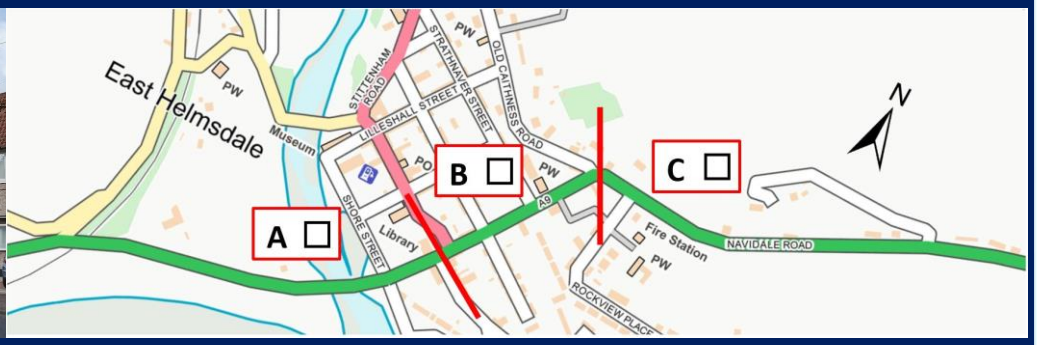
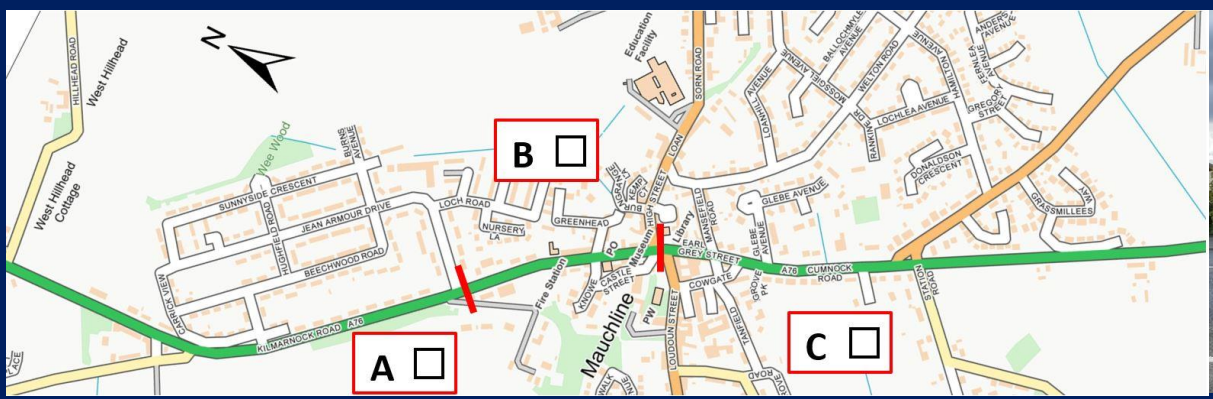
Scottish Road Research Board (SRRB)

Vulnerable road user perception of speed

Final Project Report





JUNE 2023

CONFIDENTIAL

Scottish Road Research Board (SRRB)

VULNERABLE ROAD USER PERCEPTION OF SPEED

Final Project Report

REPORT (1.0) CONFIDENTIAL

PROJECT NO. 70058582

DATE: JUNE 2023

Scottish Road Research Board (SRRB)

VULNERABLE ROAD USER PERCEPTION OF SPEED

Final Project Report

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APPENDICES

EXECUTIVE SUMMARY

In 2019, Transport Scotland's Scottish Road Research Board commissioned WSP to study the gap between vulnerable road users' perception of vehicle speeds in comparison to actual speeds on Scotland's roads.

Following a literature review and pilot study, the project was paused during the most significant portion of the COVID-19 pandemic and resumed in 2022.

This report concludes the project, presenting the findings of the project from 2022-2023 and suggesting the next steps for further research.

Analysis of a household survey of 589 Scottish residents across 13 settlements bisected by a trunk road found that traffic speed, volume, and noise were the most commonly cited barriers to active travel near the trunk road. In respondents' wider areas, they also cited lighting and crossing times as barriers to active travel.

By using the relative speed estimate – that is, the mathematical difference between estimated speed and recorded speed – as the dependent variable for statistical analysis, this project was able to provide the following further insights:

- On average, respondents overestimated traffic speeds by 7.5mph.
- People with a disability that limits their day-to-day mobility or with pets in the household were more likely to overestimate traffic speeds.
- When we considered factors individually, there was no significant difference between estimation levels across gender, vehicle ownership, children in household, or age.

Taking all of these variables into consideration at the same time through regression modelling, the following demographic and geographic factors appear to have a statistically significant impact on overestimation of traffic speeds:

- Disabilities affecting mobility
- Pets and/or children in household
- Vehicle in the household
- Length of time at current address
- Lower traffic volumes and lower actual speeds
- Narrower roads
- Commercial settings
- Barriers between pedestrians and traffic

To further understand the implications of these findings, Transport Scotland could consider conducting field trials of speed indicator devices on trunk road high streets in combination or comparison with other interventions to support residents to estimate speed more accurately and feel safer in the trunk road environment.

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Introduction

In 2019, WSP was appointed to investigate the gap between vulnerable road users' perceived vehicle speeds and actual speed, and the impacts the actual and perceived trunk road conditions have on residents' ability to walk or cycle in their local area.

This project was undertaken in five stages:

Stage 1: Literature Review

A review was undertaken by Edinburgh Napier University's Transport Research Institute (ENTRI) of any existing research to assess if perceptions of speeds and gap acceptance have been quantified in similar environments to strategic roads in Scotland.

The outcomes of this review were detailed in the End of Stage 1 summary note. The most important outcome from the Stage 1 Literature Review was that there is insufficient existing evidence to draw any conclusions on vulnerable users' perceptions of speed on strategic roads bisecting rural settlements.

This literature review was updated during Stage 4 as part of the post-COVID-19 restart. The updated literature review is described in brief in Section 2 and included in the appendices.

Stage 2: Pilot Study

Following Stage 1, WSP developed and carried out a pilot study to assess the performance of the survey and analysis process.

The pilot survey was undertaken in Earlston on 28th November 2019 and concluded that, with minor revisions to the questionnaire used, public perception of speed against actual can be measured and, with a larger dataset, triangulation of this data with household make-up could be carried out.

The findings of the pilot study are presented in the End of the Stage 2 summary note (issued January 2020).

Stage 3: Methodology Formalisation

The outcomes of the pilot study were reviewed by WSP and ENTRI and a revised methodology for the wider study was proposed. This revised methodology was presented in the Stage 3 summary note (issued July 2020). Further data collection was then placed on indefinite hold due to the COVID-19 pandemic.

In August 2021, Transport Scotland and WSP agreed that the project should work toward a re-start, and a project re-start proposal was developed (submitted October 2021).

Stage 4: Field Work

In autumn 2022, a survey-based field study was conducted across 13 settlements to study how people living adjacent to trunk roads perceive the traffic conditions in their local area. This report describes the survey development and fieldwork methodology.

Simultaneous with conducting the survey, WSP commissioned the collection of traffic speed and volume data from Automatic Traffic Counters (ATCs) at each study site.

Stage 5: Analysis and Reporting

The survey data was analysed in conjunction with traffic speed and volume data to provide both general and settlement-specific insights into residents' perceptions of speeds and barriers to active travel.

The sample was analysed as a whole along the following dimensions:

- Respondents' perception of traffic speed relative to measured speed
- Location of residents' perceived traffic issues
- Key times of traffic issues
- Barriers to active travel
- Differences in average accuracy of traffic speed estimation across demographic groups
- Identification of factors related to relative estimation of traffic speed (multiple linear regression model)
- Factors increasing probability of overestimation of traffic speeds by 5+ or 10+ mph (logistic regression models)

Settlement-specific findings are included as datasheets in Appendix A.

1 Literature Review

As part of Stage 1 of the study, Edinburgh Napier University's Transport Research Institute undertook a Literature Review of peer-reviewed and grey literature addressing the perception of speed and speeding in rural settlements bisected by main routes for motorised transport. The full findings of the Literature Review are presented in Appendix C.

The Literature Review examined existing research to assess if perceptions of speed and gap acceptance have been quantified in similar environments to strategic roads in Scotland. The literature review included research into "self-regulation" of non-motorised road users, as well as the wider variables.

Following post-COVID-19 resumption of the project in summer 2022, the literature review was updated to reflect any additional publications.

The key findings of the Literature Review are presented below, including the assessment of how strongly the evidence supports the stated finding.

Literature Review Findings

- There is a paucity of research addressing resident 'roadside' perceptions of traffic speed, not least in rural settings. (Strong)
- Research and public policy within the past few decades have focused on drivers, thereby neglecting pedestrians, e.g. older pedestrians and their travel requirements. (Strong)
- Healthy older pedestrians find higher-speed traffic challenging to road crossing and this relates both to their attention and speed of walking. Moreover, at higher speeds, pedestrians tend to accept smaller time gaps, i.e. they initiate riskier crossings. Adding cognitive decline and diseases such as Alzheimer's or Parkinson's and the road crossing task on such roads is much harder and may not be attempted. (Strong)
- Perceptions of vulnerable road users of high traffic volume and the traffic speed as 'fast' also perceived a higher proportion of road traffic being HGVs. (Medium)
- "Self-explaining roads" focuses on functionality, homogeneity and predictability to make roads safer. Roads designed in this way are also more user-friendly and are designed for pedestrians and cyclists as well as motorists. It combines objective data with resident speed choice ratings. (Medium)
- For cycle users being overtaken by motor vehicles, lateral clearance does not appear to be the only factor that influenced rider's risk perception, although current standards are only related to it. A combined factor of lateral clearance, vehicle type and vehicle speed had a more significant correlation with the perceived risk. High-speed roads may also present a greater risk to cycle users. (Medium)
- Research specifically addressing traffic and health and quality of life finds that close proximity to main road traffic reduces this, not least through reduced walking, although there is no evidence regarding impacts of speed of traffic per se. (Medium)

2 Methodology

Introduction

Following the completion of the pilot study in Autumn 2019 and the project restart in summer 2022, the fieldwork methodology was revised to maximise the efficient collection of representative, high-quality data.

