women. While all categories of single individuals travelled less than their respective cohabiting group, the differences between them varied considerably.

Figure 11 Average Daily Domestic Travel by Car, and Access, by Single Men and Women With Children, in Sweden in 1994.

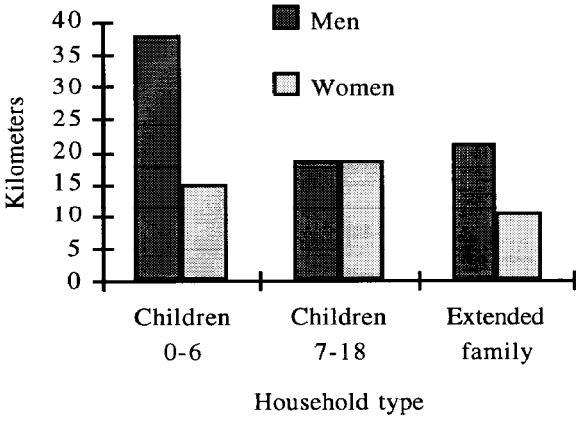
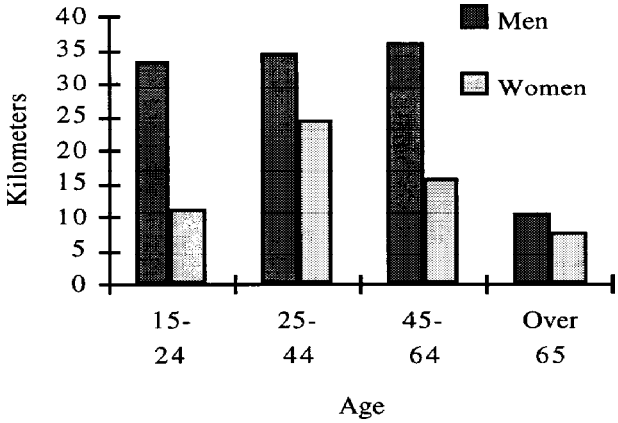


Figure 12 Average Daily Domestic Travel by Car, and Access by Ages of Single Men and Women With No Children, in Sweden, in 1994.



While the pressures of single parenthood are well known, they influence men and women's travel patterns in different ways. It has been shown in studies outside of Sweden, that women are the primary chauffeurs of children in the family and that women's travel is dependent upon the presence and age of children, while men's are determined by other factors.[17, 18] Though respondents were not asked how much they chauffeured their children, it can be deduced from Figure 11 and 14 that because women's daily trip lengths by car increase slightly with older children, and men's decreased, that similar patterns are also evident here. The only time when the daily travel lengths by car between men and women are similar is with single and cohabiting parents with older children.

Figure 13
Average Kilometers Travelled by Age, Per Person and Day,
by Cohabiting Individuals Without Children, in Sweden in 1994.

