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Analyzing the Impact of Perceived Exertion on Walking for Short-Distance Trips: A Comparative Case Study of Malta and the Netherlands

Karyn Scerri[1], Maria Attard[1], Dorine Duives[2], and Oded Cats[2]

Abstract

Understanding people's travel behavior is key to creating spaces that discourage car use, especially for short, walkable distances. The scope of this study is to understand better people's propensity to use a car rather than walk for short-distance trips by focusing on the concept of perceived exertion (PE). A comparison is performed of two case study locations: Malta, a Euro-Mediterranean island with a high car dependency, and the Netherlands, a European country with a high active mode share of walking and cycling. Surveys were distributed to two university populations in each of the case study locations to analyze the parallels and variations in travel behavior and perceptions. Applying a mediation model analysis, the results show a partial mediation (Malta) and a full mediation (Netherlands) of PE in the relationship between car use frequency (CF) and distance threshold (DT), that is, the distance people are willing to walk rather than use a car. The mean DT for walking varied significantly between the two samples, resulting in 15.18 min (1.2 km or 0.7 mi) in the Netherlands and 17.99 min (1.4 km or 0.9 mi) in Malta, despite the comparatively larger active mode share in the Netherlands. Complementing this, the ordinal logistic models for the two countries indicate that those that perceive walking for short trips to be more effortful and those with a high CF are less inclined to walk long distances. Findings are compared with previous research, and policy-relevant suggestions based on these findings are provided.

Keywords

pedestrians, human factors, perceived exertion, Malta, Netherlands, walking, behaviors

The importance of adaptable, sustainable urban mobility was re-asserted during the COVID-19 pandemic, highlighting the importance of prioritizing active transport to create cities that fulfill citizens' basic activities within 15 min of walking or cycling for short distances (*1*). Replacing short car trips with active modes is, firstly, advantageous to people's physical health, as studies show that one in ten men and women would meet their recommended physical activity levels if they switched from vehicle to walking for one of their daily short trips (*2*). Secondly, walking these short-distance trips would result in economic benefits through a reduction in health cost savings (*2*, *3*), reduced traffic congestion, and decreased emissions, especially since a higher level of hazardous exhaust is emitted during short car trips because the engine is still cold (*4*, *5*).

Encouraging people to shift to more active modes requires a solid knowledge base that explores the multiple factors that influence people's modal choice, including attitudes and preferences, and how these vary cross-culturally. Factors like convenience (*6*), trip complexity, and those that can drive and are accustomed to it have all been linked with an increased likelihood to use the car for short-distance trips (*5*). Socio-demographic factors like older age and being a male have also been linked

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with increased likelihood of car use for short trips (*5*, *7*) as well as other factors, including availability and perceived safety of pedestrian infrastructure, topography, weather, safety, diversity of activities in the urban environment, trip purpose, having physical disabilities, and socioeconomic status (*4–6*, *8*). The influence of culture on travel behavior has been effectively outlined as significant for mode choices, including that of walking, as although other factors like the physical environment can facilitate or discourage walking, culture is a determinant of walking behavior (*9*), and social and cultural differences have also been associated with sedentary behavior differences (*10*). The urban environment's impact is particularly important because characteristics within the urban walking environment can act as determinants of mode choice, especially for walking, including aspects like streetscape design and greenery, traffic infrastructure, land use, street furniture, and safety (*11*, *12*). Prevalent use of cars for short-distance trips contributes to the vicious cycle of car dependency, as the demand for infrastructure grows, inciting more car use and traffic congestion, which ultimately threatens the historical and cultural environment of cities while simultaneously making the environment less attractive for non-motorized users, and results in costly expenditure to cover the costs of congestion, traffic accidents, and pollution (*13*, *14*).

The definition of short-distance trips varies depending on the mode of transport. When considering walking as the main mode of transport, the average trip length can vary depending on the trip type, such as trips originating from home to a destination or to and from public transport, as well as the context of where the trips are done (*15*). Whereas European literature considers walking lengths of up to 8 km (5 mi) to be short distance (*16*), a U.S.-based study considers 2.25 km (1.4 mi) as a short-distance trip (*5*). There is also variation in the average time of a short walking trip, as a 30–45-min walk can also be considered a short walking trip (*17*) depending on the context. Considering the average walking speed of 4.8 km/h (3 mph) (*18*), the walkable distance threshold (DT), (distance people would be willing to walk rather than use a car) of a short-distance trip is often cited as 1.6 km (1 mi) (*7*, *19*, *20*).