This section describes the survey design, fieldwork and data collection approach, and approach to data analysis.

Survey Design

The four-part survey was divided as follows:

Part A – Local Trunk Road Focus

Respondents were first asked to indicate where on a map of their local area most problems occurred. For the section they indicated, they were asked about perceived vehicle speeds, time issues occur, road crossing conditions and walking and cycling conditions along the study area.

Part B – Barriers to Active Travel

In Part B, respondents were asked to indicate the degree to which a range of factors hindered their ability to walk or cycle in a) the study area and b) the wider area (20-minute walk / a mile). The following factors were chosen to be scored as Never, Rarely, Often or Always impacting their ability to walk or cycle:

- Speed of traffic
- Amount of traffic
- Lack of crossing points
- Signalised crossings not allowing adequate time to cross.
- Poor road lighting
- Poor footways
- Noise pollution
- Air pollution
- Fear for personal safety
- Lack of safe cycling infrastructure, hindering cycling

Part C – Resident Views

Part C was a free text question that allowed respondents to provide feedback and give their opinion on what improvements they would like to see in their local area to facilitate travel of any type around their local area.

Part D – About You

Part D asked the respondent general questions about themselves / their household to capture demographic information.

A copy of the survey is included in Appendix B.

FieldWork Approach

Surveys were conducted between September 2022 – November 2022, with two WSP team members visiting each of the settlements to distribute the surveys.

A combined method of in-person/freepost return was chosen for survey distribution, with surveyors introducing themselves and explaining the survey at 1:2 – 1:5 residences depending on population density.

The respondents were left to answer in their own time and could either return the survey to the surveyor later that day or by freepost return. At houses with no response or which were not targeted for in-person discussion, surveys were posted through the letterbox for freepost return.

Sampling

The following settlements were selected as the study areas, with surveys issued to all households living within 50m of the trunk road:

- Rosyth
- Methven
- Freuchie
- Keith
- Fort William
- Inverness
- Skelmorlie
- Lochearnhead
- Drumnadrochit
- Helmsdale
- Newtonmore
- Kincardine
- Mauchline

These settlements were selected based on the combined professional experience of WSP and Transport Scotland as reflective of a variety of trunk road residential contexts.

Response Rate

Across the 13 settlements that were included in the study, there were 589 responses, a response rate of 26%.

Quantitative Data Analysis

This section summarises the approach to quantitative data analysis of the surveys; the results of this analysis are presented in Section 4.

Determination of the primary Dependent Variable

A comparison between perceived and ATC-measured traffic speeds at the location which participants marked on the Part A map was used to address the primary research question, which focused on residents' perception of speed.

The key dependent variable for the central research question was termed the 'relative speed estimate', calculated as:

Measured 85th percentile traffic speed – Estimated traffic speed = Relative Speed Estimate

As estimated traffic speed was recorded in bands (e.g., 30-35 mph), the maximum speed of the band was used for the above calculation.

Descriptive Statistics

The sample was analysed along the demographic measures described in Table 3-1.

Table 2-1 – Demographic Characteristics and Coding

Demographic Characteristic	Response Options
Gender	*Female, Male, Other, Prefer Not to Say*
Age	*In bands from 18-24 to 85+*
Number of years living in residence	*Free response*
Household description	*Retired, Immediate Family, Multi-Occupancy (related), Multi-Occupancy (not related), Single-Occupancy, Couple, Prefer Not to Say*
Mobility-Limiting Disability	Yes / No
Household vehicle ownership	*None, One, Two or More*
Frequency of contact with neighbours	*Three or more times a week, Once or twice a week, Once or twice a month, Less often or never*
Pet ownership	*Yes / No, free response to indicate type and number*

Due to the geographically-targeted nature of the analysis, the sample was not assessed or weighted against population-wide demographics.

Demographic Analysis

The analysis team used two sample t-tests for unequal variances, conducted in Excel, to compare the mean relative speed estimates between the following demographic groups:

- Male and female respondents
- Disabled and non-disabled respondents
- Respondents with and without a vehicle in the household
- Respondents with and without children in the household
- Respondents with and without a dog and/or cat in the household

Additionally, a linear regression model was used to assess the relationship between age and relative speed estimate.

Coding of Independent Variables

Table 3-2 lists the variables included in the regression models and shows how categorical variables were coded for inclusion in linear and logistic regression modelling:

Table 2-2 – Independent Variables, Data Source and Numerical Assignment

Demographic Characteristic	Data Source	Coding
Gender	*Survey*	*Female (2), Male (1), Other (3), Prefer Not to Say (0)*
Age	*Survey*	*In bands from 18-24 to 85+ - youngest age in band used for regression*
Number of years living in residence	*Survey*	*Numerical data (years)*
Household description	*Survey*	*Retired, Immediate Family, Multi-Occupancy (related), Multi-Occupancy (not related), Single-Occupancy, Couple, Prefer Not to Say*
Mobility-Limiting Disability	*Survey*	*Yes (1) / No (0)*
Household vehicle ownership	*Survey*	*None (0), One (1), Two or More (2)*
Frequency of contact with neighbours	*Survey*	*Three or more times a week (3), Once or twice a week (2), Once or twice a month (1), Less often or never (0)*
Pet ownership	*Survey*	*Dog and / or Cat: Yes (1) / No (0)*
Width of Road	*Google Maps*	*Estimated width in metres*
85th Percentile Speed	*ATC*	*Speed in miles per hour*
Volume of Traffic (10k's)	*ATC*	*7-day daily average count / 10,000*
Land Use	*Google Maps*	*Commercial (3), Mixed Use (2), Residential (1), Unoccupied (0)*
Barrier between footway and traffic	*Google Maps*	*Most of carriageway section (as indicated on map) (2), Some of carriageway section (1), None (0)*
Presence of bus stop(s)	*Google Maps*	*One or more bus stop located in carriageway section indicated on the map: Yes (1), No (0)*
Pedestrian crossing in road section?	*Google Maps*	*Pedestrian Island (1), Zebra (2), Controlled (3), None (0)*
Footway width	*Google Maps*	*Estimated width in metres*

Demographic Characteristic	Data Source	Coding
School near the section?	*Google Maps*	*School within 100m of road section: yes (1) / no (0)*
Footway	*Google Maps*	*Both sides of road section (2), One side (1), None*
Lanes of Traffic	*Google Maps*	*Number of lanes (Note that this variable was removed from analysis as all considered road sections had two lanes.)*

Model Construction

Three models were prepared using the XLMiner Analysis ToolPak in Excel:

- **Multiple linear regression model:** relationship between independent variables and relative speed estimate
- **Multiple logistic regression model 1**: relationship between independent variables and probability of 5+mph relative speed estimate
- **Multiple logistic regression model 2**: relationship between independent variables and 10+mph relative speed estimate

Model Fitting

The model was then fitted using non-automated backward elimination. The initial model was built including all available predictor (independent) variables. One by one, the variables with the highest p-value (level of statistical significance) were eliminated from the model. The process was repeated iteratively, with the analysis team removing variables until a model was obtained with all variables below the designated alpha value (*i.e.,* $p < 0.10$). This manual approach allowed the model to be tailored to the specific problem and make informed decisions based on the data and our expertise.

Qualitative Data Analysis

For the 'Your Views' section of the survey (Part C), the project team manually coded each response into key categories and summarised the feedback in the Settlement-Specific Datasheets (Appendix A) with additional emphasis placed on more frequently occurring feedback.

3 Results

Introduction

This section presents the results of the household survey. First, the respondent sample is described along demographic lines (Section 4.2). Then, in Section 4.3, perceptions of area transport issues across the sample are summarised.

In Section 4.4, average relative speed estimates are compared across six demographic categories and statistically significant differences are noted.

About the Sample

Gender

The gender split of the survey respondents was relatively even, with 50% identifying as female and 49% as male. The remaining 1% either identify in another way or indicated they preferred not to provide this information.

Age

72% of the total respondents were between ages 55 and 84, with the relative majority in the 65-74 age range. There were only 17 respondents aged 25-34 and 1 aged 18-24.

Number of Years Living at Residence

Respondents skewed toward long or short tenancies in their residences. The highest percentage (28%) of respondents reported that they had lived in their home for less than five years; 22% reported living there for over 25 years.

Household description

Almost half (48%) of all respondents reported being retired, with 20% living in an immediate family group.

Disability

When asked if they consider themselves to have any disability or other long-term health problems that may limit their mobility in any way, the majority of respondents (72%) responded that they did not. The remaining 28% considered themselves to have some sort of disability or long-term illness impacting their mobility.