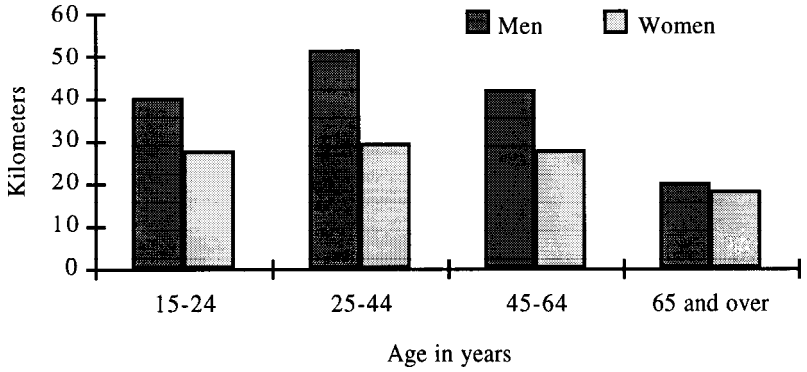
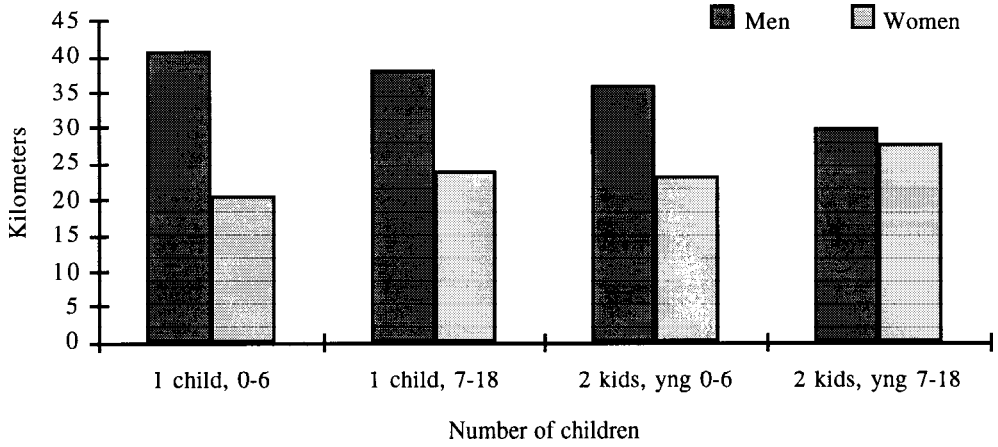
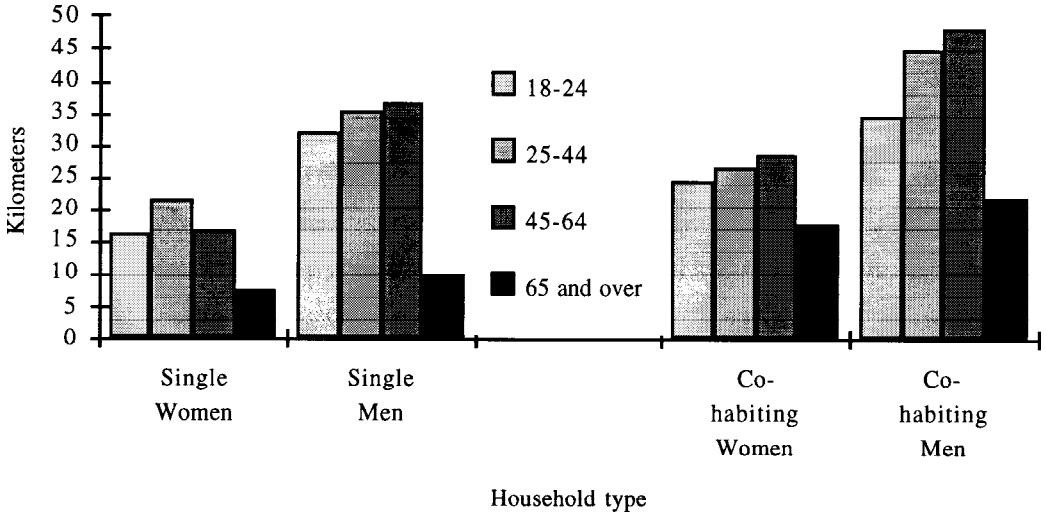


Figure 14
Average Daily Kilometers Travelled by Car, Per Person in Sweden in 1994,
by Cohabiting Individuals With Children, and By Age of Youngest Child.



As is evident in Figures 12 and 15, single and cohabiting men without children under 65 have average daily travel lengths by car which are significantly longer than the respective women. If children were the factor limiting women's travel then these differences would be expected to be less.

Figure 15
Average Daily Kilometers Travelled by Car, Per Person,
by Age and Household Status in Sweden, in 1994.



