Understanding the trip making characteristics of car deficient households in Finland

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Abstract

In many households, there are more adults with a driving licence than there are cars. These households can be considered car deficient. This research explores car deficient households in a Finnish context using data from the Finnish National Travel Survey. Using logistic regressions, the research sought to understand what variables predict if a respondent lives in a car deficient household and for respondents living in car deficient households, we sought to understand the variables the predict access to use a car as a driver. Gender, work status, age, family size, household income, and number of trips by mode and purpose were all found to predict who lives in a car deficient household. In car deficient households, gender was found to be the strongest predictor of having access to use the car. The findings support previous research and raise new topics for future study, including studying intra-household contracts and analysing the activities engaged in by car deficient households.

Key words: Car deficient households, sustainability, travel behaviour, transport equity, transport disadvantage

Introduction

Private motor vehicle travel plays a central role to mobility (Morris et al. 2020; Tiikkaja & Liimatainen 2021). Private motor vehicles offer a range of travel benefits that include facilitating access to destinations, reduced travel times, safety, and comfort for travellers (Dargay et al. 2007; Morris et al. 2020; Spinney et al. 2009). Research demonstrates that there are positive connections between car ownership and a range of quality-of-life outcomes

including employment, earnings, and residential location (Delbosc & Currie 2012; Spinney et al. 2009). However, while there are numerous benefits associated with private motor vehicles, they are also responsible for many challenges to modern society, including congestion, pollution, and public health issues associated with living a sedentary lifestyle and road traffic crashes (Morris et al. 2020).

Globally, transport accounts for 24% of greenhouse gas (GHG) emissions (Wang & Ge 2019). Of these transport emissions 72% originate from road transport, of which 44% are from passenger cars (Wang & Ge 2019). Despite statistics on car usage and ownership showing that there have been consistent increases in both annual kilometres driven and rates of ownership (Dargay et al. 2007; Delbosc & Currie 2012), it is recognised that there is a need to reduce reliance on private vehicles, internal combustion engines, and fossil fuels to meet United Nations sustainable development goals and GHG emission targets (Griggs et al. 2013; United Nations 2018).

The Finnish government has set a target of carbon neutrality by 2035 (Särkijärvi et al. 2018). To reach this target, transport emissions need to be reduced by as much as 39%. In the first instance efforts should be made to cater for peoples' travel needs through active and public transport. However, Finland remains a car dependent nation (Viri et al. 2021), and it is likely that private vehicle travel will continue to be a dominant mode of transport into the future (Viri et al. 2021), particularly in rural areas that are not well served by public transport and when travelling during adverse weather conditions in winter months. As such, understanding private motor vehicle access and use remain important research issues to help achieve required emission reductions while also ensuring an equitable transport system.

Background

Car access has important implications for mobility and accessibility (Spinney et al. 2009; Tiikkaja & Liimatainen 2021). Research in Finland and internationally has shown that age, gender, socio-economic status, and residential location can be associated with an increased risk of mobility and accessibility inequalities (Blumenberg et al. 2020; Delbosc & Currie 2012; Morris et al. 2020; Tiikkaja et al. 2021). With findings showing that car owners and main drivers

in households are often the least mobility constrained (Anggraini et al. 2008; Tiikkaja & Liimatainen 2021).

While car ownership in general has been researched, fewer studies have explored the differences in car usage in households with fewer cars than drivers, particularly within a Finnish context (Tiikkaja & Liimatainen 2021). These households are often referred to as "car deficient" in the literature (Anggraini et al. 2008). However, the term "low-car" ownership is also used as some argue there are negative connotations with the former term (Delbosc & Currie 2012). Clearly, household decisions on the number of cars that they own and operate can have important implications for travel behaviour (Delbosc & Currie 2012). Some car deficient households may choose to share vehicles, perhaps successfully combining car travel with travel by other modes (Tiikkaja & Liimatainen 2021). Other car deficient households may share vehicles because their income prevents them from owning as many cars as there are drivers. In these households, car deficiencies may limit the mobility of household members and, potentially, their access to opportunities, which raises issues of transport equity (Tiikkaja & Liimatainen 2021).