Vehicle Ownership

Participants were asked about the number of vehicles in their households. 89% of the respondents owned at least one vehicle, with 34% of them having two or more vehicles. 11% of respondents had no vehicle in the household.

Frequency of Contact with Neighbours

The majority of respondents reported (78%) meeting or seeing their neighbour(s) at least once a week.

Pet Ownership

63% of the respondents did not have any pets, while the remaining 37% owned at least one pet.

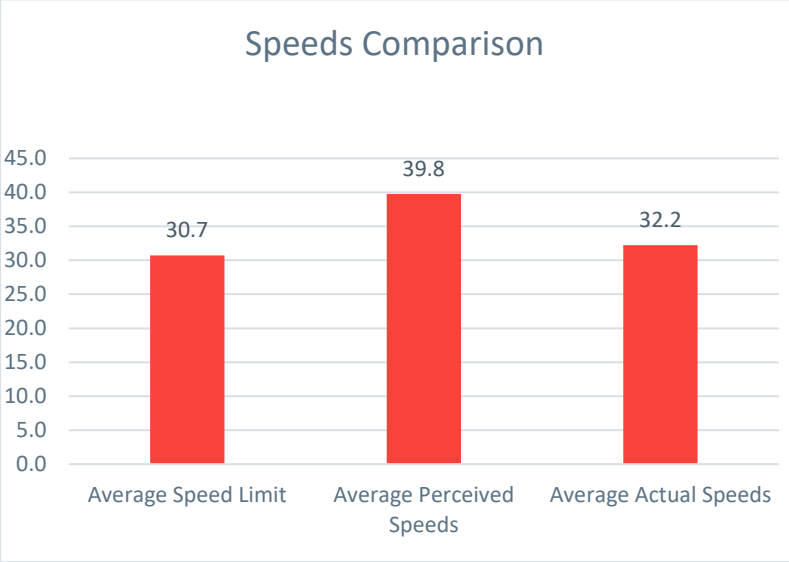
Perceptions of Area Transport Issues

Speed Estimate

Participants were asked to estimate what speed they thought most traffic was travelling through their local area. This perceived speed was compared to the actual 85th percentile speed (captured over a 4-day period within two weeks of the study), and the speed limit for the section, as shown in Figure 4-1.

As illustrated in Figure 4-1, residents' perceived traffic speed (39.8 mph) was higher than the actual 85th percentile speed (32.2 mph); both are higher than the average posted speed limit across all road sections (30.7 mph). This suggests that traffic is travelling through these settlements at speeds above the speed limit, but not to the extent that residents are perceiving.

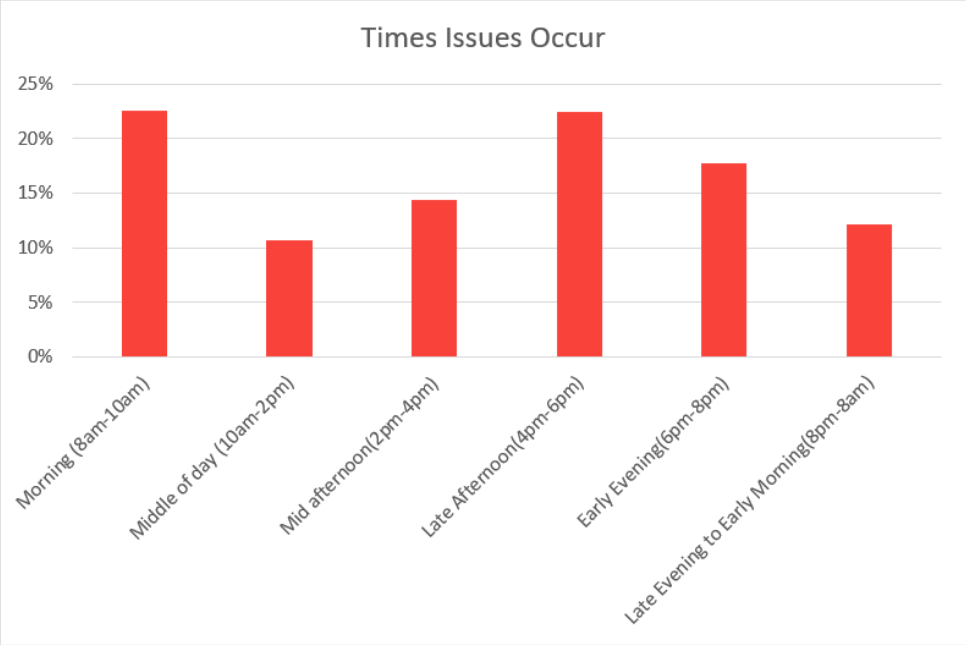
Figure 3-1 – Speeds Comparison



Time of Issue Estimate

Respondents were also asked to indicate what time issues most frequently occurred or were most severe on their local trunk road. As shown in Figure 4-2 below, traffic issues were considered most problematic and morning and late afternoon peaks, but with continuing difficulties throughout the day.

Figure 3-2 – Times Issues Occur



Waiting Times Estimate

To identify a proxy measure for pedestrian suitability, respondents were asked to estimate how long it took to cross the road within their local area. As illustrated in Figure 4-3, the majority of respondents reported waiting at least a minute to cross the road, with a significant number of people reporting waiting over three minutes.

Figure 3-3 - Road Crossing Waiting Times

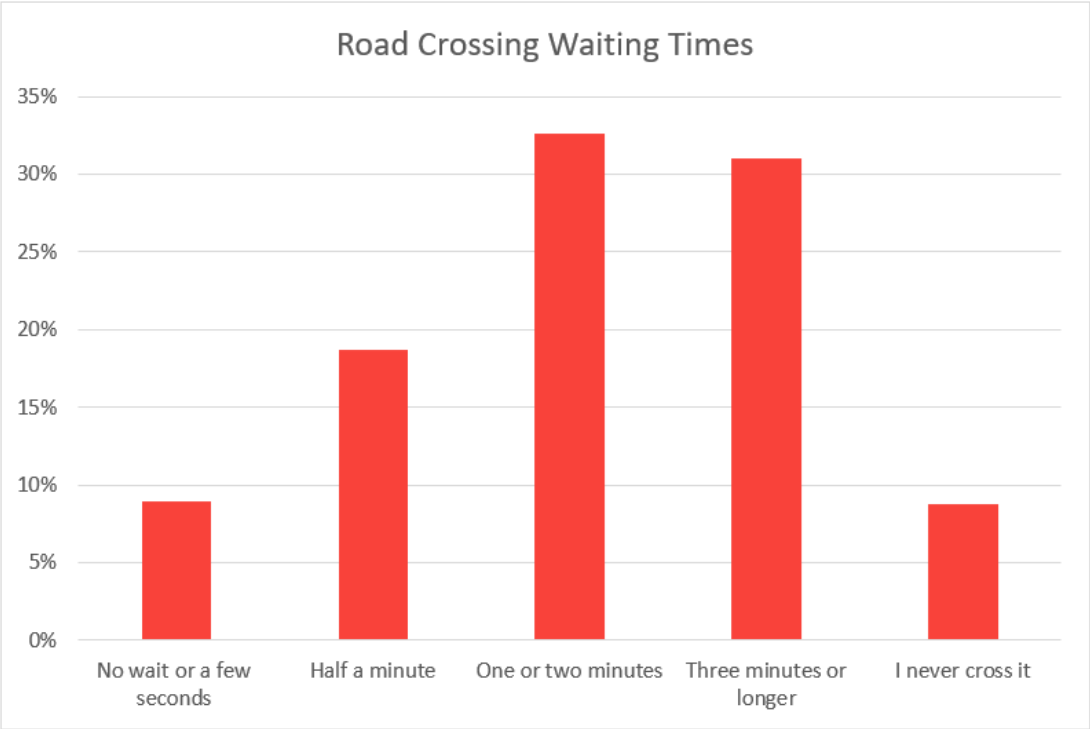
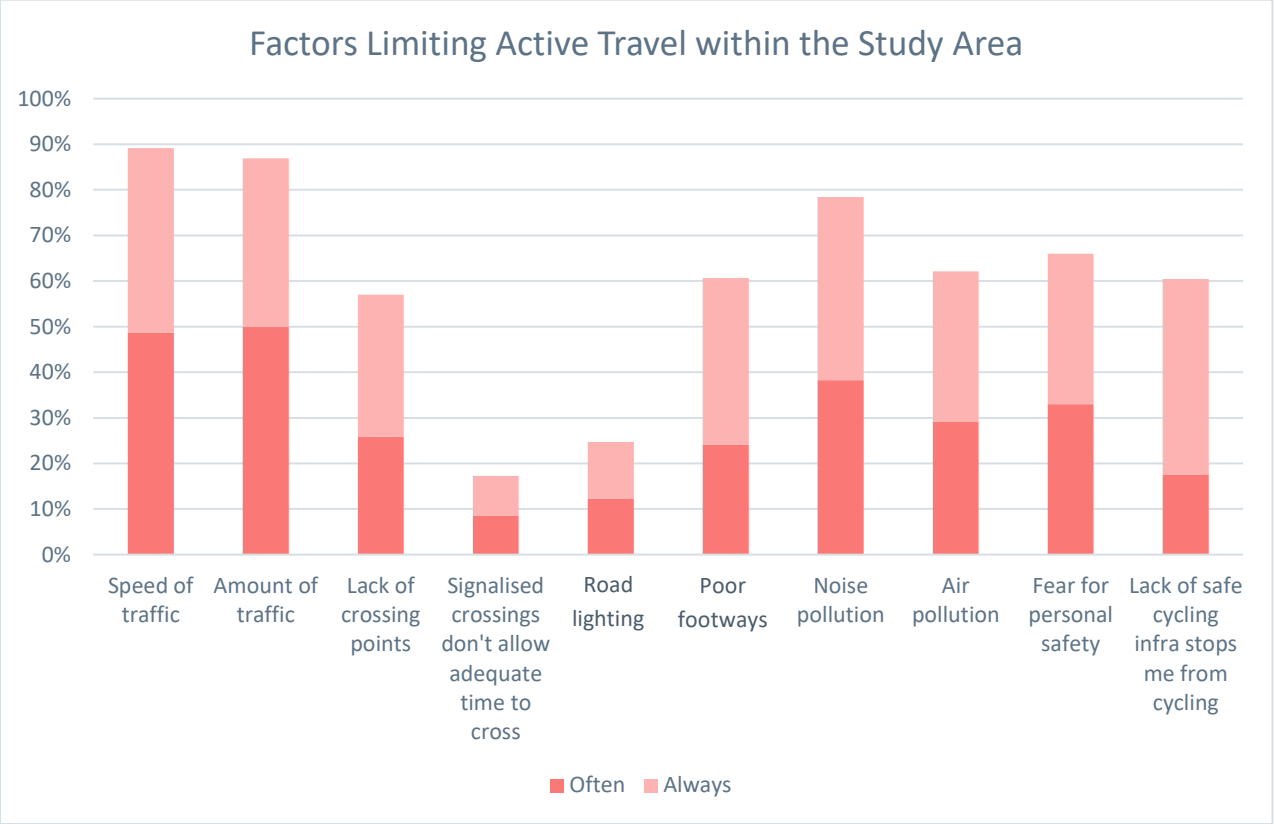