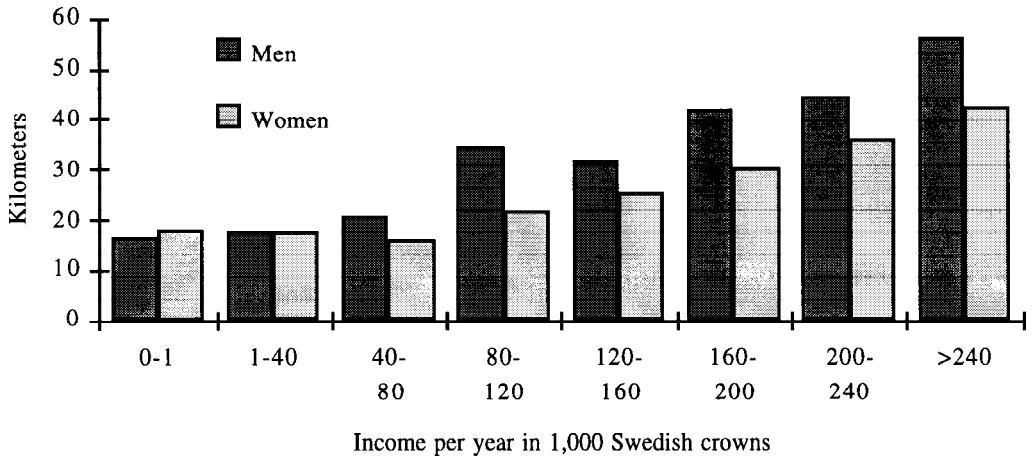
A more direct comparison of the travel lengths of single and cohabiting individuals in Figure 15, shows that cohabiting men, as they increase in age up to 65, have proportionally longer average daily travel lengths than the respective women. From the tables presented in this section, household types and presence of children can be seen to affect the daily travel lengths by car of men and women. Couples with children exhibit longer travel lengths per day, by both men and women, mirroring the spatial complexity that family life demands. While men's travel lengths decrease with the presence of children and the age of their children, women travel farther with older children than with younger. Children in the survey, from the ages of 6-15, are making 45% of their trips as the passenger in a car and 43% by walking and biking. Most urban areas in Sweden have well-developed bike paths which are often completely separated from the roads. Public transportation is also used by children, though to a lesser extent. Of the person trips made by children 1994, 7% were made by public transportation.

If the degree of social equality can be seen in travel patterns, then the above results imply that men and women are not socially equal. If women and men's lifestyles are mirrored in different spatial orientations to their surroundings, then women's lifestyles show a more spatially limited scope of activity. Is this spatial limitation a result of social limitations, or are women more socially limited because they are denied full spatial equality? One way out of this circular causality can be to acknowledge the fact that women and men's social positions are not the same, therefore the fact that their travel patterns are different is to be expected. In Sweden, where sexual equality is considered to be one of the highest in the world, equality between the sexes is still not evident, as was mentioned, in employment status and wages. Since women have traditionally been seen as the main caretakers in a household, this has been cited as a reason for their shorter travel lengths. However, in comparison to many other countries, parents in Sweden are not completely responsible for childcare. Governmental daycare in Sweden is subsidized and considered a right for all, as well as a paid year of parent leave, subsidies for children under 18, rent subsidies for single parents, dental care subsidies for children, medical care coverage and paid sick leave. The current government, as well as the previous, however, is dismantling the Swedish welfare state which has initiated budget cuts by taking away many of the various subsidies which are mentioned here. Despite these recent changes, the combination of working full-time joined with the responsibilities for children should constrain the temporal and spatial resources of men as well as women.
In an earlier study done on men and women's travel patterns in Sweden, it was suggested that travel

patterns are more determined by income levels than by sex[19, p. 29]. Since the automobile is expensive to buy, use and maintain in Sweden, it is obvious that higher income could potentially increase the daily use of the car. Because of the substantial taxes on gasoline and on cars, in 1992 Swedes spent between 14-20% of their total income on transportation. Since men were also seen to earn more than women in the population in general, and in comparable salaried jobs, men obviously have more income at their disposal to spend on car use.

Figure 16

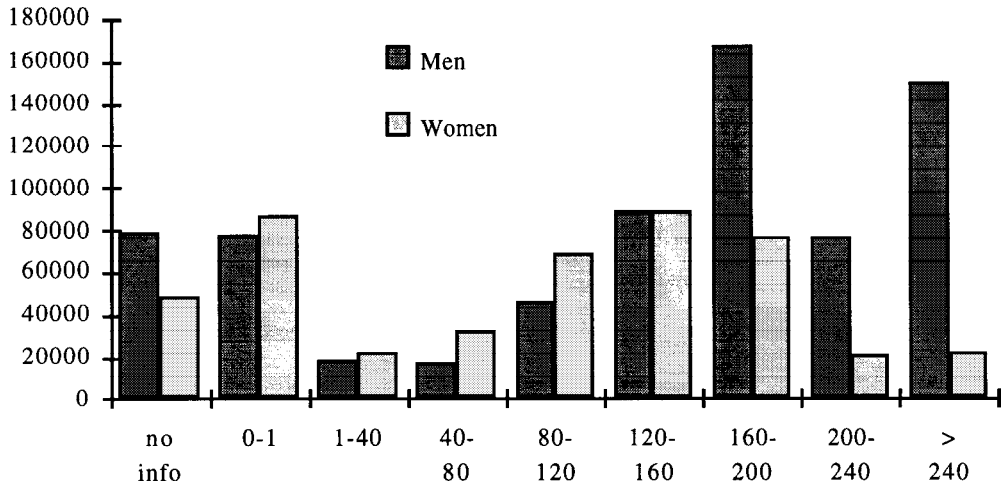
Average Daily Kilometers Travelled by Income (1,000/year) and Sex,
for the Swedish Population, Ages 6-84, in 1994.