Delbosc and Currie (2012) explored this issue in Melbourne, Australia where they identified that there were two groups of low car ownership households. The first group live voluntarily in households with low car ownership. These households do not experience restrictions in their mobility and typically lived in areas with better public transport alternatives, higher urban densities, and the households had higher incomes. The second group of households were those who were involuntarily car deficient, these households were increasingly likely to report transport disadvantage, low social support, or low wellbeing. (Delbosc & Currie 2012)

In the U.S, Blumenberg et al. (2020) investigated car deficient households in California. They identified that on average car deficient households have lower incomes than non-car deficient households, that they travel less, make fewer trips and use more public transport (Blumenberg et al. 2020). They also noted the challenges of car sharing in households, and that sharing a vehicle can negatively affect the household location, employment outcomes and the ability of household members from engaging in activities. In complimentary research conducted by Morris et al. (2020), they identified that a lack of access

to a car can result in an increased reliance on walking and public transport, which can shrink the geographic region where activities can take place. Combined this results in households engaging in fewer out-of-home activities. Moreover, the activities most likely to be foregone are generally associated with high subjective wellbeing, suggesting that constrained mobility comes with significant emotional costs (Morris et al. 2020).

Numerous studies demonstrate the importance of gender in travel behaviour suggesting that it also plays a role in household-level decisions surrounding car access. The allocation of car resources is influenced by factors including the relative economic position of spouses, the costs associated with travel time, division of household labour, gender roles and personal preferences (Scheiner & Holz-Rau 2012; Tiikkaja & Liimatainen 2021). While much of the research investigating car deficient households has been undertaken at the household level (Scheiner & Holz-Rau 2012), when investigating car deficiency at an individual level, inequalities are also identified between household members (Tiikkaja & Liimatainen 2021). Scheiner & Holz-Rau (2012) investigated the importance of social roles and economic power in intra-household negotiations regarding car usage in car deficient households in Germany. They found that working as an employee outside household had a strong effect on car access, while suggesting that gender roles and patriarchal structures may also influence car access.

However, despite being twice as common as zero-vehicle households, car deficient households have received relatively limited attention from scholars, particularly within a Finnish context. As such, the aim of this research was to explore “car deficient” households or households with “low car” ownership in a Finnish context, and specifically exploring gender differences and differences in car access and usage by spouses. The research questions to be answered are:

- What variables predict if a respondent lives in a car deficient household? and;
- What variables predict access to use a car as a driver in car deficient households?

Methodology

Data

The analysis presented in this manuscript is based on the results of the Finnish National Travel Survey 2016 (NTS) (Pastinen et al. 2018). The NTS is a one-day travel diary documenting all trips made by the participant that were under 100 km long (Pastinen et al. 2018). The NTS targets all Finns who were at least six years old, with the exception of residents of Åland.

The NTS has been conducted since 1974, approximately once every six years. In 2016, the sample size for the national survey was 22,635 respondents and additional regional samples were also drawn. However, the analysis presented in this study only considers the national sample, as inclusion of the regional samples would result in uneven regional distribution of respondents (Pastinen et al. 2018). Furthermore, regional samples do not include information on the respondent's spouse which was critical for the analysis in this manuscript. Altogether, 9,307 people responded to the national sample of the NTS in 2016, representing a response rate of 41.1% (Pastinen et al. 2018).

The respondents of interest from the 2016 NTS were selected as depicted in Figure 1. First, respondents with no spouse living in the same household were removed from the sample and only the respondents with a spouse were retained. Second, respondents with no driving licence were removed from the sample. Third, only respondents with a spouse with a driving licence were retained. Fourth, households with no car were excluded since the purpose was to study the effects of car use in car deficient and non-car deficient households.

