Identifying Travel Party Composition of Joint Household Trips in Two Large German Household Travel Surveys

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Short summary

Previous studies on joint household trips were often limited by data availability and focused just on specific types of joint trips. This study employs an iterative matching process with flexible criteria, successfully identifying travel party composition for over 90 % of trips with stated household company in the two large German household travel surveys SrV and MiD. Household-level weights are calculated to enable robust comparison between the two datasets. More than one third of joint trips on weekdays in Germany are parent-child trips. Joint household trips of multiple adults are predominantly performed on weekends. The prevailing purpose of joint household trips is leisure, with education purposes being equally or even more relevant for parent-child travel. The extensive matched dataset offers valuable opportunities for further research and can be a foundation for data-driven behavioural models that capture interdependencies within households.

Keywords: Household travel surveys, Intra-household interactions, Joint trips, Travel behaviour, Travel party composition

1 Introduction

Mobility behaviour is often analysed at the individual level, even though social interactions are determining its context. This social context must be analysed in order to understand mobility behaviour. Intra-household interactions are particularly relevant because joint trips often occur within households, and household travel surveys provide detailed data on these trips and the individuals involved.

While many household travel surveys capture whether or not a trip was joined, usually they do not explicitly ask with whom a trip was made. Thus, trips must be matched across household members to identify joint trips. Singhi (2001) made first attempts to match joint household trips. Gliebe & Koppelman (2002) matched joint household trips to get an empirical basis for modelling activity-travel choices on a household level, but their emphasis was on the behavioural models rather than the optimal identification of joint trips. Kang & Scott (2010) compared the application of restrictive and flexible matching criteria and concluded that flexible criteria are essential to account for reporting inaccuracies. Ho et al. (2012) incorporated consistency checks for matches, based on the stated number of household members travelling together.

To our knowledge, all previous studies were conducted on regional travel survey data with sample sizes ranging from 139 (Singhi, 2001) to 40,003 households (Liu et al., 2022). Many studies focused only on specific interactions, e. g. interactions between adults (Gliebe & Koppelman, 2002) or home-based work tours (Liu et al., 2022). This study aims to identify the demographic groups most engaged in joint trips and to develop a typology of joint trips within the German population. The quantitative analysis of different sub-domains of joint trips such as trips made by parents with their children requires large sample sizes and complete coverage of trip records for all household members.

Table 1: Person-level descriptive statistics after filtering

variable	level	Census data 2023 [%]	SrV 2023 [%]	MiD 2023 [%]
Age[a]	0-14	14.20	16.63	10.24
	15-29	15.83	12.25	11.12
	30-44	19.79	21.09	16.73
	45-64	28.56	28.65	32.33
	65+	21.62	21.38	29.57
Gender[a]	male	49.38	49.15	49.09
	female	50.62	50.65	50.75
	other or no answer	NA	0.20	0.16
Household size[a]	1	20.64	12.24	15.15
	2	32.89	37.66	46.90
	3	17.62	18.01	16.36
	4	18.72	23.01	17.06
	5+	10.13	9.08	4.52
Municipality[b]	metropolis	17.92	38.45	16.36
	regiopolis, large city	14.34	24.73	19.86
	central/medium-sized city	23.02	24.66	24.32
	urban area	22.83	8.35	25.28
	small-town/village area	21.89	3.81	14.18

[a] Census data from the Microcensus (Destatis, 2026)

[b] Census data from the Municipalities Information System (Destatis, 2024)

2 Methodology

This study uses data from the 2023 waves of two major German household travel surveys: the 'SrV – Mobility in Cities' survey (Hubrich et al., 2025) and the national household travel survey (NHTS) 'MiD – Mobility in Germany' (Bäumer et al., 2025). The SrV dataset covers 283,314 individuals from 125,634 households across approximately 500 German municipalities, while MiD covers 420,979 individuals from 218,101 households nationwide. The SrV dataset includes activity locations on a 100 x 100 m grid as well as detailed person-level characteristics. The available MiD data provide person characteristics but omit location information to ensure anonymity. Both surveys capture trips on a single reporting day; MiD's reporting days are distributed throughout the week, whereas SrV collects data only on workdays (Tuesday to Thursday). The SrV sample includes only households with trip information for all members, while the MiD sample also contains households with non-response for some individuals.

