Gender disparities in travel behaviour and leisure: A Tel-Aviv metropolis Time-Use study

Ramandeep Singh[1*], Hannah Hook[2], Wafa Elias[3], and Constantinos Antoniou[1]

[1]Chair of Transportation Systems Engineering, Department of Mobility Systems Engineering, School of Engineering and Design, Technical University of Munich, Germany
[2]Social and Economic Geography Group, Department of Geography, Faculty of Science, Ghent University, Belgium
[3]Department of Civil Engineering, Shamoon College of Engineering, Israel

Short summary

Achieving gender equality in mobility and leisure is essential to enhancing quality of life and well-being. This study examines gender disparities in daily travel behaviour, time spent outside the home, and leisure activities among cultural groups in the Tel Aviv metropolis, using a time-use framework. Leveraging travel survey data (2014-2017) from 24,359 individuals across 12,930 households, the intersection of gender, cultural identity, and socio-economic factors is explored. Results indicate that women, particularly those in caregiving roles or from Arab and Orthodox Jewish communities, face greater mobility constraints and complexities than their male counterparts. Women perform more trip-chaining activities, such as chauffeuring and shopping, but spend less overall time outside the home compared to men. Notably, higher education and flexible employment correlate with increased mobility and leisure engagement for women, suggesting pathways to mitigate inequalities.
Keywords: Quality of life; Time use; Gender differences; Stated preference; Transport equity and justice

1 Introduction

As outlined by the UN Sustainable Development goals, achieving gender equality is important to building societies that prioritize human rights, social justice, and well-being, and therefore intersectional gender discrepancies in daily travel behaviour, time spent outside the home, and engagement in leisure activities must be addressed. Travel behaviour and time use are intrinsically linked to the unpaid labour burden because, for instance, the involvement of family members in diverse daily activities and household requirements, such as shopping or errands, require accessing varied locations with sometimes complicated travel patterns, known as trip-chaining, and logistical temporal complexity. The time spent outside of the home, the time spent on travel, and the participation in certain types of trips, such as chauffeuring (to pick up and drop off children or other family members), to visit family or friends, shopping, and those for leisure, recreation, or to participate in sports, might contribute substantially to the unpaid labour burden in terms of time use and the mental load. Promoting gender equality in this regard could improve work-life balance, economic empowerment, and professional development for women as well as improve quality of life, well-being, and mental health for both parents by fostering a healthy family dynamic.

However, achieving gender equality among populations with high levels of cultural, social, and religious diversity is not straightforward. Especially as Israeli families are relatively large, averaging around three children per family, and Israeli women have relatively high levels of employment in paid work (Herzberg-Druker et al., 2022), the issue of unpaid work responsibilities in the Tel Aviv metropolis context is particularly relevant. Understanding the gender gap in travel behaviour and time use among culturally and socially diverse population groups in the Tel Aviv metropolis can work toward improving cultural sensitivity in terms of gender roles, reducing stereotypes and biases, empowering marginalized communities, promoting an intersectional perspective, and informing policy recommendations aiming to correct gender inequities.

This research aims to explore how travel behaviour, time spent outside the home, and engagement in leisure and non-leisure activities vary across genders and cultural groups in the Tel Aviv

metropolis. It focuses on understanding the relationship between time use and the unpaid labour burden from an intersectional perspective. Women typically travel shorter distances but experience more complex travel patterns due to traditional gender roles that delegate them more household and childcare tasks, necessitating more frequent and diverse stops. However, in the Arab world where women are more often confined to their communities, men experience more complicated travel patterns, though the specific burden of chauffeuring trips belongs to women (Elias et al., 2015). Therefore, the Tel Aviv metropolis is a unique case study for investigating gender differences in trip types due to the great diversity in cultural groups, namely Jewish and Arab populations, and their varied implications for gender equity in travel behaviour. By examining these patterns, this research investigates how intersecting forms of discrimination might exacerbate inequalities in travel behaviour and unpaid labour, addressing broader questions about equity and quality of life.

This study is novel compared to other research for several reasons. First, while many studies have explored gender differences in travel behaviour, this study takes a comprehensive approach by linking gender-specific patterns to both the frequency and duration of different types of activities. By looking at time use and not just trip count, the study adds depth to the understanding of gender imbalances in time use outside the home, particularly for non-work-related activities. Second, the study not only examines direct gender effects, but also explores intersectionality between gender and cultural groups, allowing for a more detailed understanding of how various factors compound to influence gendered travel behaviour. Finally, the use of semiparametric regression models provides a more robust and analytical framework than traditional parametric methods used in many travel behaviour studies.