One of the limitations with the 1994 study is the few number of women in the highest income groups, and the few number of men in the lower. The lowest income group is predominantly children and individuals under 24 years of age. The number of interviewed women in the two highest income groups were very few in comparison to the number of men. While this may well reflect the economic differences between men and women in Sweden, it may not adequately represent their travel patterns. With that limitation in mind, the following will look at kilometers travelled in the different income groups. Do higher income women travel as many kilometers per day as men?

As can be seen in Figure 16 and 17, higher income men travelled a larger number of the kilometers in 1994 than did higher income women. In Figure 16, the average daily kilometers travelled have been calculated for the different income groups to better compare men and women's travel. Income, in Figure 17, is compared to the total kilometers travelled by the different income groups and is not calculated per person. What this table does show is the distribution of kilometers travelled in the population. As is to be expected, higher income is correlated to a larger number of kilometers travelled per day by both men and women. For the population over 18, car disposition also increases with income for both men and women. Higher income women have more access to a car than lower income women and lower income men, but not more than higher income men.

Figure 17
Total Kilometers Travelled in Sweden,
Ages 6-84, in 1994 by Income (1,000 Kr/year) and Sex.



The effects of income, however should not be overestimated. While women's daily travel lengths do increase with income, they are still substantially shorter than their respective men.

ON THE ROAD TO SUSTAINABLE MOBILITY

The two themes that were mentioned by way of introduction, social equity and ecological sustainability, deal with mobility patterns differently. While the previous sections of this paper have presented and analyzed men and women's travel patterns and daily use of the car, this concluding section will place the discussion of travel patterns within the theme of ecological sustainability. The sustainability of transportation is complicated by the fact that there are a variety of different types of transportation technologies that are used today. One thing which many of these technologies have in common is their use of fossil fuels. The impact of fossil fuel consumption on the environment is a well researched topic. The emissions which are seen to be most responsible for environmental and health problems are carbon dioxide, nitrous oxides, and hydrocarbons as well as particle emissions, as was mentioned in the introduction. Preliminary goals by the Swedish government want to return carbon dioxide emissions to their 1990 levels, with reductions after this goal is reached. There has been a 5% increase in carbon dioxide emissions from the 1990 level today. The 1995 goal of a 30% reduction of nitrous oxides was not met, though a 3% reduction of nitrous oxides has occurred since 1993[20, p. 14]. The goals for VOC's reductions were to reach 60% of the 1988 level, and thereafter not increase[21, p. 145-147]. Furthermore, if no increase of carbon in the atmosphere is the goal, than 50-70% reductions of carbon dioxide emissions would be needed[9, p. 43].

In order to reach these national goals, travel patterns must be seen in terms of their contribution to air pollution. Road transportation in Sweden is responsible for 40% of carbon dioxide emissions, and half of these come from the use of the car. Half of all nitrous oxide emissions come from the transportation sector with road traffic as the dominant source. In Table 6, the Swedish Environmental Protection Agency calculated the share of pollutants that come from the private use of the automobile in Sweden.

Table 6
Cars Percent of Emissions in Sweden, Kton

	Car use, kton	Total, kton	Cars percent of total, %
No_X	92	386	24
CO_2	12,000	60,000	20
HC(VOC)	125	500	25

SOURCE: Reproduced from *Biff och Bil? Om hush llens milj val.* Z, p.21.