Considering the opportunity short-distance trips present in modal shift, it is crucial to gain a better understanding of the factors that affect people's choice to use motorized transport modes even for short, seemingly walkable trips in environments with adequate pedestrian infrastructure (*21*). This lack of consideration for alternatives may stem from people's tendency to overestimate distances and walk times to nearby destinations (*21*, *22*), indicating also that drivers perceive distances as shorter than those perceived by pedestrians, potentially linking underestimations with the ability of drivers to reach distances with less effort than those walking (*23*). The concept of perceived effort or exertion (PE) refers to the conscious sensation that gauges how strenuous a task is to complete (*24*). This complex and subjective perception of exertion, in addition to the objective physiological indicators, is what characterizes the construct of walking effort (*24*). Research focusing on perceived exertion is predominantly featured in physical activity studies (*25*) but has also featured in psychophysiological studies investigating the impact of the natural environment on walking (*26*) and its mediating impact on aversion to walking as a result of strong driving habits (*4*).

This research seeks to better understand PE and its impact on travel behavior, particularly for short-distance trips using a comparative case study of Malta, and Delft in the Netherlands.

Methods

This study is based on a questionnaire survey distributed to two university populations: the University of Malta in Malta and Delft University of Technology in the Netherlands. The following sections describe the case study locations, the questionnaire and its distribution, the samples' characteristics followed by a description of the methods of analysis.

Case Study

Malta is a small island state with a very high level of motorization, amassing 411,056 registered cars that represent a motorization rate of 934 cars per 1,000 inhabitants (*27*), compared with 868 in the U.S. (*28*) and 588 in the Netherlands (*29*), and features among the top countries with the highest rates of obesity in Europe (*30*). The modal split is predominantly dominated by car use (84.3%) and a minimal share of active modes, with only 0.5% of bicycle use and 7% on foot (*31*). Because of the size of Malta, it is often compared with small European cities, with Delft being outlined as a comparable city because of the distances traveled on each trip (*32*). However, many differences can be noted; with reference to the modal split, in the Netherlands 41.7% of trips were done by car, 20.2% by bicycle, and 14.1% on foot (*33*). The Netherlands also reports lower values of passenger cars per thousand inhabitants than the European Union (EU) average and Malta (*34*). The larger share of active travel mode use in the Netherlands in addition to the differing urban environments, particularly Delft's substantially pedestrianized and walkable environment (*35*), offer an interesting opportunity to compare the two countries and further our understanding of walking behavior.

Questionnaire Outline

For this study, the target population consists of students and staff who were invited to participate through social media and flyers with a link to a web-based survey they could follow if they chose to participate in the study. The questionnaire, provided in English only to both case study locations, consists of six main sections. In the first section, initial questions with regard to the socio-demographic profile of the respondents are presented, particularly related to age, gender, employment status, and education level.

In the second section, questions with regard to the frequency of car use and walking are posed. Respondents specify how many times in a typical week (Monday–Sunday) they use a car (passenger or driver) and how many times they walk for work-related trips and non-work-related trips (e.g., shopping, post office, pharmacy, taking children to and from school, visiting relatives, supermarket, restaurants, sports facilities, etc.). The third section of the survey relates to the measure of PE, explicitly focusing on people's perception of effort for walking using an adapted scale (*4*) based on Borg's scale of perceived exertion (*36*). The scale is simplified to a seven-point scale that is verbally anchored with descriptors along the ratio scale of intensity, ranging from very easy to maximum effort. The measure is obtained in response to the following scenario: *Imagine you are about to walk 1.6 km (1 mi) at a normal pace (20-minute walk) from your home. You have nothing to carry, the road is even, and the weather is pleasant. From 1 to 7, how hard would you rate this walk to be?* (*4*).