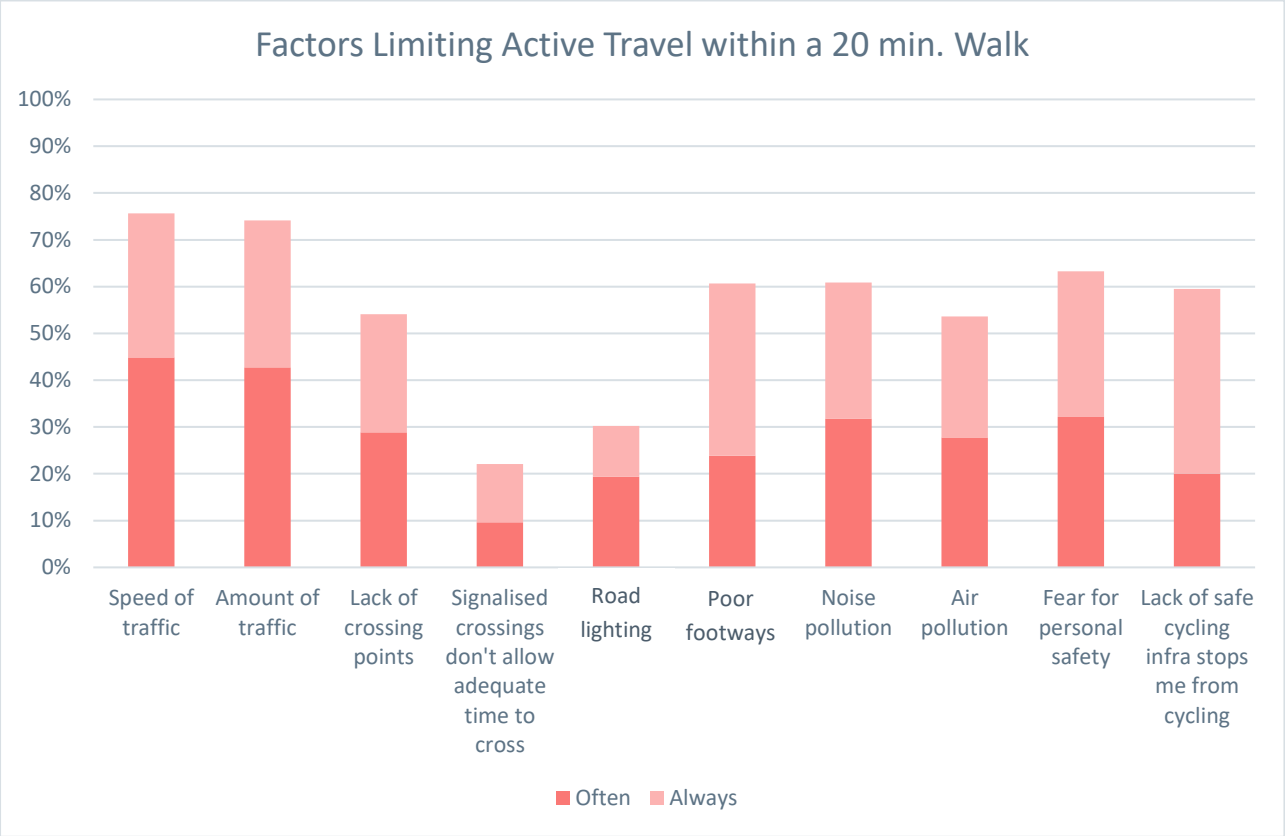
Figure 4-4 below illustrates the number of respondents who stated that each factor 'Often' or 'Always' impacted their ability to walk or cycle within the study area. With the exception of lighting and signalised crossing times, each factor was scored as 'Often' or 'Always' impacting active travel. Speed of traffic (89%), volume of traffic (87%) and noise pollution (78%) were cited most commonly as impacting factors.

Figure 3-4 – Factors Impacting Study Area



The responses regarding the wider area, shown in Figure 4-5, followed a similar trend, with all factors, with the exception of lighting and crossing times at signalised crossing, also returning over 50% for 'Often' or 'Always' impacting active travel. However, for each of the factors the percentage of responses returning as 'Often' or 'Always' was slightly lower than for the trunk road, suggesting whilst still a problem the problem is more prominent on the trunk road itself than within the wider area.

Figure 3-5 – Factors Impacting Wider Area



Demographic Analysis

Two sample t-tests were performed to compare the relative speed estimate across five demographic groups. The results of these tests are summarised in brief below.

To facilitate interpretation of statistical results, a brief explanation of all abbreviated variables is located in table 4-1 below.

Table 3-1 – Glossary of statistical abbreviations

Abbreviation	Term	Notes
M	Arithmetic mean (average)	None
SD	Standard deviation	Measures variability within the sample

Abbreviation	Term	Notes
t	Indicates a 't-test, comparing two averages across different groups	The t-test is customarily followed by the degrees of freedom in brackets.
p	Probability of outcome occurring by chance	For this study, we have considered an outcome 'statistically significant' if there is less than a 10% chance of it occurring by chance ($p < 0.1$)
R^2	A goodness-of-fit measure for linear regression models.	This statistic indicates the percentage of the variance in the dependent variable that the independent variables explain collectively.
F	Fit of independent variables to data.	In essence, this statistic tests if the regression model as a whole is useful.
β	Coefficient describing a linear/exponential relationship between the variables	In a linear regression, this is the *slope* of a line.
S.E.	Standard error	Standard deviation of the estimated population distribution
T statistic	Coefficient divided by its standard error.	None
95% CI	95% confidence interval	It is 95% likely that the actual coefficient falls between the two listed numbers.

Gender

There was not a significant difference in relative speed estimate between male respondents (M = 7.29, SD = 6.60) and female respondents (M = 7.66, SD = 6.85); t(534) = 0.63, p = 0.528.

Disability

The 149 respondents who said they had a disability which limited their day to day movement (M = 8.52, SD = 6.44), compared to respondents who said they did not have a disability (M = 7.06, SD = 6.76), recorded significantly higher relative speed estimates, t(279) = 2.31, p = 0.021.

Vehicle in Household

There was not a significant difference in relative speed estimate between respondents with one or more vehicles in the household (M = 7.49, SD = 6.59) and respondents with no vehicles in the household (M = 7.07, SD = 7.50); t(78) = 0.43, p = 0.334.

Children in Household

There was not a significant difference in relative speed estimate between respondents with children in the household (M = 7.96, SD = 7.43) and respondents with no children in the household (M = 7.36, SD = 6.58); t(93) = 0.66, p = 0.514.

Dog or Cat in Household

The 197 respondents with a cat and/or dog in the household (M = 8.23, SD = 6.99), compared to respondents who with no cat/dog (M = 6.96, SD = 6.45) recorded significantly higher relative speed estimates, t(381) = 2.09, p = 0.037.

Age

A linear regression model found no statistically significant relationship between age and relative speed estimate (p = 0.683)

Multiple Linear Regression Model

Multiple linear regression was used to test if the research variables in Table 4-2 below significantly predicted the relative speed estimate.

The reduced, fitted regression model was:

> *Relative Speed Estimate = 5.63 + 0.59*(Disability Asgt.) + 1.02 (Pets Asgt.) – 1.56*(Volume of Traffic in 10k's).*

The overall regression was statistically significant (R^2 = 0.02, F(3, 551) = 4.68, p = 0.003).

In the fitted model, the three variables were found to significantly predict Relative Speed Estimates:

- Disability Category Assignment (β = 1.39, p = 0.018);
- Pets Category Assignment (β = 1.020, p = 0.064); and
- Volume of Traffic (10k's) (β = -1.560, p = 0.015)

The full results of the linear regression model and all included independent variables, before model fitting, are detailed in Table 4-2 below.