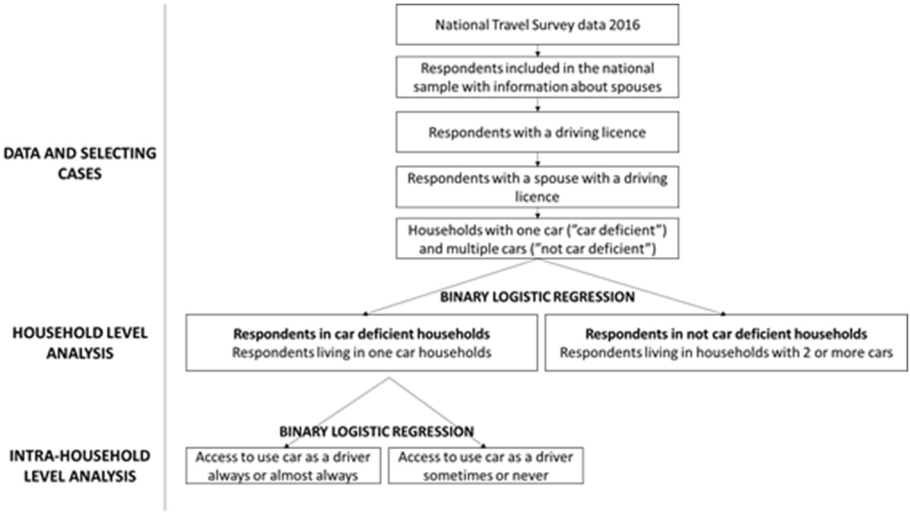

Figure 1. Study design

Analysis

From the data two binary logistic regression models were developed (Figure 1). First, we studied car deficiency at a household level to determine what variables predict if the respondent lives in a car deficient household (N=1,927) or not (N=2,850). Independent variables included both individual (age, travel behaviour etc) and household level (household income, family size etc.) level variables.

First, descriptive analyses were performed to see how each variable interacted with car deficiency. Variables of interest included number of trips (by car, walking and cycling and public transport), trips with the purpose of dropping someone off or picking them up, gender, family size, age, work status and household yearly income before taxes. Work status was collapsed into two groups, employed (full-time, part-time, or occasional workers) and not employed (laid-off, unemployed, not working at all and I don't know) to separate respondents by those needing to make commuter trips. Income was re-grouped into four even size categories. Summary descriptive statistics are presented in Table 1 and Table 2.

Table 1. Descriptive statistics for nominal and ordinal household level analysis variables.

Variables		Car deficient households (N =1,927)	Not car deficient households (N = 2,850)
Gender	Male	53.2%	53.6%
	Female	46.8%	46.4%
Household income (€)	0–39,999	33.6%	17.6%
	40–59,999	29.0%	28.1%
	60–79,999	20.1%	25.9%
	80,000 +	17.4%	28.3%
Work status	Not employed	36.5%	19.1%
	Employed	63.5%	80.9%

Table 2. Descriptive statistics for scale household level analysis variables.

Variables	Car deficient households (N = 1,927)		Not car deficient households (N = 2,850)	
	Mean	SD	Mean	SD
Age	50.5	15.36	48.1	12.09
Family size	2.76	1.16	3.18	1.35
Trip number by walking and cycling	0.75	1.33	0.44	0.91
Trip number by public transport	0.16	0.57	0.05	0.30
Trip number by car	2.02	2.14	2.55	2.27
Trip number of trips to drop off or pick up someone else	0.34	0.88	0.33	0.93

Next a series of logistic regressions were performed. Model fit was assessed using Cox-Snell R^2, Nagelkerke R^2 and -2 Log Likelihood as well as the cases predicted correctly with the model. Variables were checked for

multicollinearity by excluding the less significant variable from the model if risk for multicollinearity was detected.

The second model was constructed considering only respondents who lived in car deficient households. The aim of the second model was to study the effects of car deficiency on access to use a car as a driver at an intra-household level. The model was constructed to see what variables predict how the respondent assesses whether they have access to use a car as a driver for their trips. In this model, household level variables (household income and family size) were not considered since the model was used to predict intra-household issues regarding access to use a car with the focus instead placed on individual level variables.

The respondents were asked to assess whether they have access to use a car as a driver for their trips always or almost always (1,466), sometimes (368) or never (82). The respondents who answered that they had access to use a car as a driver sometimes or never were combined into one group to avoid uneven group sizes. The intra-household logistic regression was developed using the same process as the household level analysis. Statistical analyses were conducted using IBM SPSS 27-software.

Results

Predicting car deficient households

Binary logistic regression was performed to assess which variables predict if a respondent lives in a car deficient household (one car in the household). The final model predicted 66.8 percent of the cases correctly with Cox and Snell R^2 of 0.112, Nagelkerke R^2 of 0.151 and -2 Log Likelihood of 5458.252 (Table 3).