The fourth section of the survey pertains to people's access to a car (i.e., they own a car or can be driven by someone) and whether or not they hold a driving license (i.e., they can drive a car themselves). This section acts as a participant selection element. Based on their response, those with car access are directed to the fifth section, which measures the DTs. The measure was obtained in response to the following scenario: *Imagine that you have to take a letter to the post office. The way to the post office is neither hilly nor dangerous. You have no other errands, the weather is fine, and you are not pressed for time. How far would you walk if you had a car available for the same trip?* (*4*). Respondents indicate their threshold using the following scale: I would not walk; I would walk up to 5 min; I would walk up to 10 min; I would walk up to 20 min; I would walk up to 30 min, thus limiting the upper bound to 30 min for a walkable short-distance trip.

The sixth and final section of the survey is answered by all participants and involves a set of Likert-scale questions to assess respondents' perceptions of their neighborhood environment using the following scale: 0—Very bad; 1—Bad; 2—Neutral, 3—Good, 4—Very good. The indicator variables to assess the perceived quality and walkability of the neighborhood include: Cleanliness of street and pavement; Visual appeal of architecture and open spaces; Trees, green spaces, and water bodies; Safety from crime; Street furniture (benches, bins); Road infrastructure (presence and quality of pavements, cycle lanes, street crossings); Land use (current variety of shops, restaurants, schools, public services, etc.); Safety from traffic (speed, accidents); and Level of air and noise pollution (*12*, *37*, *38*).

Characteristics of Respondents

A total of 169 respondents were collected from the University of Malta and 95 respondents from Delft University of Technology during May and June 2022. Note that not all respondents could answer all sections of the survey since only those with access to a car could answer the DT question. Therefore, for analyses requiring only those with car access, the sample consisted of 152 respondents from Malta and 57 respondents from the Netherlands. The socio-demographic profile of the questionnaire participants is outlined in Table 1. Comparing the survey samples with their respective national transport surveys, the Malta sample is comparatively younger than the National Household Travel Survey (NHTS), as 32% of respondents were between 41 and 60 years, closely followed by the 18- to 40-year group (31%) in the NHTS (*32*). The NHTS data show that with reference to gender (51% were females), driving license (65% had a license), and car access (84% had access), the sample is representative (*32*). The Netherlands sample is also comparatively younger than the Netherlands Mobility Panel (MPN) data because in the MPN 33% were between 18 and 39 years, closely followed by 31% between 40 and 59 years (*33*). However, the MPN data show that with reference to gender (53% were males), car access (84% had access), and driving license (67.4% had a license), the Dutch sample is similarly distributed (*33*). This difference in age groups is often associated with university samples and so the findings of this study potentially differ from the general public. The findings of the study must be interpreted with the understanding that certain travel behavior associated with older age groups, for example, may not be captured but requires further testing over larger, more general populations to minimize bias.

Data Analysis

The main methods of data analysis in this study are ordinal logistic regression (OLR), mediation analysis, and

Table 1. Socio-Demographic Profile of Survey Samples

Categories		Malta sample (n = 169)		Netherlands sample (n = 95)	
		Count	%	Count	%
Age	18–34	87	51.5	60	63.2
	35–44	28	16.6	15	15.8
	45–64	51	30.2	19	20.0
	65 +	3	1.8	1	1.1
Gender	Female	97	57.4	39	41.1
	Male	71	42.0	54	56.8
	Other	1	0.6	2	2.1
Employment	Full-time employee	122	72.2	51	53.7
	Part-time employee	12	7.1	17	17.9
	Student	34	20.1	26	27.4
	Unemployed	1	0.6	1	1.1
Car license	Yes	148	87.6	79	83.2
	No	21	12.4	16	16.8
Car access	Yes	152	89.9	57	60.0
	No	17	10.1	38	40.0

principal component analysis (PCA). The OLR analyzes the ordinal response variable of DT as the dependent variable with the independent variables of age, gender, PE, and car use frequency (CF) to test whether frequent car users had lower DTs because of the perception that walking is more physically exerting. To further examine the potential mediating effect of PE on the relationship between CF and DT, mediation analysis is conducted, also testing the mediating effect of PE between walking frequency (WF) and DT in a separate mediation analysis. The mediation model is essentially a modified form of linear regression, carrying the same assumptions, but it focuses on explaining why a relationship exists between two variables by testing if the effect of a predictor variable on an outcome operates either fully or in part through an intervening or mediating variable (*39*). Moreover, to develop our understanding of PE and its potential variation between the two case study areas, PCA is used to reduce the nine neighborhood environment factors to test the correlation between neighborhood perception and PE. Suitability for PCA was assessed through correlation examination, the Kaiser-Mayer-Olkin test of sample adequacy, and Bartlett's test of sphericity. Oblique rotation is used because the neighborhood factors are believed to correlate with one another (*40*), and factor retention was based on eigenvalues, visual examination of scree plots, and factor loadings (*41*).

