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Socio-spatial inequalities in urban mobility: the immigrant-native travel time gap in German cities – a mixed method study

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ABSTRACT

The study ascertains to what extent immigrants in major German cities spend more time on daily mobility and attempts to identify the underlying reasons for this phenomenon. High travel time expenditures have detrimental impacts on health and well-being, employment, and civic engagement besides other areas of life. Daily mobility disadvantages can be linked to residential segregation, which indeed has increased considerably in German cities in recent decades. We hypothesise, that living in disadvantaged neighbourhoods that provide lacking access to public transportation and local services contributes to higher travel time expenditures of immigrants in German cities. We utilise the representative Mobility in Germany 2017 survey, which provides detailed information at the individual- and household-level ($N_{individuals} = 54,259$), enriched with address-level neighbourhood data. Results of hierarchical regression models indicate that immigrants invest a greater amount of time in daily mobility related to commutes, errands, and care work for equivalent distances travelled. However, neither car-ownership, individual transport choices, living in disadvantaged neighbourhoods, nor socio-economic differences fully account for the travel time expenditure gap to natives. Semi-structured qualitative interviews (N= 29) suggest that immigrants make compromises in their daily mobility to protect themselves from perceived unsafe situations, which increases their travel time expenditures.

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Socio-spatial inequality; immigrants; daily mobility; travel time; neighbourhood

1. Introduction

The experiences of immigrant populations are highly diverse and are shaped by intersecting factors such as race, ethnicity, socio-economic status (SES), and migration history. While many immigrants encounter economic and structural disadvantages, others, particularly those with higher education, professional backgrounds, or certain migration statuses, may exhibit upward mobility and integrate into more privileged segments of society

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(Alba and Foner 2015; Waters and Pineau 2015). Nonetheless, research also suggests that even economically successful immigrants may encounter racial discrimination. For some, these challenges contribute to segregated living arrangements. Immigrants are often constrained in their ability to choose where they live, work, or how they navigate their daily commutes and trips to other destinations. The link between residential segregation and daily mobility has been evidenced by numerous studies (Candipan et al. 2021; de la Prada and Small 2024)- for instance, residential segregation is reduced when daily mobility between different neighbourhoods increases (Hołubowska and Poorthuis 2024). However, immigrants make fewer trips throughout the day, travel at slower speeds, and have longer commute times than natives (Akhavan et al. 2019; Bautista-Hernández 2020; Casado-Díaz, Simón-Albert, and Simón 2022; Dilmaghani 2022). This is especially true in metropolitan areas (Casado-Díaz, Simón-Albert, and Simón 2022). These daily mobility constraints are similar to those experienced by groups of lower SES (Allen and Farber 2021; Giesel and Köhler 2015; Sánchez, Isabel, and González 2014).

In capitalist societies, time is a valuable resource, and the lack of time is being recognised as a correlate of socio-economic deprivation with profound negative consequences for mental, physical and economic well-being (Amato et al. 2019; Giurge, Whillans, and West 2020; Halonen et al. 2020). Time scarcity is commonly understood as a lack of sufficient discretionary or leisure time and a high level of time spend on purposes like paid labour (Williams, Masuda, and Tallis 2016). Long travel times are one of the major contributors to time scarcity (Giurge, Whillans, and West 2020; Tranter 2010) and leave individuals with less time for leisure activities, including those that promote subjective well-being, better health, and greater social connectedness (Awaworyi Churchill and Smyth 2019; Besser, Marcus, and Frumkin 2008; Hilbrecht, Smale, and Mock 2014; Stanley et al. 2011), as well as with reduced employment opportunities (Kneebone and Holmes 2015). The act of travelling long hours itself (long hours of sitting, increased exposure to air pollution, etc.) leads to adverse health outcomes (Hilbrecht, Smale, and Mock 2014; Hoehner et al. 2012). Not only does longer travel times mean to have less time for rest and leisure (Xiao, Yang, and Chi 2020) but it is also a source of frustration (Milner et al. 2017).

In the United States (U.S.), it is acknowledged that immigrants' longer daily travel times are due to their transportation choices, particularly to their lower dependence on cars in comparison to natives (Akhavan et al. 2019; Smart 2015; Yum 2020). Their preference against cars is attributed to a lack of economic resources, preventing them from owning a vehicle (Welsch, Conrad, and Wittowsky 2018).

In Europe, particularly Germany, the question of whether immigrants experience a travel time gap compared to natives, and if so, the underlying reasons for this phenomenon, remains unanswered. Germany serves as a noteworthy case study for these questions, primarily due to its high dependency on cars (Saeidizand, Fransen, and Boussauw 2022) and its status as one of the world's largest immigration countries. It is unclear whether Germany will show similar patterns to the U.S., as ethnic segregation is mainly driven by immigration and not, as in the U.S., by historical racial discrimination.

The present study contributes to the field in three ways: First, we will investigate the travel time expenditures of immigrants in German Cities. Second, we seek to ascertain the extent to which relevant neighbourhood characteristics, including public transport accessibility, access to local services, and residential quality, explain immigrants'

longer daily travel time expenditures in German cities. We utilise the Mobility in Germany survey of 2017 ($N_{individuals}$= 54,259), which allows to differentiate between different trip purposes, provides information on individuals, households and has been enriched with independent data on respondents' neighbourhoods. A common challenge in the study of daily mobility behaviour is the inability to infer the intentionality behind certain mobility patterns (Daramy-Williams, Anable, and Grant-Muller 2019; Yu 2016). Our third contribution is to address this challenge. We conducted semi-structured qualitative interviews with immigrants residing in German cities (N=29) in March and April 2022, inquiring about their perceptions of daily mobility and the rationales behind their travel decisions.

Many studies examining travel time expenditures have concentrated on commuting. While this is a significant aspect of daily mobility, other activities, such as running errands like grocery shopping or attending medical appointments, daily mobility related to care work like taking children to school, and leisure activities, such as getting to the cinema, also contribute considerably to overall mobility patterns (Nobis and Kuhnimhof 2018). Our study therefore is focused on a wide range of mobility purposes: commuting, errands, shopping, care work and leisure activities.

Our results indicate that immigrants spend more time travelling than natives for equivalent distances in German cities, even after controlling for SES and demographics. This discrepancy can be attributed, in part, to immigrants' reduced reliance on cars. Neighbourhood characteristics only explain longer travel time expenditures for specific trip purposes, contradicting to our expectations. Instead, our qualitative analysis suggests that immigrants may be willing to accept 3in order to avoid compromising their perceived personal safety, for instance for female immigrants, sexist harassment. We also found that because immigrants experience mobility modes other than cars as unsafe, they harbour reservations about transport policies aimed at reducing private vehicle use for environmental sustainability.

2. Research background

In Germany, car ownership is the most decisive factor in everyday travel due to the country's strong car-oriented infrastructure, suburbanisation, and limited public transport options in certain areas. Immigrants in Germany are less likely to own a car (Mattioli 2017; Welsch, Conrad, and Wittowsky 2018) and if they do possess a vehicle, the number of cars in immigrant households does not increase with household size, in contrast to native households (Suhl, Welsch, and Reutte 2012). The reasons for these discrepancies are primarily attributed to the disadvantaged SES of immigrants, given the high costs of cars (Delbosc and Shafi 2023; Lubitow, Tompkins, and Feldman 2019). Moreover, the gender disparity in mobility behaviour (women utilising automobiles less than men) among Turkish immigrants in Germany is more pronounced than among native Germans (Suhl, Welsch, and Reutte 2012). Studies conducted in Europe and the U.S. indicate that immigrants also utilise bicycles less frequently than natives (Basaran, Kristoffersen, and Haustein 2021; Lubitow, Tompkins, and Feldman 2019; Welsch, Conrad, and Wittowsky 2018; Yu 2016). This leaves walking for shorter distances and using public transportation for longer distances as the predominant travel mode among immigrants. Even in German cities that provide sophisticated public

transit systems, using public transportation is considerably slower than travelling by car (Mocanu, Joshi, and Winkler 2021).