Being female was found to decrease the odds of living in a car deficient household with odds of 0.522. Being employed was also found to decrease the odds of living in a car deficient household with odds of 0.529. An increase in age decreased the odds of living in a car deficient household. As expected, larger family size decreases the odds of living in a car deficient household (odds 0.802). Income was also a significant predictor, with higher income groups having reduced odds of living in a car deficient household.

Undertaking more walking and cycling (OR 1.301) or public transport (OR 1.944) trips were significantly associated with living in a car deficient household. As expected, households that made more car trips were less likely to be car deficient, while an increasing number of trips to drop off or pick up someone else was associated with living in a car deficient household.

Interaction variables were also checked in the model to assess if there were any interactions with gender and the other variables. A significant interaction was identified between age and gender, indicating that females are more likely to live in car deficient households as they get older compared to males (OR 1.010), no other significant interactions were identified between gender and the other independent variables in the model.

Table 3. Car deficient household, logistic regression.

Variables		B	STD. ERROR	WALD	SIG.	OR
Gender (female)		-0.651	0.248	6.901	0.009	0.522
Work status (employed)		-0.636	0.085	55.423	<0.001	0.529
Age		-0.010	0.004	7.947	0.005	0.990
Family size		-0.220	0.031	50.917	<0.001	0.802
Yearly household income before taxes (euros)						
	0–39,999			90.808	<0.001	
	40–59,999	-0.468	0.089	27.402	<0.001	0.626
	60–79,999	-0.696	0.098	50.455	<0.001	0.499
	80,000 +	-0.917	0.101	82.437	<0.001	0.400
Trip number by walking and cycling		0.263	0.031	72.455	<0.001	1.301
Trip number by public transport		0.665	0.083	63.548	<0.001	1.944
Trip number by car		-0.060	0.017	12.253	<0.001	0.942
Trip number of trips to drop off or pick up someone else		0.161	0.042	14.929	<0.001	1.174
Gender (female) * age		0.010	0.005	4.257	0.039	1.010
Constant		1.658	0.253	42.974	<0.001	5.249
Cox and Snell R^2 0.112 Nagelkerke R^2 0.151 -2LL 5458.252						

Predicting access to car amongst respondents living in car deficient households

The second binary logistic regression was developed to assess what factors predict access to use a car as a driver always or almost always in car deficient households.

Gender was found to be significant in predicting access to use a car as a driver in car deficient households. Females had a significantly lower probability (OR 0.242) of having access to the car as a driver for their trips. Increasing the number of trips by walking and cycling (OR 0.905) and by public transport (OR 0.670) were found to significantly decrease the odds of having access to use a car as a driver in car deficient households. Trip number by car was also significant with odds of 1.286, indicating those who make more trips by car increasingly report having better access to a car.

Surprisingly, being employed was found to decrease the odds of having access to use the household car in car deficient households (OR 0.711) The model predicted 78.0 percent of the cases correctly with Cox and Snell R^2 of 0.136, Nagelkerke R^2 of 0.205 and -2 Log Likelihood of 1808.733 (Table 4).

Table 4. Access to use car as a driver in car deficient households, logistic regression.

Variables	B	STD. ERROR	WALD	SIG.	EXP (B)
Gender (female)	-1.419	0.123	133.072	<0.001	0.242
Trip number by car	0.251	0.034	53.745	<0.001	1.286
Trip number by walking and cycling	-0.100	0.040	6.226	0.013	0.905
Trip number by public transport	-0.400	0.090	19.743	<0.001	0.670
Work status (employed)	-0.341	0.125	7.447	0.006	0.711
Constant	1.926	0.141	185.875	<0.001	6.864
Cox and Snell R^2 0.136 Nagelkerke R^2 0.205 -2LL 1808.733					

Discussion

Past studies indicate that car owners and main drivers in households are often the least mobility constrained (Anggraini et al. 2008; Tiikkaja & Liimatainen 2021). Lack of access to use a car may limit mobility and access to activities (Tiikkaja & Liimatainen 2021). This study explored car deficient households in a Finnish context using the findings from the Finnish National Travel survey (2016). Car deficient households were defined as households with fewer cars

than drivers (Anggraini et al. 2008), and in this study analysis was limited to households with two spouses who both held a driving licence and shared at least one car in the household. The research questions in this paper were: What variables predict if a respondent lives in a car deficient household and what variables predict access to use a car as a driver in car deficient households?