Results

Comparisons between the two samples are performed for the measures of PE, DT, CF, and WF. The PE score acquired through an adapted Borg's scale of PE shows the mean Maltese sample score (1.63) is slightly lower than the Dutch sample (1.78), but the difference is not significant (p = 0.191). However, there is a significant difference (p = 0.049) in DTs, with the Maltese sample reporting a higher DT than the Dutch sample. The mean DT (distance people would be willing to walk rather than use a car) is 17.99 min for the Maltese sample and 15.18 min for the Dutch sample, which when using an average speed of 4.8 km/h (1 mph) (*18*), amounts to 1.4 km (0.9 mi) and 1.2 km (0.7 mi), respectively.

To analyze the respondents' CF and WF, five times per week is used to indicate the highest frequency whereas zero indicates the lowest frequency. Therefore, each respondent's combined frequency measure of work and non-work-related trips in a week range between 0 and 10. The mean CF of Malta (6.05) is significantly higher than that of the Netherlands (2.09). This difference is significant at the 0.01 level of significance. On the other hand, with reference to WF, the mean frequency of Malta (3.48) is similar to the Netherlands' mean (3.18), with no significant difference (p = 0.326). Although the modal share for walking in the Netherlands is higher than in Malta (*33*), the resultant lower mean of WF in this study may be because of a comparatively larger share of other modes used in the Netherlands, particularly the bicycle (*33*), and so active travel trips may be more commonly done by bicycle rather than on foot.

DT Analysis

An OLR is performed to analyze DTs as the dependent variable with the predictors of age, gender, PE, and CF. Table 2 provides the model fitting information for both case studies. The four predictor OLR model with a change

Table 2. Model Fitting Information for Ordinal Logistic Regression

	Intercept only	Final	Chi-square	Degrees of freedom	Significance	Value
Malta						
−2 log likelihood	148.872	100.105	48.767	18	0.000	na
Deviance	na	na	89.694	na	na	na
Pseudo R-square (Nagelkerke)	na	na	na	na	na	0.611
Netherlands						
−2 log likelihood	148.872	134.255	14.617	4	0.006	na
Deviance	na	na	123.844	na	na	na
Pseudo R-square (Nagelkerke)	na	na	na	na	na	0.240

Note: na = not applicable.

Table 3. Results of the OLR Analyzing DT Determinants

		B	Standard error	Wald chi-square	Degrees of freedom	*p*-value
Malta (*n* = 152)	Age	0.184	0.162	1.290	1	0.256
	Gender	0.490	0.301	2.650	1	0.104
	CF	−0.123	0.054	5.159	1	0.023
	PE	−0.628	0.195	10.370	1	0.001
Netherlands (*n* = 57)	Age	0.070	0.282	0.062	1	0.804
	Gender	0.021	0.481	0.002	1	0.966
	CF	−0.235	0.123	3.678	1	0.055
	PE	−0.503	0.248	4.117	1	0.042

Note: OLR = ordinal logistic regression; DT = distance threshold; CF = car use frequency; PE = perceived exertion.

in deviance (−2 log likelihood) of 48.767 for Malta and 14.617 for the Netherlands provides a significantly better fit than the intercept model since the *p*-values of both samples (Malta = 0.000, Netherlands = 0.006) are smaller than the 0.05 level of significance. Moreover, the Nagelkerke pseudo R-square values indicate that the four predictor OLR model explains 24% (Netherlands) and 61% (Malta) of the total variation in responses. The low R-square values and low value of the goodness of fit of the model imply that there are other predictors of walking DTs that need to be considered in future research that may explain the remaining variance, including aspects like attitudes, personal preferences, and also the frequency of use of other modes like the bicycle. This also highlights the need for larger scale sampling over larger populations to better capture the potential impact of predictors such as age, gender, and ethnicity.