Any discussion concerning the environmental damage which is inherent in the use of transportation technologies must not only take fuel use and efficiency into consideration, but also the occupancy per vehicle. Since both men and women travel 69% of their kilometers in a car, the occupancy of this mode is important to elucidate. The best estimations of vehicle occupancy that can be obtained from the study material are that men travel approximately 50% of their kilometers and person trips as the single occupant of a vehicle. For women, one fourths of her kilometers were travelled alone. Despite the fact that men and women are proportionally travelling an equal number of their respective trips by car, a closer look at the characteristics of this use shows a difference in the extent that it impacts the natural environment since energy use per person kilometer decreases with higher vehicle occupancy.

Some of the difficulties involved in comparing the environmental impact of the different travel modes are due to: the types of transportation technologies which are used, the presence of a catalytic converter or not in the car fleet, the use of preheaters in the car fleet, the length of the trips made, and a lack of knowledge of the actual loads. One half of the Swedish car fleet, for example, are equipped with catalytic converters, and 30% with engine preheaters. Because of these difficulties, the environmental impact of the modes will be discussed in terms of energy per person kilometer travelled. Following Lenner's 1993 calculations of energy use and emissions for the different transportation modes in Sweden, these modes were compared and categorized into low energy and high energy intensive[22].

There were 24 different possible travel modes which were divided up into three groups. The first group is called *high energy intensity* modes and includes: car as driver and passenger, moped, motorcycle, taxi, truck, plane, snow mobile, tractor, rental car, and limousine. The second group is called *low energy intensity* modes and includes: walk, bike, train, commuter train, tram, subway, and bus. The third group is referred to as *other* and includes: ride to school, boat, sea traffic, and commercial driving. Since the 'ride to school' was stated as such, mode use was impossible to identify. Boat traffic was also minimal and not categorized because of the variety of boat traffic which includes ferries and private boats.

The above categorization is a rough simplification of the differing emissions and energy use per person kilometer which distinguish the above travel modes. The categorization was based upon two observations. First of all, the modes were judged on the basis of their energy use per person kilometer travelled. Using a value of 0.25 kWh/pkm, all modes above this value were placed in the high energy intensive category, and all below in the low energy intensive value. This number was arrived at by comparing the energy used per person kilometer of the different travel modes. Secondly, due to insufficient data, energy use per person kilometer was not judged on the actual load factors which were used, but on a comparison of available figures on average energy use per passenger kilometer[a. 22, p. 12-17].

Table 7
Kilometers Travelled Differentiated by the Energy Intensity of Travel Modes, and Sex, in the Swedish Population, Ages 6-84, in 1994, Percent

	Low Energy Intensity Modes		High Energy Intensity Modes		Other	
	% km's	% of total	% km's	% of total	% km's	% of total
Men	48.5	14.9	63.6	83.8	51.3	1.3
Women	51.5	24.3	36.4	73.8	48.7	1.9
	(100%)		(100%)	(100%)		
% Total		18.6%		79.9%		1.6%

SOURCE: Calculated from the 1994 Swedish Travel Survey.

In Table 7 it can be seen that of the 71 billion kilometers travelled by men in Sweden in 1994, 84% occur using modes types which are high energy intensive. While men and women travel an almost equal number of kilometers in the low energy intensive modes, this only represents 15% of men's total kilometers, but one fourth of women's. Of the number of person trips made by the different modes, women are travelling approximately half of their trips by the high energy modes, and men two-thirds of their person trips by high energy modes. While women do travel three-fourths of their trips by high energy intensive modes, this is one-third of the kilometers travelled by high energy intensive modes, the remaining two-thirds being travelled by men. Of the 45 billion kilometers which are travelled by women, three-fourths are using high energy intensive modes and one-fourth are made in low energy intensive modes.

CONCLUSIONS

There are many theoretical discussions concerning the reasons behind the differences in men and women's spatial mobility. Differing spatial needs are not only dependent upon women's traditional role in the family, and on women's position as 'socially inferior' with regard to wages and occupational segregation, but also on structural factors such as the location of jobs and access to transportation facilities which limits the available job market of women. Many women may also choose to work closer to home to enable them to spend less time travelling and to be more available for their households should the need arise, but this fact should not limit their access to employment opportunities, nor can it be seen in isolation from the spatial constraints which women face. More specifically, it can be suggested that social inequality has a component of concrete spatiality which is not only a result of individual decisions, but also a result of how society is structurally organized.