Although immigrants are more reliant on public transportation, this does not imply that they have more or equal access to it. This problem is closely associated with ethnic segregation, the unequal distribution of immigrants across urban neighbourhoods. In Germany, segregation is an important measure of inequality (Helbig and Jähnen 2019) and has a particularly adverse impact on immigrants (Glitz 2014). Therefore, immigrants are often constrained in choosing where they reside, work, and conduct their daily errands (Wiedner et al. 2021). In some instances, the location of one's residence and place of work may not align, resulting in longer commuting times (Casado-Díaz, Simón-Albert, and Simón 2022). Evidence from the U.S. shows that the disparities in different travel mode choices of immigrants and natives are most pronounced when immigrants reside in neighbourhoods densely populated by other immigrants (Smart 2015). Female immigrants residing in segregated and socio-economically disadvantaged neighbourhoods perceive an even more significant limitation on their daily mobility (Lee, Vojnovic, and Grady 2018).

Studies from China and the U.S. show that the built environment, beyond the traffic infrastructure, is more predictive of commuting mode choices than socio-demographic characteristics (Akhavan et al. 2019; Chatman 2014; Liu and Xiao 2022). A study of 17 European cities also showed that immigrant neighbourhoods have less access to public transport, although this does not apply to the German and Dutch cities in the sample where natives experienced lower accessibility Bartzokas-Tsiompras and Photis (2019). Nevertheless, the direction of causality between segregation and mobility behaviour remains ambiguous. Segregation does not only lead to unequal mobility patterns due to infrastructural disadvantages, but differences in mobility behaviour also contribute to segregation patterns (Candipan et al. 2021; de la Prada and Small 2024).

The majority of research on this topic originates from the U.S., a context that differs significantly from Germany. First, urban settlement structures in the U.S. are characterised by stronger suburbanisation and higher car-dependence in cities (Schwarz 2010), whereas German and other European cities tend to be more walkable (Buehler 2011; Dieleman and Wegener 2004). Consequently, the influence of car ownership on daily travel may be less pronounced in Germany. Second, segregation also differs between the two contexts. In Germany, economic inequality is generally less severe (Brandolini and Smeeding 2006), which contributes to lower levels of residential segregation (Helbig and Jähnen 2019). Additionally, patterns of ethnic segregation diverge, as Germany has fewer mono-ethnic areas compared to the U.S. (Musterd 2005; Wiedner, Schaeffer, and Carol 2022).

Against this background, our objective is to analyse the travel time of immigrants in German cities. Furthermore, we want to elucidate the factors contributing to potential longer travel time expenditures. We posit that immigrants invest a greater amount of time travelling the same distances as natives for trips that are most constrained by neighbourhood conditions, namely running errands, shopping trips, care-related journeys, and commutes to work. This is in contrast to trips for leisure purposes, where individuals are more flexible in choosing their destinations (1). Moreover, we test various explanations for higher travel time expenditures among immigrants, in particular that they travel less by car and more often by public transport as well as by foot/bike (2a) and

that immigrants live in neighbourhoods of inferior residential quality that have worse access to public transportation and to local services (2b).

The use of standardised surveys of daily mobility or purely observational data carries the risk of misinterpreting observed differences in immigrant mobility behaviour as a consequence of economic or residential factors, when in fact, these differences may be attributed to socio-cultural constraints including discrimination, language barriers, unfamiliarity with traffic rules, and so on (Basaran, Kristoffersen, and Haustein 2021; Lee and Scott 2017; Yu 2016). Therefore, we conducted semi-structured qualitative interviews with immigrants from German cities to gain insight into the extent to which certain daily mobility choices of immigrants are due to discrimination or other factors that are not accounted for in standardised surveys (3).

3. Data and methods

In order to gain a comprehensive understanding of daily mobility patterns of immigrants in German cities, we adopt a mixed-methods approach. The following chapter presents a detailed examination of the quantitative data and methodology, as well as our qualitative approach.

3.1. Quantitative data and methods

3.1.1. Sampling, data and weighting

This study uses individual-level data on daily mobility, SES, and demographics from the 2017 *Mobility in Germany* (MiD) survey. The MiD was conducted by the social research institute *infas* in 2017 on behalf of the *Federal Ministry of Transport and Digital Infrastructure*. It is representative of the German population across all ages. The survey data were made available to us by the *German Aerospace Center*.

The MiD follows a two-stage sampling: household interviews followed by individual interviews. A random sample of households across Germany was selected based on population registers, as well as through random-digit-dialing of both landline and mobile phone numbers (triple-frame design). A questionnaire was administered to each household, requesting basic information about the household and offering the option of a more detailed follow-up interview with each member. These interviews were conducted via postal mail, computer-assisted telephone interviews, or online, and were available in multiple languages. All respondents consented to anonymised data use for research (infas 2019). Respondents logged daily journeys on a randomly assigned day over 1.5 years to avoid day-of-week and seasonal bias (infas 2019). The net response rate was 6 % at the individual level (RP3 response rate according to AAPOR 2016).

The sample exclusively encompasses respondents aged 20 to 60 years, as the daily mobility behaviour of children, adolescents, and pensioners diverge considerably from those of the working-age population. The sample is limited to large cities in Germany, as defined by the *German Federal Ministry for Digital Affairs and Transport*. This includes 82 German cities with a population of at least 95,000 (BMVI 2024) (a list of all cities can be found in Table A1 in the Online Appendix). The analytical sample comprises 54,259 individuals from 31,576 households who undertook 186,896 individual journeys.

Gathering information about daily mobility presents a significant challenge, particularly in terms of determining exact journey details. To address this, respondents were provided with notebooks or online options for recording their journeys. When respondents recorded their journeys retrospectively, an interviewer was present to assist. Journey endpoints were determined by interactive lists or by writing down addresses. Travel distance, duration, and speed were calculated from respondent data.

The data have been weighted according to a number of factors, including the season and day of the week of the survey, the respondent's place of residence, household size, employment status, education, age, and gender. Furthermore, the data weights address the disparate selection probabilities associated with the survey's triple-frame design and adjust for non-response rates among specific sub-populations. For further details, please see (Follmer and Gruschwitz 2019). A non-response survey was employed to obtain preliminary data on non-respondents. No significant differences were observed in travel patterns between respondents and non-respondents. However, the realised survey exhibited a slight under-representation of respondents with a high volume of daily journeys (Follmer and Gruschwitz 2019).