Specifically, using a travel survey dataset (2014-2017) of 24,359 individuals living in 12,930 households in the Tel Aviv metropolitan region taking 312,451 trips, gender differences among Jewish, subdivided into secular, religious, or Orthodox, and Arab cultural groups are analysed. The survey includes self-reported records of time spent on travelling to the activity location (trip travel time) and time at the activity (stay time) for 12 different activity categories: work, studies, shopping, business appointments, personal appointments, visits to relatives/friends, health, recreation, sport, chauffeuring, and other activities.

The remainder of this extended abstract is structured as follows: Section 2 summarizes the semiparametric regression method used in this analysis, Section 3 briefly summarises the results alongside a discussion of the results, and Section 4 provides policy recommendations and conclusions.

2 Methodology

Semiparametric regression is a statistical regression method which enables flexible non-linear relationships between dependent and independent variables to be modelled. The relationships do not need to be specified a priori, rather they are generated from the data via basis functions that take the form of thin plate regression splines. The splines are interpolation functions that fit the data points, with a 'wiggliness' penalty that represents the trade-off between alignment with data points and smoothness. The structure of the splines comprises the sum of a linear predictor and random effects, and as such, the resulting models are classified as possessing a generalised additive mixed model (GAMM) structure. The models are fitted via penalised iteratively reweighted least squares (PIRLS), the model parameters are estimated through restricted maximum likelihood (REML) optimisation. Further information on the structure and theory of the models can be found in Wood (2017) and Wood et al. (2015). The 'mgcv' package in R Wood et al. (2015) is used to perform the modelling.

The general form of the models is as follows:

$$g(y_i) = \alpha + \sum_{k=1}^{K} f_k(x_{np,i}) + \sum_{m=1}^{M} \beta_m x_{p,i} + \epsilon_i, \tag{1}$$

where $g(\cdot)$ is a link function, y_i is the model response variable, α is the model constant, f_k are the smooth basis functions based on penalised thin plate regression splines of the model covariates $x_{np,i}$ modelled non-parametrically, β_m are the coefficient values for the covariates $x_{p,i}$ modelled parametrically, and ϵ_i is the model error term such that $\epsilon_i \sim \mathcal{N}(0, \sigma_\epsilon^2)$.

The model response variables in time units are continuous measures of time and we apply a Gaussian family specification with no additional transformations. The model response variables of

frequency counts are discrete measures of activities and trips per day and so we apply a Poisson family specification with no additional transformations. In terms of the form of the model covariates, we initially model all continuous covariates non-parametrically with smooth splines. In cases where the relationship is a clearly known parametric form (e.g. linear), we replace the non-parametric specification with the parametric form to improve model parsimony. The categorical variables are modelled with a fixed effects form. The fixed effects form is considered to be most appropriate when categories are drawn from a finite sample rather than a large population, and we are interested in making inferences about the individual effects of each category of the variable included in the model (Searle et al., 1992). This is the case for the categorical variables in the data set. The fixed effects structure allows for the categorical variables to be correlated with the other covariates in the model (Searle et al., 1992). We also include interaction effects with gender for all other covariates in the model to further investigate whether there are specific additional gendered impacts within each variable.

3 Results and discussion

We undertook an iterative process to develop the final model forms for the 4 regression models, including robustness checks of the specification of the smooth covariates as per Wood (2017), outlier testing, and trials of log transformations. For conciseness we have not included full details of the model development process here, but these can be made available on request. We found that all models performed best without log transformations. It should be noted that during the model development, we found that the original model for daily time spent on leisure activities per person had extremely poor performance, capturing less than 1% of variance in the data. For this reason, we changed the response variable for this model to measure the absolute time spent on individual leisure activities rather than the daily time spent on leisure activities per person. All other models are measures of time spent on activities and frequency of activities per person per day. The goodness-of-fit indicators for each final model form are summarised in Table 1. As shown in the table, the models on daily non-home activity frequency and time and leisure activity time perform best capturing approximately 24%-41% of variation in the data while the model on daily leisure activity frequency represents approximately 12% of variation in the data. Although the R-squared indicators are relatively low in terms of predictive performance, we are still able to draw valid statistical inference conclusions regarding the relationships between the response variables and the covariates.