This paper has tried to pinpoint the background factors that can be correlated with why men and women have such different travel patterns. It has been seen that household composition, employment, age and income affect the number of kilometers that are travelled daily in a car. In general, the activity patterns of working, middle-aged couples with children are spatially wider in scope than other members of the population, but single men still travel substantially longer per day than both single and cohabiting women. Income is another important factor which, when low, limits the daily travel lengths of both men and women, but when high, increases men's daily travel lengths more than women's. It can be summarized that background factors, especially income, are important in determining daily travel by car. However, in almost all of the material presented and despite the effects of, for example, household composition and income, women are still making shorter daily trips by car.

From the results of this study, women's mobility patterns are judged to be more ecologically benign than men's because of first, the fewer kilometers which are travelled by women, second, the fewer number of kilometers women travel as the sole occupant of a vehicle, and third, the fact that women use high energy intensive modes to a lesser extent than men. This difference in mode use refers to the frequency of women's trips by walking and public transit in comparison to men's. For these reasons, women's travel patterns can be seen to have a higher actual adaptability to a transportation system which is ecologically sustainable and socially equitable. This is due again to the fewer kilometers which are travelled per capita by women and the modes which are used, but also by the fact that women's daily trips by car are, in almost all of the examples given, substantially shorter than men's. An ecologically sustainable transportation system is one in which the private use of the automobile would be much more limited than it is today, and where walking, biking and public transit would fulfil some of the needs which are currently met by the automobile. Shorter daily travel lengths can more easily be substituted by low energy intensive modes, such as walking and biking.

Social equity and ecological sustainability have been the starting points for an analysis of men and women's travel patterns. If it is the case that women are limited socially because of spatial limitations or that they are spatially limited because of differing social roles, one way of increasing women's equality with men could be by increasing women's access to a wider range of spatial activities. Despite the complexity of reasons underlying social inequalities, if social equality is the goal and spatial equality is the means then equal access to transportation technologies can be seen to be a necessity. An increased use of the car would result in increased environmental degradation. If social equality is dependent upon spatial access, then equality between men and women can not be attained with the present transportation patterns and infrastructures in Sweden at the same time that the goals of reducing carbon dioxide, nitrous oxides, and hydrocarbons are met. In other words, the spatial patterns that are seen today in Sweden can only be sustained for a minority of the population.

Any policies which try to reduce travel by car must clearly understand the importance of transportation for present lifestyles in Sweden, and the consequences that the differing impact of political initiatives would have on differing members of the population. Some current proposals for the next national transportation plan in Sweden emphasize economic measures, such as gasoline and road taxes, because they are seen as being both effective in reducing emissions, and politically feasible. Technological developments combined with taxes are one suggestion for reaching the goals for reduced emissions. Such initiatives would especially impact women, children and the elderly by financially limiting their travel. Since these groups already travel less by car, such measures would only increase the inequalities that are already obvious today, and place further financial pressures on lower income individuals and households. Another factor which would need to be studied is the organization of public transportation schedules. Are the transit needs of individuals who work part time being met to the same extent as those that work full time? Peak hour traffic tends to get more resources and attention than off hour traffic. How does this affect the quality of transit that is available for different groups of the society? As stated prior, ecological sustainability can not be reduced to user pay strategies where money determines car use, it must also be reached with as much social equity as is possible and this means supporting and financing forms of transportation that are accessible by all members of the population.

It can, finally, be suggested that the differences which are evident in men and women's use of the car are based on more personal and individual factors having to do with preferences, attitudes, values and experiences which can be related to automobility. Environmental attitudes, for example, have, in other studies in Sweden, been seen to differ on the basis of sex, where women are more often, more environmentally minded than men. Technological systems have also been seen to have symbolic aspects which are more

or less masculine or feminine, ones such as the automobile falling in the prior category. Experiences of technological systems can also be judged to be more or less alienating or suitable for men or women. A questionnaire study has been done in Gšteborg, Sweden by the author to unravel these factors which may better explain women's limited use of the car in comparison to men's. Questions range from general environmental opinions to questions concerning the respondents competence in simple car repairs. The survey material presented in this paper and the questionnaire study mentioned above will be presented in a doctoral thesis being done at the Institution of Interdisciplinary Studies of the Human Condition, Section for Human Ecology.