3.1.2. Variables

The variables included in the analysis are described in Table 1, while Table 2 presents the summary statistics. The key independent variable in our analysis is immigrant status whereas travel time expenditures per mobility purpose are our outcome variables of interest. The literate commonly uses travel time as an indicator for long daily commutes or long all-purpose travels (Joly 2004). While this is a more precise measure of inequality than daily travel distance, which does not provide much indication of how burdensome daily mobility might be, it is still problematic. It equates individuals who have travelled very long or very short distances in the same amount of time. Consequently, we employ travel time expenditures as the pivotal metric, which calculates travel times under the assumption that travel distance is equivalent. Statistically, this is achieved by using travel time as the dependent variable, while travel distance is held at its mean by incorporating it as a control variable. The difference to travel speed is not only a matter of semantics but also of practical significance. The knowledge that immigrants might travel at lower or higher average speed merely permits very abstract interpretations. Conversely, the utilisation of travel time expenditures facilitates the articulation of the impact of neighbourhood characteristics in terms of the additional time residents must invest in their daily mobility to reach destinations that are comparable in distance, which allows us to interpret the results in the context of time scarcity research in general. To test hypotheses (2a), we introduce car ownership, distance travelled on foot and by bicycle as the main mode of transport, as well as the proportion of distance travelled using public transport as the main mode of transport (in %) as control variables. Regarding hypothesis (2b), we control for access to public transportation, proximity to local services, and residential area quality, all measured at the 1km-by-1km grid level. Lastly, we incorporate a set of demographic and socio-economic control variables, including household income, employment status, gender, age, and the presence of children in the household.

Table A1 in the Online Appendix presents a descriptive analysis of the relationship between the explanatory variables, including the accessibility of local services, area

Table 1. Variable description.

Variables
Immigrants: Immigrants are defined as individuals who either themselves or at least one of their parents were not German citizens by birth.
Daily Travel Time (minutes): Total travel time on the day of the survey is the sum of the duration of each trip in minutes from start to end point by any transport mode. Responses were capped at the 99th percentile and log-transformed (West 2022). We differentiate the distance travelled by purpose, namely for commuting (going to work, school, or training), errands (running errands or accompanying others), leisure (recreational activities like attending concerts or dining out) and shopping.
Daily Distance Traveled (kilometers): Total distance travelled on the day of the survey is the sum of the length of each trip in kilometers from start to end point, by any transport mode. If missing (initially 8.91% of all trips) distance travelled was imputed based on the start and end point of each trip and its duration and/or mode of transportation. Responses were capped at the 99 percentile. Distribution is log-linear and was log-transformed for inclusion in regression analyses. Different purposes are distinguished: commuting, errands, shopping, care-work and leisure.
Distance travelled by Car, Public Transport and Bike and Foot (%): Percentage of total daily distance travelled by either car, public transport, or by bike/foot as the main mode of transportation.
Employment: The respondents were classified into categories based on their employment status. These categories include individuals engaged in paid employment, encompassing those employed on a full-time, part-time, or training basis. The category of individuals not engaged in paid employment included students, pupils, homemakers, retirees, unemployed individuals, and caregivers.
Household Income: The economic status of households was determined based on equivalised income. The disposable income of the households, which was calculated after taxes and deductions, was divided into 15 categories and adjusted for household size by weighting the first person aged 14 and over by 1, each additional person in that age group by .5 and each child under 14 by .3. The adjusted disposable household income was then categorised into five quantiles based on the entire sample, including non-urban residents, respondents who were not mobile on the day of the survey, are retired, or declined to participate in the localised sample.
Quality residential area: Describes the quality of a residential address based on the characteristics of its surrounding environment. In order to evaluate the quality, an index value is derived from specific, measurable characteristics. Each criterion is evaluated across four classes, ranging from 'very poor' (1) to 'very good' (4), and assigned a distinct weighting. These include the unemployment rate per district, the type of buildings within the block (such as residential, commercial, or mixed-use), the social class associated with the address, building density at the settlement block level, distance to the nearest public transport stop, the type of residential building, the building's use (whether residential, commercial, or mixed), distance to the nearest business centre street type at the address, purchase price per square meter, and the location of the house within the municipality.
Accessibility local services: Assess the accessibility of local amenities at the address-level. In order to evaluate the quality, an index value is derived from specific, measurable characteristics. Each criteria is evaluated across four classes, ranging from 'very poor' (1) to 'very good' (4), and assigned a distinct weighting. Distances to 13 types of local services (general practitioners, pharmacies, supermarkets, drugstores, shopping centres, grocery shops, bank branches, ATMs, hairdressers, kiosks, post offices, restaurants, and petrol stations) are calculated for 21 million addresses.
Distance to the next bus/tram/train station (meters): The distance to the nearest bus, tram, or train station with at least 28 departures on a typical weekday was measured as the shortest straight-line distance between the address of the household and the nearest station.

quality, public transport quality, car ownership and the percentage of kilometers travelled by car as the main mode of transport for each trip purpose.

3.1.3. Statistical approach

Because the MiD questioned every member of each randomly selected household, the data on individual respondents are clustered within households. We therefore applied a multi-level approach that accounts for this data structure. Our main dependent variable average daily travel time expenditures is metric but highly skewed (see Figure 1 in the Online Appendix) and was log-transformed to be included in a linear regression analysis. We estimated multi-level ordinary least squares (OLS) random-intercept-fixed-slope multi-level models. We specified fixed slopes because we do not test whether the statistical association between, for example, immigrant status and travel time expenditures varies between different households. However, we assume that different households differ in terms of the average travel times of their members,

Table 2. Summary statistics: daily travel time expenditures (minutes).

Variables	*N*	Mean	SD	95% CI
Individual characteristics				
Immigrant	2540	98.102	80.207	94.98, 101.22
Native	21604	102.013	82.447	100.91, 103.11
Female	23963	101.910	82.478	100.87, 102.95
Male	22278	98.994	82.763	97.91, 100.08
Age				
20–30	8983	102.223	83.868	100.49, 103.96
31–40	10422	102.203	81.735	100.63, 103.77
41–50	12042	99.715	81.485	98.26, 101.17
51–60	14794	98.910	83.381	97.57, 100.25
Education				
Elementary school or no degree	1974	88.138	76.120	84.78, 91.5
Secondary school	6859	94.669	78.331	92.82, 96.52
A-level	8758	100.225	81.229	98.52, 101.93
University degree	20691	105.845	85.593	104.68, 107.01
Employed	38549	100.254	81.977	99.44, 101.07
Unemployed/in training	7656	101.633	85.633	99.72, 103.55
Household characteristics				
cIncome				
Very Low	1703	102.645	85.389	98.59, 106.7
Low	3114	97.616	80.244	94.8, 100.43
Middle	14577	100.195	82.432	98.86, 101.53
High	20018	99.839	81.449	98.71, 100.97
Very High	6829	103.903	86.664	101.85, 105.96
Kids	15457	98.949	79.231	97.7, 100.2
No kids	30550	101.195	84.232	100.25, 102.14
Cars	38296	98.380	80.818	97.57, 99.19
No Cars	7941	110.665	90.027	108.68, 112.64
Neighbourhood characteristics				
Quality residential area				
Very Low	4213	99.449	81.425	96.99, 101.91
Low	9329	99.569	79.986	97.95, 101.19
High	10986	101.622	84.287	100.05, 103.2
Very High	16657	101.719	84.725	100.43, 103.01
Accessibility local services				
Very Low	2270	98.863	80.336	95.56, 102.17
Low	18011	99.45433	81.338	98.27, 100.64
High	15276	102.770	84.662	101.43, 104.11
Very High	5659	102.369	85.907	100.13, 104.61
Distance to the next tram station[A]				
<499 m	8311	103.389	86.794	101.52, 105.26
500–999 m	6638	100.550	81.486	98.59, 102.51
1000–2499 m	22094	98.351	80.791	97.29, 99.42
Distance to the next train station[A]				
<499 m	1414	103.723	82.727	99.41, 108.03
500–999 m	10624	101.736	83.769	100.14, 103.33
1000–2499 m	29696	99.678	82.057	98.75, 100.61

Notes. Average daily travel time in minutes for different individual, household, and neighbourhood characteristics for respondents aged 20-60 years in German cities. Extreme values for daily travel times (top 1 percentile) were re-coded to the next highest value.