To ensure data quality and completeness, households with incomplete or inconsistent trip information were excluded: 1,867 SrV households with differing reporting dates among members, and in MiD, 61,347 households with non-response for some members and 2,938 households with overlapping trips for the same individual. After filtering, the SrV sample comprised 277,806 individuals from 123,767 households, and the MiD sample included 312,455 individuals from 153,816 households. Table 1 compares the filtered, unweighted samples to census data from the Municipalities Information System (Destatis, 2024) and the Microcensus (Destatis, 2026). Both samples generally reflect the age and gender distribution of the population, though the MiD sample slightly under-represents children and over-represents seniors. Single households are under-represented in both datasets; however, since they do not contribute to joint household trips, this does not affect the analysis. The SrV sample is more urban-focused as it is being funded by local municipalities and mobility providers.

Matching trips

The anonymized MiD data lacked precise location information but included 10 spatial context variables (e.g., distance to bus stops, quality of local amenities), which were concatenated to create a pseudo-location. While pseudo-locations served as proxies for matching trips, their reliability

Table 2: Trip matching criteria

Data	It.	Origin	Destination	Start	End	Mode	Company
SrV	1	same	same	±5 min	±5 min	same	same
	2	±150 m	±150 m	±5 min	±5 min	same	same
	3	same	±500 m / NA	±20 min	±20 min	same	same
	4	±500 m / NA	same	±20 min	±20 min	same	same
	5	±150 m	ignore	±20 min	ignore	ignore	same
	6	ignore	±150 m	ignore	±20 min	ignore	same
	7	±150 m	ignore	±20 min	ignore	ignore	±1
	8	ignore	±150 m	ignore	±20 min	ignore	±1
	9	ignore	ignore	±60 min	±60 min	ignore	same
MiD	1	ignore	ignore	same	same	same	same
	2	same	same	same	same	ignore	same
	3	2 diff. values	2 diff. values	same	same	same	ignore

was limited due to a high share of missing values in their constituting variables (around 25%). Trips were matched based on start and end times, (pseudo-)locations, main transport mode, and the stated number of accompanying persons. Flexible matching criteria, as suggested by Kang & Scott (2010), were applied iteratively to account for inconsistent reporting. Several matching iterations with increasingly flexible criteria were conducted, to first capture consistently reported trips and avoid mismatching of those. The matching criteria were developed step by step supported by manual checks. Contradictory matches (e.g., trip A matched B, B matched C, but C did not match A) were automatically identified and excluded. These cases were relatively rare but were excluded to ensure consistency. Data processing and trip matching was implemented in R.

The SrV dataset included the number of accompanying household members, enabling consistency checks against the number of matched trips. In each iteration, only matches with at least as many persons as stated in the company variable were accepted. Unmatched trips were reused in the following iteration. In the final iteration, joint trips with fewer persons than stated were accepted. Table 2 shows the applied matching criteria throughout the iterations. Later iterations (5 to 8) also captured partly joint trips, where origins or destinations differed slightly, or main transport modes varied (e.g., accompanying someone to a station).

In contrast, for MiD a consistency check against the number of accompanying household members is not possible as only the total number of accompanying persons is known in the paper-and-pencil interview (PAPI) survey mode (household members or not). In the computer-assisted web and telephone interview (CAWI and CATI) survey modes, the presence of household members among accompanying persons is known, but not their number. Manual reviews revealed that start and end times were reported more consistently in MiD than in SrV, allowing for stricter time-matching criteria. However, the absence of precise location data and the inability to verify the completeness of travel parties limited the number of iterations to three.