REFERENCES

1. R. Hjorthol, T¯I, *Kvinners arbeidsreiser: Et viktig premis for offentlig planleggning* , (1990).

2. P. Freund, G. Martin, *The Ecology of the Automobile*. (Black Rose Books, New York, 1993).

3. L. Pickup, in *Women in Cities: Gender and the Urban Environment* J. Little, L. Peake, P. Richardson, Eds. (Macmillan Education, London, 1988) pp. 98-116.

4. Regionplane och trafikkontoret, Regionplane och trafikkontoret, *Stor- och l gkonsumenterna av trafik i Stockholms l n* , (1995).

5. Kvinnliga bilkŒren, *Kvinnor och m n...om bilen. Rapport f r Sveriges Kvinnliga Bilk rer om en SIFO-unders kning i november 1993*. (Kvinnliga BilkŒren, Stockholm, 1993).

6. NaturvŒrdsverket, *Bil och Biff? Om hush llens milj val*. (NaturvŒrdsverket Fšrlag, Stockholm, 1996).

7. Statistics Sweden, *Svenskarnas Resor 1994, Teknisk Rapport*. (SCB, Stockholm, 1995).

8. L. Krantz, B. Vilhelmson, Gšteborgs universitet Kulturgeografiska insitution, Handelshšgskolan, *F r ndringar av den dagliga r rligheten i Sverige 1978-1994* , (1996).

9. L. FrŠndberg, Tourism as Long Distance Mobility: A Quantitative Analysis of Swedes' Leisure Travel from a Sustainability Perspective", Licentiate Thesis, Gšteborg University ,Department of Interdiscipinary Studies, Section of Human Ecology (1996).

10. Statistics Sweden, *P tal om kvinnor och m n, lathund om j mst lldhet,1996*. (SCB, Stockholm, 1996).

11. G. Pratt, S. Hanson, "Time, Space, and the Occupational Segregation of Women: A Critique of Human Capital Theory", *Geoforum* 22, No.2, 149-157 (1991).

12. S. Hanson, G. Pratt, "Geographic Perspectives on the Occupational Segregation of Women", *National Geographic Research* 6(4), 376-399 (1990).

13. S. Hanson, G. Pratt, *Gender, Work, and Space*. International Studies of Women and Place (Routledge, New York, 1995).

14. M. Wachs, "Men, Women, and Wheels: The Historical Basis of Sex Differences in Travel Patterns", *Transportation Research Board* 1135, 10-16 (1987).

15. M. Wachs, M. Crawford, *The Car and the City*. (University of Michigan Press, Ann Arbor, 1992).

16. J. F. Madden, "Why Women Work Closer to Home", *Urban Studies* 18, 181-194 (1981).

17. S. Rosenbloom, *The Transportation Needs of Salaried Mothers and Older Women Alone* . (The Drachman Insitute, Tuscon, 1991), vol. Working Paper 91-04.

18. P. Tranter, Behind Closed Doors: Women, Girls and Mobility, Women on the Move South Australia, 1994), pp. 25-30.

19. Sika, Samplan, *Hur vi reser och varf r: Om olika samh llsgruppers resm nster* , (1995).

20. NaturvŒrdsverket, *Sverige mot minskad klimatp verkan, uppf ljning av m len av v xthusgasar 1994.*(NaturvŒrdsverket Fšrlag, Stockholm, 1995), vol. Rapport 4459.

21. NaturvŒrdsverket, *Trafik och milj . Underlagsrapport till Naturv rdsverket aktionprogram Milj 93*. (NaturvŒrdsverket, Stockholm, 1993).

22. M. Lenner, *Energif rbrukning och avgasemission f r olika transporttyper* . (Swedish Road and Traffic Research Insitute, Linkšping, 1993), vol. VTI meddelande 718.

* This paper is a background chapter for a doctoral thesis being presented at the University of Gšteborg, Institution of Interdisciplinary Studies, Section of Human Ecology.

ENDNOTES

a. 1993 energy use was averaged with 1995 kWh/pkm. For short trips the following values were used: Car (1.2 passenger)- 0.884, Bus-0.218, Commuter train-0.116, and Tram-0.189. For long trips the following values were used: Car (2 passengers)- 0.321, Bus-0.128, Train- 0.141, and Plane- 0.74-0.92. p. 12-17.

b. This is: ride to school, boat, sea traffic, and commercial driving.