Table 1: Overall model performance metrics

Model	No. obs	R-sq	Variance explained	BIC
Daily non-home activity frequency	40983	0.41	0.72	1.54E+05
Daily non-home time	40983	0.30	0.30	9.05E+05
Daily leisure activity frequency	40983	0.12	0.13	8.77E+04
Leisure activity time	38859	0.24	0.24	8.04E+05

The main goal of this investigation is to explore intersectional gender disparities in travel behaviour, particularly in terms of activity frequency, time spent outside the home, and engagement in leisure activities in the Tel Aviv metropolis, identifying a number of significant differences. The detailed results for each model is given in Appendix A, where we present a summary table of each regression model with the magnitude of the effect of each gender-related categorical and continuous covariate on the response variable. In the following section, we present a summary of the key results with a brief discussion.

First, regarding overall activity and travel frequency, women were found to take approximately 0.29 fewer trips per day than men, conflicting with findings outside of the Tel Aviv metropolis finding that women take more trips than men Elias et al. (2015); Havet et al. (2021). However, women with university education as well as those unemployed or on pension were found to make more trips than men with similar characteristics. Women identifying as Arab also made more trips than their male counterparts, conflicting with findings in the Galilee region of Israel where women in Arab communities make fewer trips Elias et al. (2015). Next, men were found to spend on average two hours longer outside the home than women, confirming findings in previous research undertaken in Israel Elias et al. (2015). Factors such as household role (e.g. being a parent), cultural group, and employment status also contributed to differences, with Arab and Orthodox Jewish women

spending significantly less time outside the home than men in these groups.

Further, while women were found to engage in slightly more leisure activities per day than men, the difference becomes statistically insignificant after controlling for other factors. However, women with higher education, those married or without children, and those in the Orthodox Jewish cultural group engage in more leisure activities than their male counterparts, though this does not necessarily indicate that they engage in higher quality leisure activities Yerkes et al. (2020). Interestingly, while men reduce their time on leisure activities when they engage in more non-leisure tasks (like work or chauffeuring), the impact is more pronounced for women suggesting that women may face more complex scheduling challenges, as stated in previous research Schwanen (2007); Shirgaokar & Lanyi-Bennett (2019). Finally, the influence of activity type on daily trips also revealed gendered patterns. Women engaged in more shopping, health, and chauffeuring activities, while men undertook more business-related trips, confirming findings in previous research Solá (2016). Women also spent more time on leisure activities than men when they did engage in them, particularly in complex trip chaining.

These findings highlight significant gender inequalities in daily mobility, time use, and access to public spaces in the Tel Aviv metropolis. The findings suggest that women, particularly those with caregiving responsibilities or from religious or ethnic minority groups might face more constraints on their mobility compared to men. The fact that women perform more trips for activities such as shopping, chauffeuring, and health-related errands – typically associated with caregiving and the unpaid labour burden – reinforces traditional gender roles, where women are primarily responsible for household and family needs. This suggests that many women in the Tel Aviv metropolis remain responsible for a disproportionate share of unpaid domestic labour, potentially limiting their opportunities for leisure, professional engagement, and personal development, and contributing to greater responsibilities during the 'second shift' Hochschild & Machung (1989).

Additionally, women, particularly from religious minority cultural groups who are parents, spend less time outside the home than men. This limitation on time in public space reflects broader societal norms or constraints that may affect women's freedom to move through the city. Cultural or religious expectations, combined with practical concerns such as safety or family obligations, may discourage women – especially those from Orthodox Jewish or Arab communities – from fully engaging in activities outside the home. This disparity not only limits women's access to opportunities but also suggests that public spaces in the Tel Aviv metropolis may not be equally accessible for all genders.

Next, the findings show that women with higher levels of education or who are not working (especially pensioners) tend to make more trips than their male counterparts. This may suggest that both education and flexible time availability may empower women by expanding their mobility. If these women are more independent with greater agency in their daily lives, they may be more able to freely participate in leisure and non-home-based activities. This highlights the importance of improving education and supporting policies that promote flexible work schedules or retirement benefits to improve women's QoL.