Household weighting

Filtering the datasets to include only households with trip information for all members on the same day altered their socio-demographic and spatial distributions. Large households were disproportionately filtered out in MiD, as they were less likely to provide complete data for all members. As a result, the pre-calculated weights from the original datasets are not suitable for analysis after filtering. Additionally, the SrV sample is predominantly urban, while the MiD sample, as an NHTS, is more evenly distributed across different municipality types. To enable better comparability between the two datasets, new person-level weights were calculated using the raking algorithm, based on the four variables listed in Table 1. Since census data only includes the genders male and female, individuals of other genders or with no gender response, were randomly assigned as male or female for weighting purposes. Joint trips involve multiple household members, so household-level weights were required for their analysis. These were calculated as the mean of the weights of all household members, following the approach suggested by Estevao & Särndal (2006) for hierarchical samples with complete coverage of all units within a cluster, which is the case both for SrV and the filtered MiD data. While the weighting adjusted the SrV sample's distribution across the five municipality

Table 3: Trip matches found per iteration

Survey	Stated hh company	Match	It.	Trips	Share [%]
SrV	yes	yes	1	190,394	71.11
			2	11,376	4.25
			3	11,409	4.26
			4	5,295	1.98
			5	9,246	3.45
			6	4,556	1.70
			7	3,702	1.38
			8	1,014	0.38
			9	5,584	2.09
		no	NA	25,158	9.40
	no	yes	7	2,917	0.48
			8	1,014	0.17
			9	32	0.01
		no	NA	602,326	99.35
MiD	yes	yes	1	175,723	88.23
			2	1,414	0.71
			3	7,078	3.55
		no	NA	14,942	7.50
	unknown	yes	1	53,364	37.60
			2	732	0.52
			3	945	0.67
		no	NA	86,901	61.22
	no	yes	3	1,507	0.30
		no	NA	507,345	99.70

types, it is important to note that the SrV dataset is designed for municipal-level analysis and does not aim to provide nationwide estimates. Instead, the weighting process improves comparability between the SrV and MiD datasets for the purposes of this study.

3 Results and discussion

The number of matches in each iteration is shown in table 3. Overall, the matching process successfully identified joint trips for 90.60 % of trips with stated household company in the SrV dataset and 92.50 % in the MiD dataset. In the first iteration, which applied the strictest matching criteria, 71.11 % of trips with stated household company were matched in SrV, compared to 88.23 % in MiD. Subsequent iterations with increasingly flexible criteria accounted for an additional 18.33 % of matches in SrV and 4.26 % in MiD. Iterations that allowed matching trips without stated household company identified less than 1 % of such trips in both datasets. The PAPI survey mode of MiD does not record household company. In this data, matches are found for 38.79 % of all trips.

The higher number of iterations in SrV reflects the availability of more detailed matching criteria, such as precise locations on a 100 x 100 m grid and the number of accompanying household members for all trips. In contrast, the MiD dataset relied on fewer matching criteria, as locations were unavailable and the number of accompanying household members was not included in the data. MiD showed higher reporting consistency for joint household trips. This is due to pre-filled trip diaries for accompanying household members in the CAWI survey mode (Bäumer et al., 2025, p. 60), which accounted for over 70 % of trip diaries. The pre-filled trips though increase the risk of reporting errors being propagated across multiple diaries.

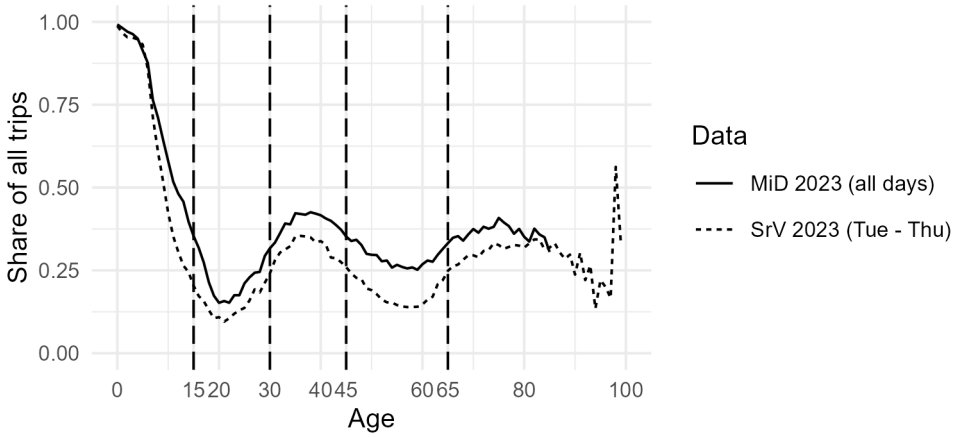


Figure 1: Share of trips with household company by age with age group classification (unweighted)