Table 3-2 – Results of multiple linear regression between Relative Speed Estimate and all included independent variables, ordered by statistical significance.

Independent Variables	Coefficient (β)	Standard Error	T-statistic	Significance (p-value)
Disability Assignment	1.566	0.640	2.449	0.015**
Volume of Traffic (10k's)	0.000	0.000	-2.142	0.033**
85th Percentile Speed	-0.199	0.117	-1.699	0.090*
Pets (Assignment)	1.005	0.613	1.639	0.102
Width of Road	-0.546	0.339	-1.608	0.108
School near the section	0.864	0.780	1.107	0.269
Years lived at current address	0.021	0.022	0.956	0.339
Presence of bus stop(s)	0.749	0.859	0.872	0.383
Footway width	-0.231	0.310	-0.744	0.457
Land Use	0.630	0.982	0.641	0.522
Frequency of meeting with neighbours	-0.176	0.288	-0.610	0.542
Children in Household	0.556	0.955	0.583	0.560

Independent Variables	Coefficient (β)	Standard Error	T-statistic	Significance (p-value)
Age	-0.011	0.023	-0.461	0.645
Gender	0.165	0.527	0.313	0.754
Vehicles in household	0.145	0.492	0.294	0.769
Pedestrian crossing in road section	-0.073	0.404	-0.181	0.856
Footway presence	-0.111	1.015	-0.110	0.913

(Note: In all tables in this and the following section, levels of significance below the following alpha values are denoted as follows: p < .10*, p < .05**, p < .01***)

Logistic Regression Model

Multiple logistic regression was used to analyse the relationship between the research variables and the relative speed estimate being above either the 5mph or 10mph threshold (5+mph / 10+mph).

5mph Threshold

As summarised in Table 4-3 below, it was found that, holding all other factors constant, the likelihood of the Relative Speed Estimate being 5+mph increased by:

- 208% (95% CI [1.50, 6.35]) for people with children in the household;
- 57% (95% CI [0.93, 2.65]) for each increase in the 'commercial' index utilised.
- 36% (95% CI [1.01, 1.83]) for each vehicle in the household (up to 2);
- 1% (95% CI [1.00, 1.03]) for each additional year of living in the residence; and

The odds decreased by 84% (95% CI [0.71, 1.00]) for each additional meter of road width beyond the sample's mean road width.

Table 3-3 – Results of fitted logistic regression model between 5+mph Relative Speed Estimate and included independent variables, ordered by statistical significance.

Independent Variables	Coefficient (β)	Standard Error	Significance (p-value)	Odd Ratio
Children in Household	1.126	0.369	0.002***	3.082
Vehicles	0.307	0.153	0.045**	1.359
Width of Road	-0.174	0.088	0.049**	0.840
Time lived at current address	0.012	0.007	0.080*	1.012
Land Use	0.449	0.268	0.093*	1.567

The full results of the logistic regression between a 5+mph Relative Speed Estimate and all included independent variables, prior to model fitting, are detailed in Table 4-4 below.

Table 3-4 – Results of logistic regression between 5+mph Relative Speed Estimate and all included independent variables, ordered by statistical significance.

Independent Variables	Coefficient (β)	Standard Error	Significance (p-value)	Odd Ratio
Children in Household	1.023	0.396	0.010**	2.782
Time lived at current address	0.015	0.008	0.047**	1.015
Disability	0.402	0.220	0.068*	1.495
Vehicles in household	0.304	0.168	0.071*	1.355
Pedestrian crossing in road section	-0.237	0.140	0.091*	0.789
Land Use	0.514	0.329	0.118	1.672
Width of Road	-0.175	0.116	0.132	0.840
Age	-0.010	0.008	0.194	0.990
Barrier between footway and traffic	0.447	0.347	0.198	1.564
School near the section	0.359	0.296	0.225	1.432
Footway presence	0.362	0.349	0.300	1.436
Presence of bus stop(s)	-0.292	0.305	0.338	0.747
Footway width	-0.053	0.112	0.639	0.949
Gender	-0.054	0.181	0.768	0.948
Volume of Traffic (10k's)	-0.084	0.287	0.769	0.919
Pets	0.049	0.212	0.819	1.050

10mph Threshold

As summarised in Table 4-5 below, it was found that, holding all other factors constant, the odds of the Relative Speed Estimate being 10+mph increased by:

- 114% (95% CI [1.37, 3.32]) for road sections with a barrier between the footway and traffic;
- 101% (95% CI [1.05, 4.19]) for each increase in the 'commercial' index utilised.
- 86% (95% CI [1.27, 2.72]) for each additional year of living in the residence; and
- 72% (95% CI [1.02, 2.93]) for people with children in the household;
- 68% (95% CI [1.17, 2.42]) for people with a cat and/or dog in the household;

The odds of the Relative Speed Estimate being more than 10+mph decreased by

- 89% (95% CI [0.82, 0.95]) for each additional mph; and
- 77% (95% CI [0.62, 0.95]) for each additional meter of road width;
- 64% (95% CI [0.39, 1.05]) for each additional 10,000 vehicles using the road per day

Table 3-5 – Results of logistic regression between 10+mph Relative Speed Estimate and all included independent variables, ordered by statistical significance.

Independent Variables	Coefficient (β)	Standard Error	Significance (p-value)	Odd Ratio
Barrier between footway and traffic	0.758	0.225	0.001***	2.135
85th Percentile Speed	-0.121	0.037	0.001***	0.886
Disability Assignment	0.619	0.196	0.002***	1.857
Pets	0.520	0.186	0.005***	1.683
Width of Road	-0.264	0.107	0.014**	0.768
Land Use	0.743	0.352	0.035**	2.102
Children in Household	0.546	0.270	0.043**	1.726
Volume of Traffic (10k's)	-0.444	0.252	0.078*	0.641

The full results of the logistic regression between a 10+mph Relative Speed Estimate and all included independent variables are detailed in Table 4-6 below.

Table 3-6 – Results of logistic regression between 10+mph Relative Speed Estimate and all included independent variables, ordered by statistical significance.

Independent Variables	Coefficient (β)	Standard Error	Significance (p-value)	Odd Ratio
Pets	0.596	0.204	0.003***	1.814
Disability	0.589	0.212	0.005***	1.802
Width of Road	-0.273	0.113	0.016**	0.761

Independent Variables	Coefficient (β)	Standard Error	Significance (p-value)	Odd Ratio
85th Percentile Speed	-0.102	0.045	0.023**	0.903
Children in Household	0.613	0.311	0.049**	1.846
Barrier between footway and traffic	0.543	0.324	0.094*	1.722
Footway	0.567	0.346	0.101	1.763
Volume of Traffic (10k's)	-0.441	0.279	0.114	0.643
Land Use	0.540	0.378	0.153	1.716
Gender Assignment	0.180	0.176	0.306	1.197
Footway width	-0.102	0.102	0.317	0.903
Frequency of meeting with neighbours	-0.093	0.097	0.336	0.911
Vehicle in household	-0.158	0.166	0.340	0.854
School near the section	0.212	0.280	0.449	1.236
Pedestrian crossing in road section	0.075	0.132	0.570	1.078

4 Discussion, Next Steps and Conclusion

Summary of Findings

The original research question was ‘What factors contribute to the gap between vulnerable road users’ perception of vehicle speeds in comparison to actual speeds on Scotland’s roads?’

By using the relative speed estimate as the dependent variable for statistical analysis, this project is able to provide the following insights:

- On average, respondents overestimated traffic speeds by 7.5mph.
- People with a disability that limits their day-to-day mobility or with pets in the household were more likely to overestimate traffic speeds.
- When we considered factors individually, there was no significant difference between estimation levels across gender, vehicle ownership, children in household, or age.

Taking all of these variables into consideration at the same time through regression modelling, the following demographic factors appear to have a statistically significant impact on overestimation of traffic speeds:

- Disabilities affecting mobility
- Pets and/or children in household
- Access to a vehicle
- Longer length of time at current address

The following geographic factors also had a statistically significant impact on overestimation of traffic speed:

- Lower traffic volumes and lower actual speeds
- Narrower roads
- Commercial settings
- Presence of barriers between pedestrians and traffic

In addition to the exploration of the research question, the following notable findings were recorded through other sections of the survey:

- Traffic speed and volume issues were noted across the day, but the morning and late afternoon were considered the most difficult times, in line with traditional peak period calculations.
- Speed, volume, and noise of traffic were the most commonly cited barriers to active travel near the trunk road. In respondents’ wider areas, they also cited lighting and crossing times as barriers to active travel.

Implications of Research

On its own, identification of the factors contributing to overestimation of traffic speed is a primarily academic pursuit – but the implications of these findings have the potential to affect the management of trunk roads in Scotland for the benefit of vulnerable road users. Some of these implications are discussed in brief below.

The findings demonstrate that people with caring responsibilities – pets and children – are more likely to overestimate the speed of road traffic, as are people with mobility impairments.

Interventions focused on safe road use among these demographics of road users may increase confidence to move about their local area – however, they may also reinforce the message that roads are dangerous, so more research is needed in this area.

Given the relationship between barriers and overestimation of traffic speed, it is similarly possible that safety measures intended to increase vulnerable road users' safety increase their perception of road traffic being unsafe. This finding is in line with the evolving approach to pedestrian guard railing in transport planning.