Further, women's travel patterns, particularly in relation to leisure activities, indicate that they may face more time poverty than men. The fact that women are more likely to trip chain by combining multiple activities (such as shopping, chauffeuring, and health-related trips) suggests that women are managing their time under greater constraints, potentially reducing their ability to fully participate in leisure activities. The added complexity of these trips means that women may be multitasking in ways that reduce their capacity for rest and recreation, further impacting their well-being. Although women spent slightly more time on leisure activities when they engaged in them, the overall lower frequency of leisure activities for some women, particularly those from minority groups or with caregiving responsibilities, highlights gender inequality in access to free time. Leisure is an important component of QoL and well-being, and the gender gap in leisure time implies broader societal inequities. Women's leisure is often secondary to their caregiving and domestic responsibilities, while men seem to have more flexibility and freedom to engage in leisure without the same constraints.

4 Policy implications and conclusions

These findings highlight the need for urban planning and transport policies that consider gender. As women's mobility patterns are more constrained and complicated, they may benefit more from public policies improving access to transportation, enhancing safety in public spaces, and providing services like childcare. Public spaces in the Tel Aviv metropolitan area could be reimagined to better accommodate the needs of women, and particularly ensuring that women from religious or minority backgrounds feel safe, welcome, and encouraged to participate fully in public life. Additionally, policies promoting gender equity in both domestic and public life, such as encouraging more equal caregiving roles and providing support for working mothers, could help reduce these gender disparities.

While the current study explores gender and cultural differences in travel behaviour and QoL, future research could expand to consider other intersectional factors such as income or disability, allowing for a deeper understanding of how these factors intersect with gender to influence travel patterns and time use. Additionally, given that the study highlights the role of household and caregiving responsibilities in shaping gendered travel behaviour, future research could examine how different family structures affect mobility and leisure time. Further, future research could focus on how improvements in public transportation infrastructure might impact gendered travel patterns by reducing the chauffeuring burden and improving access to leisure activities. Finally, while the study provides quantitative insights into gendered travel behaviour, future research could benefit from a qualitative approach to explore the lived experiences of individuals.

A number of limitations to this study are also important to discuss. First, the analysis is based on self-reported travel survey data, which can introduce biases as respondents may not accurately recall the details of their trips or time use. Second, the data was collected in 2014 and 2016/17 and therefore may not fully capture recent changes in societal norms, urban infrastructure, or transportation developments in the Tel Aviv metropolis. While a recent survey conducted by the Municipality of Tel Aviv-Yafo states that travel behaviour remained relatively stable between 2014 and 2022 of Tel Aviv-Yafo (2022), the initiation of the Israel-Gaza conflict in October 2023 will have unquestionably changed travel patterns since the publication of this report. Third, the study treats gender as a binary male/female variable, which overlooks the experiences of those who may not identify within these categories, such as non-binary or transgender people. Finally, while the study emphasizes the importance of leisure in QoL, the analysis may not sufficiently capture the subjective aspects of leisure activities, such as perceived quality or satisfaction with leisure time.

In sum, this research underscores persistent gendered inequalities in mobility and access to public life in the Tel Aviv metropolis. While education and employment empower some women, societal and cultural constraints continue to limit others, particularly those in caregiving roles in cultural minorities. Addressing these disparities through targeted policy interventions can help promote greater gender equality and enhance the overall QoL for women in the Tel Aviv metropolis.

References

Elias, W., Benjamin, J., & Shiftan, Y. (2015). Gender differences in activity and travel behavior in the Arab world. *Transport Policy*, *44*, 19–27.

Havet, N., Bayart, C., & Bonnel, P. (2021). Why do Gender Differences in Daily Mobility Behaviours persist among workers? *Transportation Research Part A*, *145*, 34–48.

Herzberg-Druker, E., Kristal, T., & Yaish, M. (2022). Does the pandemic affect inequality within families?: The case of dual-earner couples in israel. *Gender and Society*, *36*, 895-921.

Hochschild, A. R., & Machung, A. (1989). *The second shift: Working parents and the revolution at home.* Viking.

of Tel Aviv-Yafo, M. (2022). *The 9th Transportation Survey Among Residents of Tel Aviv, December 2022.* (Tech. Rep.). (Accessed at https://www.tel-aviv.gov.il/)

Schwanen, T. (2007). Gender Differences in Chauffeuring Children among Dual-Earner Families. *The Professional Geographer*, *59*(4), 447–462.

Searle, S. R., Casella, G., & McCulloch, C. E. (1992). *Variance components*. Hoboken, New Jersey: John Wiley & Sons, Inc.