Joint household trips by age and trip purpose

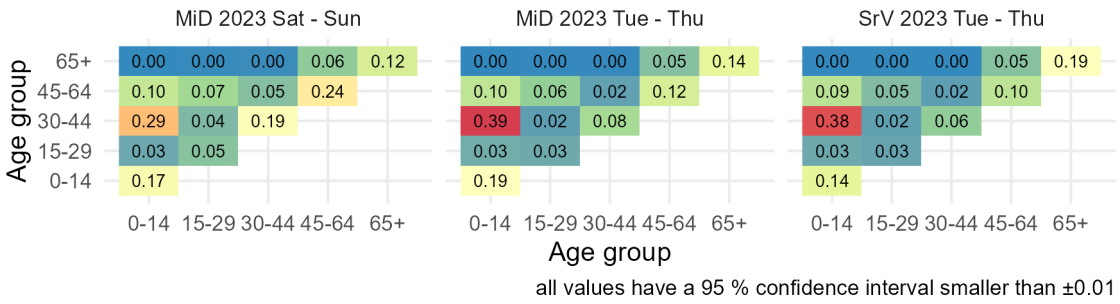
An explorative analysis revealed distinctive patterns in the participation of different age groups in joint household trips. To define suitable age group categories for this analysis, groups were created to isolate those with high shares of joint trips from those with low shares, as shown in Figure 1. Age groups 0–14, 30–44 and 65+ generally have higher proportions of joint household trips than age groups 15–29 and 45–64. Looking at joint household trips from the perspective of what is happening out on the streets, the share of joint household trips that includes a certain age group combination is relevant. Figure 2a illustrates the composition of joint trips by age group pairs, using the household weighting described earlier. Note, that the shares do not sum up to 1, as joint trips of more than 2 people can contain several age group pairs.

On workdays (Tuesday to Thursday), more than one third of all joint trips involve a child under 15 years and an adult aged 30 to 44 years, highlighting the dominance of child-parent trips. Other significant combinations include children or elderly individuals travelling with household members of their own age group. On weekends, the MiD data shows a shift, with joint trips between adults aged 30 to 44 and 45 to 64 years becoming more prevalent, while child-parent trips are less dominant.

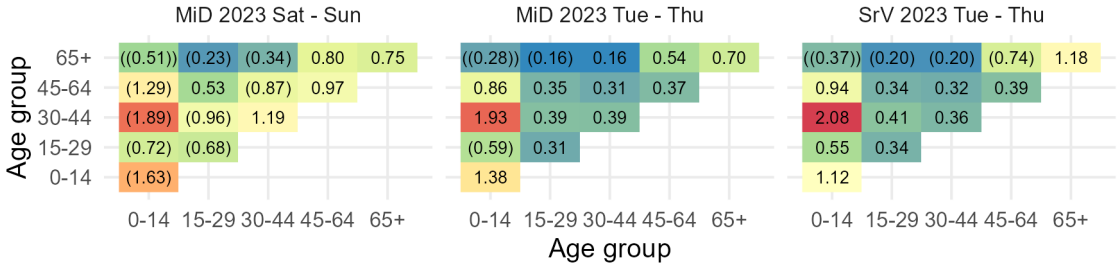
While the share of joint trips provides insight into their prevalence, it is influenced by household composition. To assess the affinity of age groups for joint trips when they live together, Figure 2b shows the mean number of joint trips between age groups in households containing these groups. On weekdays, the same dominant age pairs as in Figure 2a (e.g., children and parents) show a high tendency for joint trips. Additionally, 45 to 64 year-olds frequently travel with children in their households. The lower number of trips compared to younger parents and their children is likely due to their children being older, thus more independent. On weekends, joint trips increase across all age pairs, except for the 0–14/30–44 combination, which remains consistent with workday levels.

Based on the analysis in Figures 2a and 2b, six key age group pairs were identified for further analysis. Figure 2c shows the proportion of trip purposes for these pairs, with purposes aggregated for comparability between datasets. Trips with the purposes *home* and *return from last trip* were excluded from the analysis. Recoding them to the (pre-)previous purpose would introduce unintended sequence order effects (e. g. home-work-shopping-home vs. home-shopping-work-home).