Regarding the first research question, gender, work status, age, family size, household income, trip numbers with different modes, and trips with the purpose of dropping someone off or picking them up were all found to predict who lives in a car deficient household. An interaction variable between gender and age was also significant with females being more likely to live in car deficient households as they get older, compared to males. The results support findings by Blumenberg et al. (2020), who state that on average car deficient households have lower incomes than non-car deficient households and that they use more public transport.

For the second research question, gender was found to be significant in predicting access to use a car in car deficient households with females having lower probability to have access to use the household car for their trips. Univariate analysis highlighted that gender alone predicted 76.5% of cases correctly (Cox and Snell R^2 of 0.079 and Nagelkerke R^2 of 0.118). When adding statistically significant variables, the model was able to increase the cases predicted correctly up to 78.0% (Cox and Snell R^2 of 0.136 and Nagelkerke R^2 of 0.205).

The results also indicated that travel habits and having access to use the car are dependent in car deficient households. According to research by Morris et al. (2020), a lack of access to a car can result in an increased reliance on walking and public transport. In this study, it was identified that making more trips by walking, cycling and public transport are significantly associated with the person living in a car deficient household. Furthermore, in car deficient households making more trips by walking and cycling as well as by public transport predicts that the resident has lower odds of having access to use the household car for their trips. Having to rely on walking, cycling and public transport can shrink the geographic activity space and result in engaging in

fewer out-of-home activities (Morris et al. 2020), which can raise transport equity issues (Tiikkaja & Liimatainen 2021).

Being employed was found to decrease the odds of having access to use the household car in car deficient households, which is an indication that intra-household contracts as to who has access to use the car do not depend on work status of the family member but other issues. Being employed was found to increase the odds that there are more cars in the household, however in car deficient households, employment was negatively associated with car usage. This supports research by Scheiner and Holz-Rau (2012) who agree that in addition to economic power, gender roles and patriarchal structures may also influence car access in intra-household negotiations regarding car usage in car deficient households.

This research can be seen as a part of broader equity discussion in transport, even though it focuses on a narrow topic of car deficiency. Having a car in the household and having access to use the car can result in higher subjective wellbeing if car use enables a larger activity space with more daily activities reached (Morris et al. 2020). Relationships between out-of-home activities, wellbeing and satisfaction has been found in Sweden, USA and Germany (Scheiner & Holz-Rau 2012; Tiikkaja & Viri 2021). However, it is important to remember that households without access to a car might be satisfied with their daily travel and able to fulfill their mobility needs without a car (Bergstad et al. 2011). From policy perspective, it would be important to understand the implications of car deficiency on mobility and wellbeing in different regions. Policy measures to reduce car ownership and car use could have different effects on households and wellbeing in different travel environments. Studying car deficient households in more detail would also add understanding if political measures to reduce car use have unequal consequences by gender due to intra-household contracts.

There are limitations to this research. First, defining car deficient households can be done in different ways, if the guideline for the definition is that households with fewer cars than drivers are car deficient. In this research, we didn't include single driver households with no car, and we did not consider adult children in households that may have a driving licence. This was done since having no car at all is very different than having at least one car in the

household, and the intra-household contracts to have access to the household car are likely to be different between spouses compared to relationships between parents and children. However, it is worth noting that different definitions of car deficient households may result in different results. Second, no regional differences were considered. Analysis in rural and urban areas might result in different outcomes regarding travel behaviour and access to public transport. Third, there are limitations with the NTS data, in particular there are no identification numbers provided for spouses, which raises the potential for double counting households and spouses when undertaking this analysis. Unfortunately, this can't be verified, however it is likely to be only a rare occurrence.

Future research on car deficiency should be conducted using regional analysis. Also, qualitative analysis on intra-household contracts would help researchers to understand gender equity issues better. A map-based analysis on activity spaces of those who live in car deficient households and not car deficient households would help researcher to understand the implications of car deficiency on out-of-home activities and possibly wellbeing.

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