The variable of WF was not included since the model is testing the hypothesis that frequent car use makes people more averse to physical exertion through walking and also since having both car use and walking frequencies in the same model may fail to obtain significant results because of interactions (*4*). The Wald chi-square test is used to test the significance of the predictors. The *p*-value results of the OLR (Table 3) show that the predictors of age and gender are insignificant, but PE showed significant *p*-values for both samples (Malta = 0.001, Netherlands = 0.042), and CF was significant for the Maltese sample (0.023). The parameter estimate of the last category of each predictor is aliased (set to 0) in SPSS by default. A positive parameter estimate indicates a larger mean rating score (more likely to walk a longer distance), while a negative parameter estimate indicates a smaller mean rating score (more likely to walk a shorter distance). The parameter estimates of PE (Malta = −0.628, Netherlands = −0.503) indicate that an individual with a high PE is less likely to walk longer distances.

Mediation of PE

To further examine the potential mediating effect of PE between CF and DT, mediation analyses are conducted using the PROCESS Procedure for SPSS (*39*). In total, four mediation analyses were performed, estimating two distinct models for each data set. The first model identifies the mediation effect of PE on the relation between CF and DT. The second model introduces WF and its relationship to DT and the mediating effect of PE.

The results of the first mediation analysis (Table 4) reveal that for the Maltese data, the total effect of CF on DT is significant (p = 0.009). With the inclusion of the mediating variable (PE), the impact of CF on DT is significant (p = 0.0465) and the indirect effect of the impact

Table 4. Summary of Mediation Analyses Results

		Total effect	Direct effect	Indirect effect	Confidence interval Lower bound	Upper bound	Result
Malta (*n* = 152)	CF →PE →DTs	−0.653 (0.009)	−0.496 (0.046)	−0.157	−0.3174	−0.0247	Partial mediation
Netherlands (*n* = 57)	CF →PE →DTs	−1.334 (0.006)	−0.891 (0.079)	−0.443	−1.0012	−0.0030	Full mediation
Malta (*n* = 152)	WF →PE →DTs	1.798 (0.000)	1.633 (0.000)	0.165	0.0023	0.3782	Partial mediation
Netherlands (*n* = 57)	WF →PE →DTs	1.218 (0.039)	0.7266 (0.218)	0.491	0.0849	0.9913	Full mediation

Note: WF = walking frequency; DT = distance threshold; CF = car use frequency; PE = perceived exertion.

of CF on DT through PE is also significant since the lower and upper bootstrap intervals do not include the value of zero (*42*). Therefore, PE partially mediates the relationship between CF and DT for the Maltese sample. To test the potential mediation of PE between WF and DT, a second mediation analysis is performed. Similarly, a significant indirect effect of the impact of WF on DT is observed with the direct effect of WF on DT in the presence of the mediator also being significant (p = 0.000), thus showing a partial mediation of PE on the relationship between WF and DT in the Maltese sample.

Conversely, in the Dutch data, both CF and WF and their relationship with DT are fully mediated by PE. The mediation analyses results (Table 4) show a significant indirect effect of the impact of CF on DT but the direct effect of CF on DT in the presence of the mediator became insignificant (p = 0.079), indicating that PE fully mediates the relationship between CF and DT. Similarly, a significant indirect effect of the impact of WF on DT is observed with the direct effect of WF on DT in the presence of the mediator (PE) also not being significant (p = 0.218), thus showing full mediation of PE on the relationship between WF and DT in the Dutch sample.

Neighborhood Perception Analysis

Next, we proceed to the analysis of the items making up the neighborhood perception ratings. The motivation for this analysis is firstly to contextualize the case study areas with reference to neighborhood quality from the perception of the participants, considering the juxtaposing urban streetscapes of the two case studies. Secondly, this analysis was included to investigate the potential correlations between neighborhood scores and PE and to better understand if there is any evident link between people's perceived quality of their neighborhood environment and how effortful they perceive walking to be for short distances. This is in line with previous research to further explore the notion that an improved urban walking environment can have an effect on people's perceived effort of walking (*4*). We find that all Pearson correlation coefficients are positive, and the Cronbach's Alpha values (Malta = 0.858, Netherlands = 0.851) exceed the 0.7 threshold value, indicating good internal consistency. The neighborhood factors analyzed and their respective mean ratings by the two samples show an overall systematic difference between the two countries (Table 5). The Kaiser-Mayer-Olkin estimate (Netherlands = 0.835, Malta = 0.853) and the significant Bartlett's test result (Netherlands and Malta p = 0.000) verified the sampling adequacy for principal component analyses. For the Dutch data analysis, two components have eigenvalues over 1 and explain over 59% of the variance, whereas for Malta one component has eigenvalues over 1 and accounts for 47% of variance. The resultant factor scores added to the data were used as predictors in a linear regression analysis to determine any significant correlation between PE and neighborhood perception. No significant correlations were found between the neighborhood factor scores and PE for Malta (p = 0.505) or the Netherlands (p = 0.469).