Shirgaokar, M., & Lanyi-Bennett, K. (2019). I'll have to drive there: How daily time constraints impact women's car use differently than men's. *Transportation*, *47*, 1365-1392.

Solá, A. G. (2016). Constructing work travel inequalities: The role of household gender contracts. *Journal of Transport Geography*, *53*, 32-40.

Wood, S. N. (2017). *Generalized additive models: an introduction with r* (Second ed.). Boca Raton, FL: CRC Press, Taylor and Francis Group.

Wood, S. N., Goude, Y., & Shaw, S. (2015). Generalized additive models for large data sets. *Journal of the Royal Statistical Society. Series C: Applied Statistics*, *64*(1), 139–155.

Yerkes, M. A., Roeters, A., & Baxter, J. (2020). Gender differences in the quality of leisure: a cross-national comparison. *Community, Work and Family*, *23*, 376-384.

Appendix A - Model results

Please note that the summary results below have been filtered to report on statistically significant gender-related covariates only. A conventional cutoff level of $\alpha = 0.05$ is used for statistical significance across all models.

Table 2: Gender-related impacts on daily trip frequency

Covariate	Level	Effect (change in no. trips)
Categorical variables		
Gender	Female	-0.29
F:Household role	Spouse - no kids	-0.051
F:Education status	BA	0.052
F:Education status	Masters	0.074
F:Employment status	Pensioner	0.077
F:Employment status	Unemployed	0.098
F:Religious identification	Arab	0.19
F:Education status	PhD	0.25
Continuous variables		
F:Visit to rel/friends per day		0.031
F:Recreation trips per day		0.031
F:Personal app. per day		0.032
F:Shopping trips per day		0.045
F:Business app. per day		0.049
F:Sports trips per day		0.053
F:Study trips per day		0.054
F:Chauffeuring trips per day		0.055
F:Health trips per day		0.069
F:Work trips per day		0.08
F:Other trips per day		0.096

"F:" denotes female gender interaction

Table 3: Gender-related impacts on daily time spent outside the home

Covariate	Level	Effect (change in hours)
Categorical variables		
Gender	Female	-2.00
F:Religious identification	Arab	-0.78
F:Household role	Parent	-0.44
F:Religious identification	Jewish - Orthodox	-0.36
F:Religious identification	Jewish - Religious	-0.31
F:Education status	High school certificate	0.44
F:Employment status	Part time	0.72
F:Employment status	Unemployed	0.89
F:Employment status	Unemployed, seeking	1.06
F:Household role	Partner	1.11
F:Employment status	Pensioner	1.25
Continuous variables		
F:Household size		-0.11
F:Chauffeuring trips per day		0.14
F:Business app. per day		0.16
F:Shopping trips per day		0.18
F:Personal app. per day		0.19
F:Recreation trips per day		0.31
F:Sports trips per day		0.33
F:Health trips per day		0.39
F:Visit to rel/friends per day		0.42
F:Other trips per day		0.58
F:Study trips per day		0.75
F:Work trips per day		1.53

"F:" denotes female gender interaction

Table 4: Gender-related impacts on daily frequency of leisure activities

Covariate	Level	Effect (change in no. trips)
Categorical variables		
F:Employment status	Soldier - compulsory service	-0.63
F:Employment status	Unemployed, seeking	-0.19
F:Employment status	Part time	-0.09
F:Education status	High school certificate	0.13
F:Religious identification	Jewish - Orthodox	0.18
F:Education status	High school no certificate	0.19
F:Household role	Spouse - no kids	0.21
F:Household role	Parent	0.21
F:Household role	Other relation	0.28
F:Education status	PhD	0.34
Continuous variables		
F:Work trips per day		-0.27
F:Other trips per day		-0.27
F:Health trips per day		-0.10
F:Chauffeuring trips per day		-0.08
F:Personal app. per day		-0.06
F:Business app. per day		-0.05
F:Shopping trips per day		-0.05
F:Home trips per day		0.04

"F:" denotes female gender interaction

Table 5: Gender-related impacts on time spent on leisure activities

Covariate	Level	Effect (change in hours)
Categorical variables		
F:Household role	Other relation	-0.58
F:Household role	Spouse - no kids	-0.17
Continuous variables		
F:Other trips per day		-0.36
F:Work trips per day		-0.15
F:Household size		-0.08
F:Business app. per day		-0.06
F:No. accompanying persons		-0.05
F:Chauffeuring trips per day		0.05

"F:" denotes female gender interaction