[A]These variables are reported by the MiD survey as categorical, as shown in Table. Addressing this limitation is not possible, as the exact place of residence of respondents is not disclosed in the dataset due to data protection restrictions.

which we account for by specifying random intercepts (and by controlling for certain household characteristics, see above). We estimated these models separately for different mobility purposes (commutes, errands, shopping, care work, leisure). The regression models are defined as follows:

$$Y_{ij} = b_{00} + b_{m0}X_{mj} + b_{0p}W_p + e_{ij} + u_{0j} \quad (1)$$

Where Y_{ijk} are travel time expenditures for individual i in household j who resides in neighbourhood k and b_{000} is the grand across-households intercept. 1 … M are predictors X at the individual level (e.g. immigration) and b_{m00} each of their slopes fixed across households. 1 … P are predictors W at the household level (e.g. household income) and b_{0p0} each of their slopes. e_{ijk} are residual errors at the individual level and u_{0j0} residual errors at household level. We estimate the regression models using the MIXED routine of Stata 17.

In order to ascertain the presence of multicollinearity among the independent variables, a variance inflation factor (VIF) analysis was conducted. The results of this analysis are displayed in Table A5 in the Online Appendix. The VIFs range from 1 to 2.1, indicating negligible levels of multicollinearity (Kutner, Nachtsheim, and Neter 2004).

3.2. Qualitative data and methods

3.2.1. Sampling

In Germany, the largest immigrant community are Turkish-speaking individuals, closely followed by Arabic-speaking migrants (Statistisches Bundesamt 2022). These two groups experience similar structural racism and discrimination based on their religions, or the visibility of their minority status. Consequently, in order to avoid the potential for significant bias associated with ethnic differences (Borrelli and Ruedin 2024), individuals who were native speakers of Turkish or Arabic were sampled.

The recruitment agency *Bilendi*, which has over 300,000 clients in Germany, facilitated the acquisition of respondents. All respondents are over the age of 18, live in German cities with a population of at least 300,000, have at least one parent who was born in an Arabic- or Turkish-speaking country, or were themselves born in such a country. Participants were offered a compensation of 30 euros to ensure accessibility for those from a lower SES.

A total of 29 individuals were interviewed, and 28 completed a socio-demographic questionnaire. Despite our efforts to correct the gender imbalance, women were significantly more likely to respond to our requests for interviews. Therefore, the final sample consists of 22 female and five male interviewees. Our participants have a relatively low average age, yet in terms of employment, education, household size, household income, and households with children, it is fairly balanced. The detailed socio-demographic characteristics of our interviewees can be found in Table 3.

3.2.2. Interviews

The interviews were conducted in March and April 2022 via telephone in German and structured by a semi-standardised questionnaire comprising 15 questions. The objective was to gain a comprehensive understanding of the respondents' daily mobility behaviour, with a particular focus on travel time expenditure, the quality of the surrounding neighbourhood, public transport accessibility, and the motivations, both intentional and constrained, that drive their transport choices. The questionnaire was developed based on a comprehensive literature review and subsequently refined through a pretest. The complete questionnaire can be found in the Online Appendix in Table A2. Each interview lasted between 20 and 45 minutes. The interviews were recorded and transcribed in

Table 3. Summary statistics: semi-structured interviews.

Category		*N*
Gender	Female	22
	Male	5
	Diverse	1
Age	<30 years	10
	30 – 40 years	8
	40 – 50 years	6
	50 – 60 years	4
	>60 years	0
Language	Arabic	11
	Turkish	15
Employment	Employed	13
	Not employed	7
	In training	8
Education	Secondary school	7
	A-levels	9
	University degree	12
Household Size	One person	5
	Two person	8
	Three or more persons	15
Household with kids	Yes	16
	No	12
Household Income	<1500 Euro	6
	2600 – 4000 Euro	10
	1500 – 2600 Euro	4
	>4000 Euro	6

full. The quotes used in this paper were translated from German to English for publication.

Prior to the interviews, participants were informed of their anonymity and the details of the interview procedure, including that the interviews would be recorded. The entire qualitative research process was evaluated and approved by the Ethics board of the Berlin Social Science Center.

3.2.3. Analytical approach

The analysis was conducted using MAXQDA. A qualitative content analysis was conducted in accordance with Mayring's approach (Mayring 2010), which entails a systematic process of deductive and inductive coding for the analysis of interview data. Deductive categories were derived from existing theories and hypotheses, while inductive coding permitted the emergence of new themes from the data, thereby ensuring a comprehensive analysis that both tested predefined concepts and uncovered unanticipated insights (see coding frame in Table A3 in the Online Appendix). The process included the segmentation of the text into manageable units, the coding of these units according to the developed categories, and the continuous review and refinement of the categories to accurately capture the content of the text.

4. Limitations

Survey-based mobility data faces challenges like underreporting, recall bias, and survey fatigue, as mobility protocols are more demanding than typical questionnaires. This has led to increased use of mobile phone data for mobility research. However, mobile phone data poses its own challenges, including the inability to distinguish between

mobility purposes and the necessity of imputing mode of transportation based on travel times, which can introduce biases, particularly when travel times (rather than locations or distances) are the variable of interest. In the context of Germany, exploratory studies have concluded that, under the German data protection law constraints, mobile phone data is inadequate in representing the population at the level of municipalities or below (Destatis 2019). These limitations render mobile phone data unsuitable for the purpose of this study.

Furthermore, the definition of 'immigrant' employed by the MiD survey is broad, an immigrant as anyone with at least one parent not born a German citizen. The MiD does not ask about ethnicity, country of origin or first language, even though studies have demonstrated variations in daily mobility according to these characteristics (Bartzokas-Tsiompras and Photis 2019; Borrelli and Ruedin 2024; Casado-Díaz, Simón-Albert, and Simón 2022). It must be acknowledged that the quantitative results do not allow for attributing any differences in immigrant mobility behaviour to a more specific cause, such as language barriers, cultural differences, or racist experiences.

In addition, while the contextual data on neighbourhood characteristics that are utilised in our analysis has been added at the address-level, exact address-level information for respondents is legally protected in Germany, therefore inaccessible to researchers working with the MiD. Consequently, the incorporation of additional neighbourhood data, such as population density, is not possible.

While additional qualitative research was conducted precisely because of these limitations, our funds did not allow us to conduct interviews with a more diverse range of ethnic or racial groups.

Furthermore, most of our qualitative sample consists of women. Women, in general, experience more time inequality than men (Chatzitheochari and Arber 2012) and incur higher travel time expenditures. Moreover, the daily mobility of female immigrants may be particularly influenced by their neighbourhood characteristics (Lee, Vojnovic, and Grady 2018). Although this justifies a particular interest in the daily mobility behaviour of female immigrants, male experiences may be underrepresented.

Finally, due to our research design, the interviews were conducted exclusively with immigrants. Consequently, the qualitative results cannot provide insights into the native population or any differences between the two groups.

5. Results

The following chapter presents the results of our three hypotheses. First, we examine if immigrants invest a greater amount of time in travelling the same distances as natives for running errands, shopping trips, care-related journeys, or commutes to work (H1). Second, we analyse to what extent higher travel time expenditures of immigrants are attributable to them travelling less by car (H2a), to them living in neighbourhoods that provide less access to public transportation as well as to local services and are of inferior residential quality overall (H2b). Third, we present the results of the semi-structured interviews to explore to what extent certain daily mobility choices of immigrants are intentional and if they are constraint by factors not accounted for in our standardised survey (H3).