Discussion

This study has built on existing work investigating travel behavior determinants that impact people's propensity to use a car rather than walk for short-distance trips. This study particularly focused on the aspect of PE. The results provide insights into the impact of PE of walking in two very different case study locations using a survey study in combination with OLR and mediation analyses.

Distance Thresholds

The mean DTs that people were willing to walk for both samples (1.4 km [0.9 mi] and 1.2 km [0.7 mi]) were slightly lower than the often-cited 1.6 km (1 mi) walkable DT (*7*, *19*, *20*). However, there is a difference between the distance that can be walked versus the distance people are willing to walk, and how DTs are measured must be accounted for. In this study, pre-defined categories of how long people would be willing to walk were provided, while keeping all values within a walkable short-distance

Table 5. Descriptive Statistics and Component Analysis Results of Neighborhood Factors

Factors	Malta (n = 169)			Netherlands (n = 95)			
	Mean	Standard deviation	Factor loadings	Mean	Standard deviation	Factor loadings (oblimin with Kaiser normalization)	
Cleanliness of street and pavement	1.76	1.065	0.800	3.00	0.863	0.679	na
Visual look of architecture and open spaces	1.64	1.110	0.797	3.02	0.922	0.817	na
Trees, green spaces, and water bodies	1.41	1.141	0.664	3.11	0.803	0.736	na
Safety from crime	2.54	0.970	0.524	3.07	0.925	0.792	na
Street furniture	1.73	1.010	0.705	2.60	0.880	na	0.553
Road infrastructure	1.31	1.134	0.751	3.00	0.923	na	0.826
Land use	2.08	1.102	0.563	2.74	1.013	na	0.811
Safety from traffic	1.57	1.067	0.636	2.94	1.019	0.383	0.527
Level of air and noise pollution	1.16	1.082	0.698	2.52	1.119	0.660	na

Note: na = not applicable.

trip (i.e., an upper bound of 30 min walking). The average time of a short walking trip varies in the literature, ranging from 10 min of walking or less (*43*) but also a 30- to 45-min walk can also be considered a short walking trip (*17*), depending on the context. For this study, short walking trips to a destination were considered to be up to 30 min or less of walking. Nevertheless, a study using a ratio judgment measurement of how much people prefer to drive or walk for a given distance showed an average of 4.1 km (0.9 mi) as the mean DT (*4*) whereas another study required participants to choose between walking versus driving for a given distance and elicited a lower mean DT of 3.4 km (2 mi) (*13*). Comparing these with this study's findings, these studies obtained considerably higher thresholds; although the potential impact of overestimation should also be considered as people may not want to report short walking DTs for fear of being perceived as lazy (*4*).

The mean DTs of both samples expressed in time values (17.99 min and 15.18 min) resonate with the relevance of concepts like the 15-min and 20-min cities, as it is noteworthy that people are willing to walk up to 15 to 18 min even when they have a car available for that same trip. These findings can contribute to land-use planning policies because short car trips can be shifted to active modes, particularly walking, and thus creating compact, dense cities can facilitate this shift (*44*, *45*). By bringing destinations closer to people through a high density mixed land-use pattern, active modes of transport can effectively compete with motorized vehicles to carry out short-distance trips (*46*, *47*).

Perceived Exertion

The findings indicate that an individual with a high PE is more likely to walk a shorter distance, and so creating walkable environments that minimize people's exertion may enable people to increase their thresholds for walking. The significant correlation between WF and PE indicates an important relationship, whereby people who walk less frequently perceive walking to be more physically exerting. However, the direction of this relationship requires further testing as this could also be interpreted that people who perceive walking to be effortful walk less frequently. The relevance of minimizing people's PE of walking is crucial, emphasizing the need to identify factors that affect people's perception of effort to walk short-distance trips, particularly measures in the urban walking environment that can be implemented to potentially decrease people's level of PE.