When traffic volume and actual speed are higher, people are more accurate in their estimates of speed. One interpretation of this finding is that a constant flow of traffic is more predictable, whereas the speed of a single vehicle on an otherwise empty road is more difficult to estimate. Measures that regularise traffic flows or otherwise reduce the disruption of less frequent vehicles could reduce perceptions of excessive speeds.

Similarly, on narrower roads speed estimates are less accurate, potentially due to decreased congruence of the traffic speed with the road aesthetic. Traffic speeds were also more frequently overestimated in retail areas, where pedestrian footfall is likely to be higher. Taken in combination, these findings suggest that measures to slow traffic and clarify traffic speeds (such as high-visibility speed indicator devices) in commercial areas, particularly those with a traditional 'High Street' aesthetic, would potentially play a helpful role in attaining a more realistic estimation of vehicle speeds.

Conclusion and Next Steps

Over the course of a four-year research project, WSP investigated local residents' perception of vehicle speeds in comparison to actual trunk road speeds. The study methodology comprised a literature review, household survey of 13 settlements bisected by a trunk road, statistical analysis and regression modelling to determine the key factors behind overestimation of traffic speed.

The study identified statistically significant demographic and geographic factors leading to this overestimation: people with caring responsibilities or mobility impairments are particularly likely to overestimate speed, and speed overestimation is more likely in areas with pedestrian guard rails, lower traffic flows, narrower roads, and commercial areas.

Further qualitative and experimental research could be undertaken to develop interventions to improve road safety, both perceived and actual, for vulnerable road users in Scotland. To further understand the impact of potential measures, Transport Scotland could consider conducting field trials of speed indicator devices on trunk road high streets in combination or comparison with other interventions to support residents to more accurately estimate speed.

Further research could also be undertaken in the form of focus groups with people from the following demographic groups:

- Disabilities affecting mobility
- Pets and/or children in household
- Long-term area residents

These focus groups could be used to further understand estimation of traffic speed and the impacts of perceived traffic speed on utilitarian and recreational active travel in Scotland.

Appendix A: Settlement-Specific Datasheets

Appendix B: Example Survey

Appendix C: Full Literature Review

Transport Research Institute

Part of Edinburgh Napier University

VULNERABLE ROAD USER PERCEPTION OF SPEED. A LITERATURE REVIEW

Report

Project No.: 70058582
Scottish Road Research Board (SRRB)

CONFIDENTIAL | WSP
June 2023

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Introduction

The objective of the research project is to assess the gap between perception of speed and actual speeds, and its impact on vulnerable road users in terms of raised concerns. A specific early task is to conduct a Literature Review to assess the evidence relating to any gap between perception and objectively measured speed on the Trunk Road Network (TRN).

Inclusion criteria

The focus of the Literature Review is to report on peer reviewed and grey literature addressing the perception of speed and speeding in rural settlements bisected by main routes for motorized transport. As noted in the Proposal document the aim is that a Literature Review will be undertaken of any existing research to assess if perceptions of speeds and gap acceptance have been quantified in similar environments to strategic roads in Scotland. The literature review will include research into "self-regulation" of non-motorised road users, as well as the wider variables including:

• Does footway / road width have an impact on accuracy of perception?

• Does perception of vehicle speeds vary by vehicle type?

• Does age have an impact on accuracy of perception?

• Does personal situation have an impact such as disability or having dependents?

• Does level of lighting (daytime/night-time) have an impact?

Target audiences/populations included in interventions

All adults and children

Study design

Pre-post interventions; experimental and quasi-experimental studies (i.e. studies with some form of control or comparison group), reviews and qualitative research.

Dates

Originally 2004 to 2019. First revised to be from 1995 to 2019, and then from July 2020-August 2022.

Geography

We searched the global literature for papers published in English.

Literature searches

Search terms used: rural traffic speed resident perception; traffic speed and severance; rural resident assessment traffic speed; resident speed perception wellbeing; rural resident annoyance traffic speed; rural roadside Level of Service; community perception traffic speed; pedestrian gap accept; pedestrian age(ing) and perception; street lighting pedestrian speed perception.

Search engines used were TRIDS; TRB; ScienceDirect; and Google Scholar. In addition, grey literature was also included such as governmental departments and road safety

institute reports. Taylor Francis Online was added after the first searches when the inclusion criteria were broadened.

The literature in context

In seeking literature addressing vulnerable road user perceptions of motorised traffic speed in rural communities located with main traffic routes bisecting them, after an initial search of appropriate academic search engines no direct evidence was found. The main body of research found in these initial searches either addressed the views and/or reported behaviours of motor vehicle drivers addressing aspects of speed and speed limit adherence including through use of driver simulators or else focused on pedestrian exposure and risk in attempting road crossing. By way of example, a paper by Galante et al, (2010)[1] investigated drivers' speed behaviour in a section of a rural highway crossing a small urban community in the existing scenario without any traffic calming device and in two different modelled scenarios with traffic calming in the urban community. Moreover, a test search using 'traffic speed misperception' generated 207 'finds' but all of those in this find which addressed road traffic (less than half) did so in consideration of motor traffic speed by either the driver or in consideration of interventions to eradicate misperceptions of drivers.

Perhaps the most pertinent finding from the original searches, albeit with the caveat of an urban focus, has been the studies addressing aspects of community severance and a link to perceived speed. Community severance (CS) refers to the separation of people from facilities, services, and social networks within a community, and/or people changing travel patterns due to the physical or psychological barriers created by transport corridors and their use. Separation of neighbourhoods and reductions of accessibility are some of the main effects of CS (Grisolia, J., Lopez, F., de Dios Ortuzar, J. 2015;[2] Ancieas, P. et al. 2017[3]).

The most appropriate papers found for this Literature Review were ones which formed part of a larger study led by a multi-disciplinary team across UCL and which produced a Street Mobility Project Tooklit as an output[4] and did address perceived speed of motorised traffic, albeit in urban areas in two of the three papers included in this Review. The focus of one was impacts on walking and wellbeing (and thus outside of the original inclusion criteria). The main summary of this paper by Anciaes et al, (2019)[5], given its rarity in the context of the research topic, is reported below in the body of the Literature Review together with shorter summaries of findings for the other two and in only focusing on aspects relevant to the Review. These and other UCL papers addressing aspects of

[1] Galante, F. et al, 2010. Traffic calming along rural highways crossing small urban communities: Driving simulator experiment. *Accident Prevention & Analysis*, 42(6): 1585-1.594.
[2] Grisolia, J., 2015. Burying the Highway: The Social Valuation of Community Severance and Amenity, *International Journal of Sustainable Transportation*, 9: 298–309
[3] Ancieas, P. et al. 2017.[3] Urban transport policy and community severance: Linking research and policy to link people and places*, Journal of Transport & Health*, 3: 268-277.
[4] See https://www.ucl.ac.uk/iehc/research/epidemiology-and-public-health/research/health-and-social-surveys-research-group/toolkit accessed 30th June 2019.
[5] Anciaes, P. et al, 2019. Perceptions of road traffic conditions along with their reported impacts on walking are associated with wellbeing, *Travel Behaviour & Society*, 15: 88-102.

urban community severance appeared in most of the searches across different search engines. Then, following further searches in September 2022 it was found that the few new studies published since mid 2019 were almost exclusively new papers from the UCL study team reporting on aspects of their severance work in urban areas. In total, this last search found eight new studies but after reading only three were in scope (see Appendix 1). This new search additionally included the ICE Virtual Library.

Other points of note are that in terms of issues relating to residence annoyance concerning traffic the overwhelming find from 192 searches was road traffic noise (e.g. Schomer, 2012).[6] There were no finds which met the inclusion criteria for this Literature Review. The search through the TRB (Transportation Research Board) found 112 finds but none which met the inclusion criteria. An illustration of the search finds and included studies is provided in Appendix 1 for TRIDS and TRB.

Concerning aspects of self-regulation, there does exist a literature on pedestrian gap acceptance although again studies are focused on urban settings.

In terms of structure of the Literature review, the research questions of interest, namely perceived speed and speed violations, and aspects of pedestrian self-regulation, are divided into these two areas in the Literature Review.

Consequent to the initial research find, the search was broadened to include more search terms and the inclusion dates were extended to 1995 in order to seek to capture any studies that might have been outside of the original scope due to search terms and/or being published pre 2004. Nonetheless, this cut-off date still excluded some potentially important studies. By way of example, the Abstract from an intervention programme conducted by the Danish Road Directorate is provided below. The programme from the mid 1980s sought to address residents' feelings of insecurity due particularly to speed of motorised traffic on through-roads bisecting small towns. As noted above, a further search for new studies from July 2019 to August 2022 was undertaken in order to ensure that no new and in-scope studies had been published.

The stance of the Danish Road Directorate was not that residents' concerns regarding speed were misplaced but that speed and volume of traffic were having a negative impact on how people felt about traffic safety in their local community.