5.1. The immigrant-native travel time expenditure gap

To test whether immigrants incur higher travel time expenditures for daily mobility than natives we estimated a series of regression models for the average daily travel time in minutes for each mobility purpose, controlled for the average daily travelled distances in kilometers for each purpose. The results presented in Table 4 indicate that immigrants require 10 % more time for their daily commutes to and from work, 11 % more time for errands, and 10 % more time for care-related mobility for similar travel distances as natives. Immigrants do not invest more time in leisure-related mobility, as we hypothesised. Traveling to points of interest for leisure activities allows for greater autonomy and flexibility in decision-making, whereas respondents are constrained by the distribution of general practitioners within their respective regions. These findings confirm hypothesis (H1). However, other than expected, immigrants do not incur higher travel time expenditures for daily mobility related to shopping.

5.2. Explanations for higher travel time among immigrants: choice of transport and neighbourhood characteristics

The subsequent phase of the study will entail an investigation of the potential reasons for the longer travel times experienced by immigrants in major German cities. We expand the regression models used to test hypothesis (H1). They include whether the household owns one or more cars, and the proportion of the daily distance travelled by public transport or by foot/bike for each travel purpose (in contrast to travelling by car which serves as the reference category). Controlling for these factors is essential, as car ownership influences mobility choices, even if not used for every journey. This analysis tests whether controlling for these factors changes the effect of 'immigrant' on travel time. To illustrate, if 'immigrant' becomes statistically insignificant, the gap is explained by these factors. Results in Table 5 show that immigrants incur significantly longer travel times than natives regarding commutes, errands and care-work, even if controlled for cars in the household and mode of transportation. Nevertheless, car ownership and

Table 4. Average daily travel time (minutes).

Variables	(1) Commutes	(2) Errands	(3) Shopping	(4) Care Work	(5) Leisure
Immigrant	.093***	.107**	.049	.091**	.027
	(.020)	(.041)	(.041)	(.031)	(.021)
	[.001]	[.011]	[.181]	[.007]	[.148]
Daily distance travelled (km)	.506***	.503***	.432***	.477***	.489***
	(.007)	(.009)	(.010)	(.015)	(.006)
	[.000]	[.000]	[.000]	[.000]	[.000]
Constant	2.469***	2.572***	2.634***	2.506***	2.809***
	(.019)	(.021)	(.016)	(.031)	(.017)
	[.000]	[.000]	[.000]	[.000]	[.000]
N individuals	12,655	5,984	8,128	2,769	12,055
N households	10,849	5,572	7,459	2,531	10,432
AIC	7837.623	6220.576	9131.907	2609.211	16448.72
BIC	7874.852	6254.06	9166.922	2638.842	16485.73

Notes: Multi-level OLS regression model estimates. Robust standard errors in parentheses; *p*-values in brackets; ***$p < .001$, **$p < .01$, *$p < .05$ (two-tailed tests); the outcome variable average daily travel time was log-transformed (see Table 1)*Interpretation example.* On average, immigrants require 9.7% more time for commuting compared to natives (9.7% = (exp(.093)-1)x100).

Table 5. Average daily travel time (minutes).

Variables	(1) Commutes	(2) Errands	(3) Shopping	(4) Care Work	(5) Leisure
Immigrant	.039*	.074*	.055	.090**	.045*
	(.020)	(.029)	(.038)	(.031)	(.020)
	[.047]	[.012]	[.153]	[.004]	[.026]
Household with cars	−.061***	−.058*	−.086***	−.015	−.025
	(.011)	(.025)	(.020)	(.040)	(.016)
	[.000]	[.022]	[.000]	[.718]	[.126]
Distance travelled by public transport (%)	46.074 ***	42.101***	31.577***	51.434***	32.496***
	(.015)	(.037)	(.057)	(.074)	(.030)
	[.000]	[.000]	[.000]	[.000]	[.000]
Distance travelled by foot and bike (%)	24.959***	46.773***	45.133 ***	61.237***	68.133***
	(.017)	(.068)	(.040)	(.056)	(.023)
	[.000]	[.000]	[.000]	[.000]	[.000]
Daily distance travelled (km)	.465***	.559***	.511***	.557***	.598***
	(.008)	(.012)	(.018)	(.020)	(.007)
	[.000]	[.000]	[.000]	[.000]	[.000]
Constant	2.549***	2.300***	2.319***	2.185***	2.213***
	(.025)	(.061)	(.047)	(.076)	(.028)
	[.000]	[.000]	[0.000]	[.000]	[.000]
N individuals	12,655	5,984	8,128	2,769	12,112
N households	10,849	5,572	7,459	2,531	10,477
AIC	4392.58	5235.86	8040.17	1799.18	13954.23
BIC	4452.15	5289.43	8096.19	1846.59	14013.45

Notes: OLS regression model estimates. Robust standard errors in parentheses; *p*-values in brackets; ***$p < .001$, **$p < .01$, *$p < .05$ (two-tailed tests); the outcome variable (average daily travel time) was log-transformed (see Table 1) *Interpretation example.* On average, immigrants require 4.0% more time for their commutes compared to natives, after controlling for car usage (4.0% = (exp(.039)-1)x100).

choice of transport mode are partially responsible for the higher travel time expenditures by immigrants, as evidenced by the decrease in the travel time gap between natives and immigrants (i.e. the effect of the variable 'immigrant') compared to the model in Table 4. For instance, immigrants invest 9.7 % more time in commutes for equal distances travelled, but this reduces to 4.0 % when controlling for car ownership and transport mode. These results support hypothesis (2a).

Subsequently, we examine how neighbourhood characteristics affect the immigrant-native travel time gap. We focus on three factors: accessibility of public transportation, local services, and quality of the residential area. Again, we control for cars ownership and daily distance travelled with public transportation or by foot/bike (in contrast to cars) to isolate the effect of neighbourhood qualities on travel time expenditures (see Table 7).

In contrast to our expectations, controlling neighbourhood characteristics *increases* the discrepancy in travel time expenditures between immigrants and natives for daily commutes, errands and shopping compared to the model that does not control for neighbourhood characteristics (see effect of 'immigrant' in Table 7 vs. Table 5). This may be because immigrants live more frequently in neighbourhoods that provide better access, not worse, to public transportation and local services, even though the quality of their residential areas is below average (see Table A4). This means, that the disparity in travel time expenditures between immigrants and natives persists despite enhanced neighbourhood accessibility for immigrants. Only with respect to care-related trips findings are in alignment with hypothesis (2b) as the immigrant-native travel time gap slightly decreases by controlling for neighbourhood characteristics. This suggests that

certain care-related services are less readily available in immigrant neighbourhoods. Regarding care-related mobility, the travel time of immigrants exceeds that of the native population by 9.5 % for equivalent distances without controlling for neighbourhood characteristics. This figure is reduced to 8.8 % when neighbourhood characteristics are included as controls (Table 6).

Finally, we control for demographic and socioeconomic factors, as compositional differences may explain the travel time expenditure gap. For instance, immigrants tend to be younger and have, on average, lower household incomes (Statistisches Bundesamt 2024). Controlling for these compositional differences indeed explains statistically the difference in travel time expenditure regarding care-related and shopping trips, i.e. the effect of the variable immigrant becomes statistically insignificant in these two models, but its effect on the travel time gap in relation to commutes and errands is minimal (see Table 7).