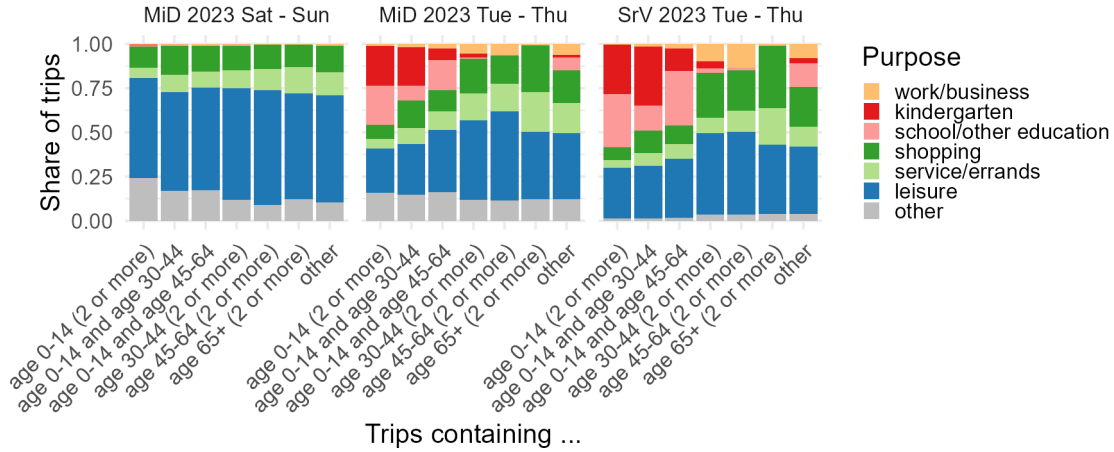
For joint trips involving children on workdays, education-related purposes are prominent, particularly when multiple children are involved. However, in MiD, these trips are less prevalent, possibly due to a higher share of trips with unknown purposes reported as *other*. Among adults, leisure is the most common trip purpose, followed by shopping, services, and errands, which are especially relevant for elderly individuals. Work and business trips are rarely joined. On weekends, leisure trips largely dominate across all age groups, with a more uniform distribution of purposes by age combinations compared to workdays.



(a) Share of all joint trips



(b) Joint trips per household with individuals of those ages



(c) Purpose of joint trips for selected age group combinations

Figure 2: Joint trips by age group combinations (weighted)

4 Conclusions

This study highlights the importance of large sample sizes when analyzing joint household trips, especially given the complexity introduced by numerous possible combinations of household members in joint travel ('Who travels with whom?'). The two German household travel surveys (HTS), SrV and MiD, provide the necessary sample sizes to enable such analyses. With the use of flexible matching criteria, over 90 % of trips with stated household company were successfully matched to corresponding trips of household members, demonstrating the robustness of the matching process.

The characteristics and contexts of joint trips vary significantly depending on the composition of the travel party and household type. Joint trips involving children and their parents constitute more than one third of all joint household trips in the two German HTS, emphasizing the central role of child-parent travel in household mobility. Other notable travel party combinations include trips involving multiple children or multiple elderly persons. On weekends, joint household trips of other age group combinations – such as adults aged 30 to 64 years – become more prevalent, while young people aged 15 to 29 years consistently show the lowest affinity for joint household trips across all days of the week. For weekday trips involving children, education is a key trip purpose. Among adults, leisure trips are the most common purpose while work and business trips are rarely joint with household members in any age group.

The extensive dataset resulting from the trip matching of SrV 2023 and MiD 2023 presents numerous opportunities for further analysis. The insights provided in this paper represent only a small portion of the potential findings that can be derived from these data. For example, the matched joint household trip data can serve as a foundation for advancing the modelling of joint household mobility. This could involve the development of explicit behavioural models or the creation of day plans for agent-based models, which replicate joint trips observed in the empirical data while incorporating interdependencies between household members. Such interdependencies could include constraints where one agent's modification of a trip is also modifying the jointly travelling household member's trip. Detailed understanding and modelling of joint household trips will be essential for an assessment of policy measures that reflect the interdependent nature of household mobility behaviour.

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