[6] Schomer, P. 2012. Role of community tolerance level (CTL) in predicting the prevalence of the annoyance of road and rail noise, *The Journal of the Acoustical Society of America,* 131: 2772. https://doi-org.ezproxy.uwe.ac.uk/10.1121/1.3688762

Herrstedt, L. 1992. Traffic calming design-a speed management method: Danish experiences of environmentally adapted through roads.[7]

The Danish Road Directorate has conducted an experiment on traffic calming in three pilot towns. The problems caused by through traffic were reduced by using the new traffic management method called “Environmentally adapted through road.” By using different kinds of speed reducing measures, vehicle speeds were slowed down. Priority was given to the local town environment, pedestrians, and cyclists. The aim was to increase safety, reduce the feeling of insecurity, and improve the local town environment. An extensive effect evaluation study programme was worked out by engineers together with architects, psychologists, economists, and biologists. The evaluation study included speeds, accidents, fence effect for pedestrians and cyclists, delays for through-going cars and side-road drivers, retail trade, noise and air pollution, energy consumption, costs, and users' opinions. The results show that vehicle speeds have been reduced significantly in the three pilot towns. The feeling of security and traffic safety have been increased. The town environments have been improved and the towns have become more attractive from the citizens' point of view.

[7] Herrstedt, L. 1992. Traffic calming design-a speed management method: Danish experiences of environmentally adapted through roads. *Accident Analysis and Prevention*, 24(1): 3-16.

The Literature Review

Perceived speed and speed violations

In selecting design speeds and setting speed limits, much attention has been given to the type of roadway and to the driver. Conversely, non-motorists have been largely ignored in the selection of safe, appropriate speeds even though the non-motorist is the most vulnerable road user.

Smith, C., Owen, R., Fosdick, T. 2022 How effective is reducing speed limits on rural roads? Phase 1 final report

This report details the findings of the first phase of a two-phase project, funded by the Road Safety Trust, to understand the impact of lower speed limits on rural roads in Surrey. Using speed and casualty data alongside stakeholder and public feedback, this first phase assesses this information in relation to those limits which had previously been reduced. The purpose of this phase is to gain an understanding of compliance, safety, and the perception of safety of incremental speed reductions. The second phase will involve similar analysis but after widespread speed limit reductions across the county.

Although largely focused on driver behaviour the research does include insights of pedestrian perceptions regarding speed. An online survey was designed by Agilysis and disseminated by Surrey County Council through their social media channels. The aim and purpose of the survey was to understand local residents' perceptions towards potential reductions in rural road speed limits, and attitudes towards risk and compliance. Over the last couple of decades many rural roads in the east of Surrey have been reduced to 40mph or 50mph whereas the west of Surrey still has the national speed limit of 60mph. This survey helps in informing the consultation process on implementing speed limit reductions for elsewhere in Surrey.

Answers to questions were largely not segmented by road user type but one question addressing respondents' likelihood to walk reported that the highest likelihood was at 20mph speed limit on rural roads, with 49% very likely and 26% likely to walk on rural roads at this lower limit. At 50mph, 42% of respondents were not at all likely to walk on rural roads, which increased to 55% for 60mph and 68% for 70mph. Pedestrians' perception of personal safety and likelihood to walk has an inverse relationship with the speed limit. The higher the speed limit, the less likelihood to walk on rural roads, and vice versa. A limitation here is that the data does not make clear whether likelihood to walk is within villages where pavements are common than outside of villages where there may only be verges.

One of the objectives of the study was to determine if perceptions of safety are higher amongst communities living close to rural roads with lower speed limits than communities living close to rural roads with higher speed limits. The findings were that there did not seem to be a difference in perceptions of safety between those living close to rural roads with lower speed limits than communities living close to rural roads with higher speed limits. However, there were differences in perceptions of safety by age (from the survey) and user group (from the interviews).

A second objective was to determine if attitudes towards compliance with speed limits are more positive amongst communities living close to rural roads with lower speed limits than communities living close to rural roads with higher speed limits. Again the finding was that there also did not seem to be more positive attitudes towards speed limit compliance amongst communities living close to rural roads with lower speed limits than communities living close to rural roads with higher speed limits. This report has identified and confirmed that higher speeds result in increases in collisions and that the public are generally supportive of lower speeds. It also notes that changing limits on their own may not necessarily achieve compliance.

Mackie, H. Charlton, S., Baas, P. 2010.[8] Lower speeds and more user-friendly streets from a self- explaining roads trial in New Zealand.

Originating in Europe, the "self explaining roads" (SER) concept focuses on functionality, homogeneity and predictability to make roads safer. Roads designed in this way are also more user-friendly and are designed for pedestrians and cyclists as well as motorists. A trial of the SER concept was conducted in Auckland, New Zealand. Working with Auckland City Council approximately 8 km of local and collector roads within a defined area were treated using SER principles. This included the development of a functional design hierarchy that aimed for 30 km/h local streets and collector road speeds of no more than 50 km/h. An extensive community involvement process was used to help develop the designs.

Prior to and following construction, perception surveys and traffic counts and speeds were conducted within the treatment area and within a nearby control area. Extensive video footage was also used to help describe the road-user interactions that occurred on the newly designed streets. Speed data collected three months after implementation showed a significant reduction in vehicle speeds on local roads (with mean speeds at or below the desired 30 km/h design speed) and increased homogeneity of speeds on both local and collector roads. The objective speed data, combined with residents' speed choice ratings indicated that the project was successful in creating two clearly different road categories.

Self-regulation of pedestrians

Higgsmith et al, 2022. Community severance and health – A novel approach to measuring community severance and examining its impact on the health of adults in Great Britain

Aspects of community severance (the separation of people from goods, services, and each other by busy roads or other transport infrastructure) have been linked to poor health and wellbeing, but few studies have examined this relationship. The researchers created a novel

[8] Mackie, H. Charlton, S., Baas, P. 2010. Lower speeds and more user-friendly streets from a self-explaining roads trial in New Zealand, ARRB Conference. http://worldcat.org/isbn/187659263X

index for community severance and estimated its association with the self-rated health of adults in Great Britain.

Perceptions of speed and volume of road traffic were the most important aspects of community severance in the researchers' factor analysis. Less important, but still loading at more stringent levels of inclusion, were factors relating to crossing points and adequate crossing time. This suggests that community severance is a combination of perceptions of traffic levels and of the ease of crossing the potential barrier. Being in the lowest income group was significantly associated with a higher community severance index score, as was being in a non-white ethnic group, being unemployed, retired and a homemaker.

An important conclusion from this paper is that there was no evidence to suggest an interaction between environment type (urban/rural) and community severance and health. The authors note that use of a community severance scoring approach may have captured rural severance issues, such as instances where roads with high speeds, or a lack of pedestrian pavements, prevent some groups crossing safely. These examples would not be captured within a study that examined severance purely as a traffic volume/speed issue that may be more relevant in urban environments. These results suggest that community severance can occur in a variety of environment types and is not limited to busy city roads.

Anciaes, P., Jones, P. 2020. A comprehensive approach for the appraisal of the barrier effect of roads on pedestrians

This paper proposed a new approach for measuring and valuing the barrier effect of different types of roads for pedestrians and for integrating the values into the appraisal of transport projects. This approach was developed based on the results of a survey of residents in areas around busy roads in two English cities. A series of stated preference exercises elicited preferences regarding crossing roads with specified design and traffic characteristics in locations with or without designated crossing facilities and making trade-offs with walking time and benefits or costs.

Road infrastructure and motorised traffic create a barrier effect on the movement of pedestrians, with possible negative implications on individuals and communities in the surrounding area. However, there are currently no robust quantitative methods to assess this effect. This paper developed a comprehensive approach for the assessment of the barrier effect of roads on pedestrians and its integration in transport appraisal. An index was created to measure the barrier effect at a given point along a road, considering the design and traffic characteristics of the road and the characteristics and walking time to the nearest pedestrian crossing facility. The index was then related with monetary values and with the estimated number of suppressed trips (i.e. the number of new trips that would be made if the barrier effect of the road was reduced), expressed as a proportion of the potential number of trips. The approach produced robust results that take into account a range of hypothetical scenarios for the road, included in three stated preference exercises, while grounding the estimates in real-world behaviour, as assessed in a revealed preference exercise.

The approach can be integrated into the appraisal of policy interventions that lead to reductions in severance, as it supports the estimation of the benefits of a wide range of improvements made to the road design, traffic, and crossing facilities, while allowing for the disaggregation of those benefits by trip purpose. The scenarios, being urban based, do

therefore have some limitations for the purposes of this research on the TRN through rural settlements in Scotland. Specifically, it does not directly address perceived speed.

Anciaes et al, 2019. Perceptions of road traffic conditions along with their reported impacts on walking are associated with wellbeing.

The researchers examined the associations between road traffic conditions, walking, and positive mental wellbeing among survey participants in four urban neighbourhoods in England bisected by busy roads (N=708). Sequential models were fitted, examining the associations between objective and perceived traffic conditions (volume and speed); between perceived traffic conditions and the ability to walk locally and use busy roads.

There is growing evidence that living close to busy roads is associated with lower levels of walking and with lower wellbeing. However, this evidence has been gathered mainly from two separate research strands which to date have seldom been integrated. In the present study the researchers attempted to decompose the chain of associations through which motorised traffic conditions may reduce the wellbeing of local residents living close to busy roads by looking at the empirical associations between objectively measured and subjectively perceived traffic conditions, the perceived negative impact of these traffic conditions on walking, and positive mental wellbeing.

The main finding was that the survey participants who perceived the traffic volume as 'heavy' and the traffic speed as 'fast', and who reported these as a factor affecting their ability to walk locally and that they avoided using the busiest road due to those conditions, had a significantly lower wellbeing score than those who did not report these perceptions. Furthermore, the researchers found a significant association between the subjective perceptions of road traffic conditions and the reported negative impacts of these on walking. More specifically, the researchers found that the joint perception of the traffic volume as 'heavy' ***and*** the traffic speed as 'fast' was associated with the reported impacts of these as being a barrier to walking locally ***and*** as a specific reason to avoid the busiest road.