5.3. Explanations for higher travel time among immigrants: intentionality versus socio-cultural constraints

The quantitative analysis demonstrated that immigrants require a greater amount of time to travel the same distances as natives (in alignment with H1). This is partly due to their reduced reliance on cars (in support of H2a), but, with the exception of care-related trips, only in part because they reside in areas with limited access to public transportation or local services (mostly in contrast to H2b).

The qualitative interviews were conducted to determine whether the higher travel time expenditures of immigrants in Germany are a result of conscious decisions or the consequences of circumstances that they felt are beyond their control and are not accounted for in standardised surveys. Four overarching themes emerged from our respondents' descriptions of their daily mobility experiences: neighbourhood and infrastructure quality, transportation accessibility, safety concerns, and political exclusion.

Our qualitative interviews substantiated the findings of our quantitative analysis regarding the quality of neighbourhoods and infrastructure. While interviewees expressed positive perceptions of local services, they also described the general quality of the neighbourhood as relatively poor. The interviewees specifically highlighted the presence of waste on the streets, high exposure to traffic noise, and a pervasive sense of insecurity.

> "Because it doesn't seem quite so safe to me. Well, that's somehow a corner that doesn't seem very safe to me." (ID 1)

> "In a backyard that we share with 3, 4 or 5 buildings, it's full of bulky waste because it feels like the entire neighbourhood dumps its waste there. The street is generally quite dirty." (ID 15)

The mobility behaviour of the interviewees is impacted by their perceptions of neighbourhood quality and their sense of safety.:

> "It somehow doesn't feel safe for me to cycle. And I don't like using Graefestraße for cycling either, […] it's also too narrow. And there are also too many people on the road and there are always roadworks." (ID 1)

We found that our interviewees often reside in areas where public transport is accessible but not reliable. Due to the high traffic density characteristic of large cities, public

Table 6. Average daily travel time (minutes).

Variables	(1) Commutes	(2) Errands	(3) Shopping	(4) Care Work	(5) Leisure
Immigrant	.054*	.082**	.073*	.084**	.042*
	(.021)	(.031)	(.036)	(.032)	(.021)
	[.010]	[.007]	[.044]	[.009]	[.044]
Household with cars	−.061***	−.042	−.058**	.005	−.013
	(.012)	(.026)	(.021)	(.041)	(.017)
	[.000]	[.101]	[.006]	[.869]	[.478]
Quality residential area	−.005	−.015*	−.002	0	−.002
	(.004)	(.008)	(.007)	(.010)	(.006)
	[.218]	[.049]	[.708]	[.994]	[.776]
Accessibility local services	.004	.020	.040***	.010	.013
	(.007)	(.012)	(.011)	(.015)	(.009)
	[.731]	[.059]	[.000]	[.664]	[.167]
Distance travelled by public transport (%)	44.734***	43.245***	34.928***	51.784***	33.891***
	(.016)	(.038)	(.050)	(.074)	(.030)
	[.000]	[.000]	[.000]	[.000]	[.000]
Distance travelled by foot and bike (%)	23.794***	46.259***	42.708***	58.508***	65.625***
	(.018)	(.067)	(.038)	(.057)	(.024)
	[.000]	[.000]	[.000]	[.000]	[.000]
Distance to the next bus station:<499 m *(Reference Category)*					
500–999 m	.011	.018	.053	.0533	−.00753
	(.011)	(.032)	(.031)	(.044)	(.027)
	[.549]	[.582]	[.090]	[.227]	[.781]
1000–2500 m	.025	.069	−.006	−.007	−.103
	(.025)	(.093)	(.096)	(.131)	(.072)
	[.559]	[.454]	[.949]	[.958]	[.155]
Distance to the next tram station: <499 m *(Reference Category)*					
500–999 m	.023	−.011	−.028	.003	−.003
	(.012)	(.023)	(.022)	(.029)	(.018)
	[.057]	[.647]	[.203]	[.908]	[.890]
1000–2500 m	−.009	−.030	−.020	−.017	−.022
	(.010)	(.019)	(.017)	(.025)	(.015)
	[.376]	[.114]	[.250]	[.508]	[.148]
Distance to the next train station: <499 m *(Reference Category)*					
500−999 m	.037**	−.005	.012	−.002	.009
	(.012)	(.025)	(.025)	(.034)	(.019)
	[.004]	[.852]	[.626]	[.964]	[.618]
1000−2500 m	.031**	−.005	−.015	−.009	.025
	(.011)	(.024)	(.021)	(.031)	(.018)
	[.007]	[.832]	[.474]	[.778]	[.165]
Daily distance traveled (km)	.458***	.558***	.501***	.556***	.598***
	(.8)	(.012)	(.017)	(.020)	(.007)
	[.000]	[.000]	[.000]	[.000]	[.000]
Constant	2.595***	2.320***	2.191***	2.139***	2.072***
	(.056)	(.110)	(.112)	(.158)	(.081)
	[.000]	[.000]	[.000]	[.000]	[.000]
N individuals	10643	5078	6851	2310	10352
N households	9087	4710	6272	2100	8931
AIC	4432.48	4833.15	7255.22	1882.64	12117.24
BIC	4548.84	4937.67	7364.53	1974.56	12233.16

Notes: OLS regression model estimates. Robust standard errors in parentheses; *p*-values in brackets; ***$p < .001$, **$p < .01$, *$p < .05$ (two-tailed tests); the outcome variable (average daily travel time) was log-transformed (see Table 1) *Interpretation example.* On average, immigrants require 5.5% more time for their commutes compared to natives, after controlling for car usage and spatial context (5.5% = (exp(.054)-1)x100).

transportation by bus is often perceived as an unreliable mode of transportation, leading to unexpected longer travel times.

> "Usually the buses come very irregularly because it is also a very busy road. So there is always a risk that the bus will arrive irregularly. That's why you always have to calculate with a bit of a extra time." (ID 16)

Table 7. Average daily travel time (minutes).