Moreover, the mediation analyses revealed interesting findings relating to PE, DTs, and car/WF. Similar to previous research (*4*, *13*), our findings indicate that frequent car users exhibited an aversion to physical exertion through walking, since PE mediated the relationship between CF and DT. Whereas in the Maltese case study, PE only partially mediated the effect of CF on DT, in the Dutch case study, full mediation was observed, indicating that CF affects DT but through the mediating effect of PE. Notwithstanding the prevalence of bicycle use in the Netherlands and its potential influence on exertion perception, this finding suggests that frequent car users had a lower DT for walking compared with Malta because they showed an aversion to exerting physical effort through walking. This poses an interesting course for future research to examine the impact of frequent cycling on people's PE of walking for short-distance trips.

In the Maltese case study, the partial mediation indicates that PE does play a mediating role, but there is also a direct relationship between CF and DTs for walking.

This suggests that although mitigating the factors that may contribute to people perceiving walking to be physically exerting can play a role in encouraging people to walk longer distances, policies and measures must also consider the determinants that currently promote such frequent car use, with over 60% being car users and 90% having car access in the Maltese sample.

Thus, measures that disincentivize the use and ownership of cars are key, albeit discouraging ownership may be more difficult because of the symbolic status and attachment associated with having a car (*4*, *48*). Nonetheless, discouraging car use, particularly for short-distance car trips that are walkable, can be an effective starting point, especially strategies that link the importance of walking to health benefits through social norms and peer pressure (*4*). This, however, should also be coupled with improved pedestrian infrastructure (*49*) to provide consolidated, walkable routes that can positively impact people's perception of walking accessibility (*50*) and help encourage a modal shift.

Neighborhood Environment Perceptions

In relation to the samples' neighborhood environment perceptions, lower mean rating scores were reported by the Maltese participants. The bi-variate correlation between PE and the principal components extracted from the samples' neighborhood perception ratings show there was no significant correlation. The lower mean rating scores of the Maltese neighborhood environment perceptions highlight the need for improved urban environment quality. Linking this with the mediation results for the Maltese case study, showing the mediating role of PE and the direct relationship between CF and DTs for walking, improvement in the urban environment and introducing infrastructure that prioritizes walking and discourages car use can play a role in increasing people's DTs for walking. Although the items extracted from the literature measuring the neighborhood quality perception (*11*, *12*, *37*, *38*) were useful to understand the differences between the two case studies, the lacking significant correlation between the ratings of PE and the neighborhood perception suggests that other subjective and objective factors may impact people's PE of walking and need to be identified. The literature within the field of physical exercise and training has explored the subjective and objective factors that can cause variation in people's rating of PE, including personality factors, socio-demographic factors like age and gender, fitness level, and environmental factors such as environmental temperature and altitude (*51*). However, further research and more theoretically robust findings are needed, particularly with regard to the objective and subjective factors that influence people's PE, to identify the trigger of observed behaviors and further contribute to the shift to more active modes of transport.

Conclusion and Future Work

This study has built on previous work to understand the relationship between CF and people's perception of walking as being more effortful. Using a case study approach, the findings show significant correlations between DTs and CF, where those that used the car more frequently had lower DTs for walking. These correlations, however, do not assert the direction of causation, since such results can be interpreted bi-directionally, that is, those with lower walking thresholds use the car more frequently. Nevertheless, the implication of these significant correlations is noteworthy as introducing policies and measures that target people's propensity to walk for short-distance trips can still have an impact. Considering the limitations of a small university sample and the possible influence of diverse ethnicities and cultures on travel behavior, there is a need for further research over wider population samples to understand the potential impact of age, gender, and ethnicity, and other potential predictors on DTs, and to analyze in greater detail the relationship between PE and neighborhood quality, especially using country comparisons that account for cultural differences.

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Author Contributions

The authors confirm contribution to the paper as follows: study conception and design: K. Scerri, M. Attard, O. Cats, D. Duives; data collection: K. Scerri; analysis and interpretation of results: K. Scerri; draft manuscript preparation: K. Scerri, M. Attard, O. Cats, D. Duives. All authors reviewed the results and approved the final version of the manuscript.

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