Variables	(1) Commutes	(2) Errands	(3) Shopping	(4) Care Work	(5) Leisure
Immigrant	.052*	.073*	.055	.054	.042*
	(.020)	(.031)	(.035)	(.032)	(.021)
	[.011]	[.018]	[.118]	[.082]	[.046]
Household with cars	−.056***	−.035	−.061**	.024	−.023
	(.012)	(.024)	(.023)	(.040)	(.018)
	[.000]	[.143]	[.007]	[.524]	[.209]
Quality residential area	−.002	−.012	−.001	.003	−.004
	(.004)	(.008)	(.008)	(.011)	(.007)
	[.507]	[.143]	[.869]	[.775]	[.531]
Accessibility local services	.011	.024*	.047***	.016	.024*
	(.006)	(.012)	(.011)	(.015)	(.009)
	[.370]	[.028]	[.000]	[.396]	[.013]
Distance travelled by public transport (%)	43.704***	41.733***	34.758***	49.390***	35.896***
	(.015)	(.034)	(.045)	(.073)	(.029)
	[.000]	[.000]	[.000]	[.000]	[.000]
Distance travelled by foot and bike (%)	22.652***	47.267***	43.257***	56.317***	66.447***
	(.016)	(.055)	(.036)	(.054)	(.023)
	[.000]	[.000]	[.000]	[.000]	[.000]
Distance to the next bus station: <499 m *(Reference Category)*					
500–999 m	.011	.018	.054	.053	−.006
	(.019)	(.033)	(.032)	(.044)	(.027)
	[.511]	[.028]	[.065]	[.244]	[.688]
1000–2500 m	.026	.070	−.006	−.007	−.103
	(.044)	(.093)	(.096)	(.131)	(.073)
	[.508]	[.469]	[.974]	[.864]	[.135]
Distance to the next tram station: <499 m *(Reference Category)*					
500–999 m	.023	−.011	−.028	.003	−.003
	(.012)	(.024)	(.022)	(.029)	(.019)
	[.067]	[.494]	[.262]	[.929]	[.668]
1000–2500 m	−.009	−.030	−.020	−.017	−.022
	(.010)	(.019)	(.018)	(.026)	(.015)
	[.207]	[.039]	[.153]	[.182]	[.062]
Distance to the next train station: <499 m *(Reference Category)*					
500–999 m	.037**	−.005	.012	−.002	.010
	(.013)	(.026)	(.024)	(.035)	(.020)
	[.006]	[.685]	[.580]	[.974]	[.477]
1000–2500 m	.031**	−.005	−.015	−.009	.025
	(.012)	(.024)	(.022)	(.031)	(.018)
	[.007]	[.532]	[.405]	[.549]	[.188]
Female	.058***	.053	.015	.073	.026
	(.012)	(.028)	(.017)	(.044)	(.015)
	[.000]	[.060]	[.395]	[.100]	[.078]
Age: 20–30 years	−.011	−.042	−.070*	−.141	−.076**
	(.017)	(.059)	(.030)	(.084)	(.025)
	[.505]	[.477]	[.020]	[.090]	[.002]
31–40 years	.016	.014	.004	.000	−.019
	(.016)	(.031)	(.021)	(.036)	(.022)
	[.352]	[.664]	[.842]	[1.000]	[.399]
41–50 years *(Reference Category)*					
51–60 years	.013	.018	.025	−.001	.034
	(.015)	(.041)	(.023)	(.032)	(.019)
	[.410]	[.653]	[.298]	[.933]	[.080]
Education: Elementary school or no degree	.016	.070	.090*	.061	.052
	(.030)	(.069)	(.041)	(.057)	(.039)
	[.595]	[.308]	[.026]	[.275]	[.184]

"Now we just take the bus and it always depends on what time of day you take the bus, whether it's full, whether there are three in a row and then you have to walk a bit. Yes, yes, that's the longest, slightly inconvenient way." (ID 1)

Table 7. Continued.

Variables	(1) Commutes	(2) Errands	(3) Shopping	(4) Care Work	(5) Leisure
Secondary school *(Reference Category)*					
A-level	.017	.000	−.000	.059	−.030
	(.022)	(.060)	(.025)	(.044)	(.029)
	[.450]	[.993]	[.990]	[.176]	[.317]
University	.011	−.012	.015	−.031	−.022
	(.017)	(.044)	(.024)	(.037)	(.025)
	[.532]	[.783]	[.552]	[.395]	[.381]
Employed	−.063*	−.132***	−.106***	−.177***	−.046*
	(.025)	(.039)	(.028)	(.036)	(.022)
	[.011]	[.001]	[.000]	[.000]	[.039]
Household income: Very low	−.013	−.058	.031	.079	−.008
	(.025)	(.050)	(.036)	(.068)	(.036)
	[.593]	[.245]	[.393]	[.247]	[.797]
Low	−.013	−.032	−.015	−.026	.031
	(.020)	(.033)	(.032)	(.043)	(.029)
	[.529]	[.330]	[.637]	[.579]	[.280]
Middle *(Reference Category)*					
High	.008	−.042*	−.006	−.022	−.021
	(.010)	(.020)	(.018)	(.027)	(.016)
	[.382]	[.037]	[.762]	[.461]	[.178]
Very High	−.012	−.025	−.023	−.058	−.018
	(.013)	(.027)	(.025)	(.033)	(.021)
	[.380]	[.352]	[.356]	[.078]	[.390]
Household with kids	−.008	−.001	.052**	.019	.065***
	(.010)	(.021)	(.018)	(.035)	(.016)
	[.452]	[.948]	[.005]	[.572]	[.000]
Daily distance traveled (km)	.465***	.563***	.501***	.554***	.601***
	(.008)	(.011)	(.016)	(.019)	(.007)
	[.000]	[.000]	[.000]	[.000]	[.000]
Constant	2.582***	2.388***	2.224***	2.213***	2.078***
	(.063)	(.117)	(.112)	(.176)	(.090)
	[.000]	[.000]	[.000]	[.000]	[.000]
N individuals	10,407	4,966	6,669	2,267	10,111
N households	8,899	4,613	6,104	2,060	8,727
AIC	4098.91	4709.24	7226.34	1795.83	11800.09
BIC	4309.17	4898.04	7423.69	1961.87	12009.51

Notes: Multi-level OLS regression model estimates. Robust standard errors in parentheses; *p*-values in brackets; ***$p < .001$, **$p < .01$, *$p < .05$ (two-tailed tests); the outcome variable average daily travel time was log-transformed (see Table 1) *Interpretation example.* On average, immigrants require 5.32% more time for commuting compared to natives, after controlling for car usage, neighbourhood context, and socio-economic factors (5.3% = (exp(.052)-1)x100).

The respondents indicated that their place of residence and the lack of reliable public transportation necessitate the use of private cars.

> "Again, it depends a bit. Yes, actually more by car, because the area where we live is very poorly connected in terms of the transport network. The S-Bahn station is not within walking distance, the metro station is not within walking distance and further buses … There's a bus that goes past us that goes to the airport and then to Hermannplatz [that provides access to the subway system]." (ID15)

Due to financial constraints, respondents frequently lack access to personal cars even though they are aware that the use of personal cars would significantly reduce the time required for their daily trips.

> "You think to yourself, okay, it would be better if you had a car, then maybe the whole thing would only take about an hour instead of three or four." (ID53)

Longer travel times, primarily attributable to the utilisation of unreliable buses, have a deleterious effect on the respondents' well-being. In addition to the length of the trip, the respondents cite buses as a source of emotional distress due to the discomfort associated with them.

> "That's quite a burden. […] I travel by bus and tram every day … I finish work at 5 pm and then there's evening rush hour. The normal journey takes 20 minutes by bus, but then, because of the evening rush hour and everything, it takes an hour, an hour and a half. You think to yourself … You're exhausted, you've been working for eight hours, you finally want to go home and just put your feet up, but you don't have the opportunity, I say, at that moment." (ID 42)

We conclude, the daily mobility behaviour of the interviewees is not entirely a matter of free choice. The longer travel times they experience, often due to lower-quality housing and limited access to private vehicles and reliable public transportation, are influenced by structural constraints rather than personal preference.

As a third theme, we identified safety concerns as constraints on daily mobility, particularly among female immigrants. The majority of our interviewees who identified as female articulated feelings of unease and vulnerability in public spaces, particularly at night. Some respondents disclosed avoiding specific locations due to safety concerns, which further contributed to longer travel times.

> "Well, it's sometimes dangerous because of the residents themselves, who are a bit of criminals and always move around in small groups. As a woman, you don't necessarily always dare to walk through certain streets. Or if you do, then with a protective shield. In other words, you make it clear that you're from the neighborhood and are left alone." ID 21

> "Yes, and especially when I'm at the main station or alone at night, it's not as convenient as when I'm out during the day […]. But at night, from 9 o'clock onward, there are fewer people around. Yes, that's when I sometimes feel uneasy. Am I being sexually harassed on the train or being approached in a stupid way? Em, yes, I get that feeling from time to time, when I suspect, okay, there's a drunk man or someone who's staring at me. I'm more careful then. And I usually sit right at the front, where the train driver is." (ID 57)

Interviewees who are commonly perceived as non-white have reported experiencing people staring at them and having unwelcoming interactions in public spaces that made them feel uncomfortable. In light of these experiences, one of our interviewees has chosen to travel by car as a means of avoiding such encounters. However, a considerable proportion of interviewees are unable to afford the use of private vehicles.

> "Well, you're still safe with a car. And because we're foreigners and there's a bit of racism here and there are some looks that bother me or they just talk to you, makes no sense for me travelling by bus or something. That's why I think the car is even safer." (ID 66)

Most of our interviewees did not report travelling in a different way due to racial discrimination, contrary to what we had assumed. However, a different narrative emerged across the interviews: feeling politically excluded, a pervasive sense of alienation from the political decision-making processes that govern transport policies. This sense of marginalisation is further compounded by the perception of exclusion from both the political sphere and activist groups that wield influence over transport policies. We find, that

these circumstances exert a deleterious effect on the self-efficacy of interviewees, which in turn has a detrimental effect on their overall well-being.

> "What I mean is … Well, I live in Charlottenburg and I'm a foreigner myself. And I'm not entitled to vote anyway. And there aren't that many foreign people living here in this neighborhood, to be honest, compared to Neukölln and Kreuzberg. And that's why I don't know if I would really be taken seriously."(ID 31)

> "I am unsure whether I would definitely have a say in the decisions. I think this part of town is generally characterised by a lot of car drivers. I'm a bit unsure whether my opinion can have a big influence. That's why I would be rather less vocal."(ID 35)

6. Discussion & conclusion

High travel time expenditures contribute to time scarcity (Tranter 2010), negatively affecting health, employment, and civic engagement (Giurge, Whillans, and West 2020; Rathjen 2015; Srivastava and Floro 2017; Xiao, Yang, and Chi 2020). Therefore, our study examines whether immigrants in German cities spend more time on daily mobility and to identify the underlying reasons. We tested if limited public transportation, local services, and inferior quality of residential areas contribute to higher travel time expenditures for immigrants. We utilised the 2017 Mobility in Germany survey ($N_{individuals}$=54,259) and conducted semi-structured qualitative interviews in 2022 (N=29).

Our findings reveal that immigrants in German cities experience longer travel times compared to natives, even after controlling for demographics and socio-economic factors. This discrepancy is partially attributable to reduced car usage among immigrants, while neighbourhood characteristics are only associated with somewhat higher immigrant travel time expenditures for care-related journeys. The qualitative data suggest the presence of further constraints on the mobility of Turkish and Arabic-speaking immigrants that contribute to increased travel times. In particular, there is a sense of insecurity when using public transportation. Interviewees felt excluded from politics and activist groups, which can result in transport policies that neglect the mobility needs of immigrants, such as limited public transit access in immigrant neighbourhoods or insufficient consideration of their daily travel patterns.

The quantitative results indicate that immigrants require on average 10 % more time for commutes, 11 % more on errands, and 10 % more for care-related trips than natives for equivalent distances. These discrepancies partly result from immigrants' reduced ownership and utilisation of cars. Contrary, neighbourhood attributes only account for a small proportion of the travel time expenditure gap between natives and immigrants for care-related trips.

These higher travel times must be viewed within broader time inequality research. For instance, women in Germany allocate, on average, nine hours more to care work than men (Statistisches Bundesamt 2024). The discrepancy in travel time between immigrants and natives is likely to compound time constraints for immigrant women.

Our findings align with U.S. and Canadian studies insofar as immigrants in German cities endure longer average daily travel times for commuting purposes, in addition to trips related to errands and care work (Bautista-Hernández 2020; Dilmaghani 2022; Landis 2022). Furthermore, the reduced reliance on cars among immigrants is

contributing to the higher travel times. The qualitative interviews conducted for this study substantiate that financial constraints represent a primary factor limiting the use of private cars by immigrants (Delbosc and Shafi 2023; Lubitow, Tompkins, and Feldman 2019).

In contrast to our expectations, the characteristics of the neighbourhood, including the accessibility of public transportation, local services and quality of the residential area, only account for a minor extent of the higher travel time expenditures among immigrants and only with respect to care work trips. This finding challenges prior research conducted in the U.S. (Akhavan et al. 2019; Bartzokas-Tsiompras and Photis 2019; Chatman 2014; Landis 2022; Lee, Vojnovic, and Grady 2018; Liu and Xiao 2022; Smart 2015). However, it also highlights that the U.S. and Germany (and Europe at large) exhibit different settlement patterns of immigrants, resulting in divergent outcomes.

Although public transit access does not explain higher travel times, the qualitative interviews revealed that the respondents perceive public buses to be unreliable and time-inefficient. This aspect is not reflected in our measurement of public transportation accessibility. The unreliability is a source of stress and anxiety, particularly for those who cannot afford personal vehicles. It is imperative that urban planning in German cities prioritise the integration of social housing units with efficient public transportation networks, such as subway, tram, and train stations, as well as a reliable public bus system.

Furthermore, our qualitative findings suggest that safety concerns influence the daily mobility of immigrants. While we did not directly observe a significant influence of racial discrimination on travel behaviour, our study revealed that many interviewees attempted to avoid specific locations, either generally or at certain times, which ultimately increases their travel time, particularly for immigrant women.

Lastly, our interviews revealed that immigrants perceive a sense of exclusion from urban planning and decisions on public transportation. In major German cities, the proportion of first- and second-generation immigrants, as defined in our study, is estimated to be between 30% and 40 % (Federal Agency for Civic Education 2024). While a transformation of the transport system in Germany towards more sustainability is necessary to avoid the potentially catastrophic effects of unchecked climate change and to meet the goals of the Paris Climate Agreement (Creutzig et al. 2015), it appears unlikely that transportation policies can be effectively implemented on a larger scale without consideration of the preferences of such a large social group. The exclusion of immigrants from such decisions may serve to perpetuate the existing disparities between natives and immigrants. Immigrants are already disproportionately exposed to transport emissions (Rüttenauer and Best 2022) and frequently lack the resources necessary to protect themselves from the adverse effects of climate change (Blondin 2022).

Urban policies ought to address residential segregation by placing a high priority on inclusive urban planning processes that proactively engage residents from a wide range of socio-economic and demographic backgrounds. This entails the establishment of participatory decision-making structures to ensure that marginalised groups are adequately represented in the formulation of policies. Targeted interventions should prioritise enhancing access to and the safety of public transportation infrastructure in underserved neighbourhoods.

For future research, our findings highlight a broader issue in quantitative mobility inequality studies. If surveys and observational data serve as the foundation for transport

policies and urban planning, yet fail to consider safety concerns or sexual, racist, and potentially other forms of harassment, the daily mobility needs of certain subgroups will be systematically misunderstood or ignored (Akhavan et al. 2019; Giuliano 2003; Yum 2020). The issue is exacerbated when surveys, such as the MiD, lack the capacity to differentiate between highly heterogeneous groups of 'immigrants' based on factors such as ethnicity, native language, generation, citizenship, and other characteristics. Surveys should incorporate questions that delve into the backgrounds, experiences, and their consequences for daily mobility behaviour of these groups.

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Data availability statement

Access to the MiD data must be requested from the German Aerospace Center (DLR). Data from the semi-structured interviews may be requested from the authors.

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