Significantly higher odds of participants perceiving the traffic volume on the busiest road as 'heavy' and the traffic speed as 'fast' (versus not heavy and not fast) were associated with three objectively measured attributes of speed: higher ratios between current/historical and historical/reference median speeds; and a larger difference between the current maximum and median speeds. Higher odds were also associated with one attribute of traffic volume: the proportion of road traffic being HGVs.

The findings also showed that the associations between traffic conditions and walking extended beyond these combinations. For example, perceiving the speed of traffic as 'fast' but the volume as not heavy (i.e. 'light/average') was associated with reporting one of the negative impacts of road traffic on walking, but not both. Likewise, perceiving the traffic volume as 'heavy' but the speed of traffic as not fast (i.e. 'slow/average') was associated with one of the negative impacts of traffic on walking – as a reported barrier to walking locally – but was not associated with avoidance of the busiest road. In addition, the researchers found that the joint perception of the traffic volume as 'heavy' ***and*** the traffic speed as 'fast' was associated with a number of objective indicators of traffic volumes/speeds, including the proportion of HGVs in the total traffic volume, and how the current median speed related to the historical and the reference (free-flow) median speeds, and with the current maximum speed.

Overall, this study demonstrated that the use of a single aspect of traffic conditions (volume or speed) will not capture the full negative impacts of motorised traffic on walking and on the wellbeing of local residents living close to busy roads. This finding was reinforced by the results which showed that the groups most likely to perceive the speed of traffic on the busiest road as being 'fast' were different to those perceiving the traffic volume and speed as being both 'heavy' and 'fast' respectively.

Finally, the researchers found that the street network distance that participants lived from the busiest road was not significantly associated with their perceptions about the traffic conditions. Living closer to the busiest urban road was associated, however, with reporting that the traffic was a barrier to being able to walk to local places, independently of perceptions of traffic volume and speed. Living closer to the busiest urban road was also independently associated with higher wellbeing, possibly reflecting unobserved influences such as accessibility to shops, transport nodes (stations and bus stops), and other facilities.

A coda to this study is that the researchers add that their findings add further knowledge to the previous studies which observed a link between wellbeing and proximity to main roads (Brereton et al., 2008, Yamazaki et al., 2005) or traffic volumes (Gundersen et al., 2013). The present study emphasized the role of the perceptions that local residents have about different aspects of road traffic conditions in mediating the links between living close to busy roads and wellbeing. The findings of this study also provide evidence suggesting that busy roads correlate negatively with wellbeing through the intermediate effect on walking, reinforcing the "community severance" hypothesis that was formulated in the 1970s but had never been confirmed in empirical studies (Mindell and Karlsen, 2012).

Anciaes, P., Jones, P., & Mindell, J. 2016. Community Severance: Where Is It Found and at What Cost?[9]

The term 'community severance' describes the effects of transport infrastructure or motorised traffic as a physical or psychological barrier separating one built-up area from another built-up area or open space. Within a community, there are differences in mobility and accessibility needs, restrictions, experiences, and perceptions. Research may assign priority to identifying the problems of the groups more vulnerable to losses in pedestrian mobility, such as people with disabilities or limiting health conditions. The researchers cite evidence also shows that the impact of traffic barriers depends on age (Hine & Russell, 1993, 1996; Russell & Hine, 1996) and leads to the loss of children's independent mobility (Hillman, Adams, & Whitelegg, 1990).

At its simplest, the assessment of barriers to mobility is the measurement of their physical attributes. In the case of road infrastructure, these attributes are carriageway width and number of lanes. In the case of road traffic, the relevant attributes are volume, composition, speed, and direction. The estimation of severance is particularly sensitive to the value of some of the inputs. These include, for example, the set of pedestrian destinations. Different values can also be defined for the traffic volume or speed thresholds that define severance, which may vary according to the

[9] Anciaes, P., Jones, P., & Mindell, J. 2016. Community Severance: Where Is It Found and at What Cost?, *Transport Reviews*, 36:3, 293-317, DOI: 10.1080/01441647.2015.1077286

characteristics of the population affected. This study did not, however, address perceptions of speed.

Perceptions of traffic speed may tangentially be captured through studies of pedestrian gap acceptance and although most of these are urban-based, they do suggest some differences between the ages and by gender. Whether or not residents as pedestrians or cyclists wish to cross a main road bisecting their community or is simply concerned about motor vehicle speeds as an indicator of lack of road safety, speed and perceived speed can be seen to be in conflict with vulnerable road users' safety. In a study of road intersections Li and Sun noted that:

> We have found that generally the energy economy can be achieved with the high transportation efficiency, and that the traffic safety is usually in conflict with the efficiency. We have also found that the pedestrian interference further worsens the intersection performance, resulting in higher vehicle traveling delays, more energy consumptions and higher safety risk.[10]

Separately, although almost no studies were found which reported on pedestrian perceptions of vehicle speed by type there exists a literature relating to cycle users and overtaking by motorist vehicle users.

With regards to ageing and effects on perceptions, there remains a paucity of evidence, not least in terms of those living in small town/village settlements and their needs. As Tourneir and colleagues note:

> Although population aging and urbanization, and in particular the development of "global age-friendly cities" (WHO, 2007), have been identified as two of the most important challenges of the present century, research and public policy within the past few decades have focused on older drivers, thereby neglecting older pedestrians and their travel requirements.[11]

Does footway / road width have an impact on accuracy of perception?

Faiz, A., Faiz, A, Wang, W., Bennett, C. 2012. Sustainable roads for livelihoods and livability.[12]

In a review of sustainability and livability regarding rural roads, albeit focused on low income countries, it suggests that a rural road must fulfil two conditions to be sustainable: first, it must contribute to and enhance rural livelihoods and livability, and secondly, its planning and design (as well as construction and maintenance) must be context sensitive to ensure a

[10] Li, X., Sun., J-Q. 2016. Effects of vehicle-pedestrian interaction and speed limit on traffic performance of intersections, *Physica A: Statistical Mechanics and its Applications*, 460: 335-347.
[11] Tournier, I., Dommes, A., Cavallo, V. 2016. Review of safety and mobility issues among older pedestrians, *Accident Analysis and Prevention*, 91: 24-35.
[12] Faiz, A., Faiz, A, Wang, W., Bennett, C. 2012. Sustainable roads for livelihoods and livability, *Procedia Social and Behavioural Sciences*, 53: 1-8.

balance among economic, social and environmental objectives, that is reflective of community values, aspirations, and needs.

Conventional roadway design standards define features such as minimum lane and roadway widths and a design speed that locks in place a road geometry that may be in conflict with environmental and social values and needs. The governing assumption is that bigger-and-faster-is-better, resulting in higher traffic speeds, increased costs and irreversible social and environmental damage.

Does perception of vehicle speeds vary by vehicle type?

Llorca, C. et al, 2017 Motor vehicles overtaking cyclists on two-lane rural roads: Analysis on speed and lateral clearance,[13] Safety Science, 92: 302-310.

Two-lane rural roads in Spain accommodate significant bicycle traffic volumes, mainly associated to sport and leisure activities. Motor vehicles' higher speed, weight and volume, compared to cyclists, represent a serious safety concern when overtaking a bicycle. Spanish traffic rules determine a minimum 1.5 m lateral distance.

This research characterised 2928 overtaking manoeuvres in the overtaking lateral clearance between motor vehicle and bicycle, as well as in the motor vehicle speed, in contrast with previous research. Two instrumented bicycles were equipped with laser rangefinders, a GPS tracker and three video cameras. They rode along seven rural road segments at a speed between 15 and 25 km/h, centred on the paved shoulder, or as close as possible to the outer edge. Besides, this methodology allowed the characterisation of the overtaken vehicle type, its left lane occupation as well as its interaction with opposing traffic flow. For each session, rider's general risk perception was also registered.

According to Walker (2007), reported in Llorca et al (2017), heavy vehicles (trucks or buses) kept a lower clearance, making the overtaking unsafe. This is in agreement with present results. The analysis suggested that lateral clearance is not the only factor that influenced rider's risk perception, although current standards are only related to it. On the contrary, a combined factor of lateral clearance, vehicle type and vehicle speed had a more significant correlation with the perceived risk. This agreed with literature models of transient aerodynamic forces between overtaking and overtaken vehicles. Results showed that effect of heavy vehicles on bicyclists was also strong. In addition to this, the combined factor of clearance and speed was higher on tangent sections where overtaking was permitted. A finding was that higher speeds and the presence of heavy vehicles are always present in the highest perceived risk levels.

Haworth, N., Schramm, A. 2014. The safety of bicycles being overtaken by cars: what do we know and what do we need to know?[14]

[13] Llorca, C. et al, 2017 Motor vehicles overtaking cyclists on two-lane rural roads: Analysis on speed and lateral clearance, *Safety Science*, 92: 302-310.

[14] Haworth, N., Schramm, A. 2014. The safety of bicycles being overtaken by cars: what do we know and what do we need to know? Australian Road Safety Research Policing Education Conference. https://acrs.org.au/publications/conference-papers/database/

Many cyclist deaths and serious injuries result from rear-end or sideswipe collisions involving a car or heavy vehicle. In Australia these crash types were particularly prevalent in rural areas, accounting for 29 of 69 rural fatalities between 1996 and 2000. As a consequence, minimum passing distance laws (often referred to as one metre rules) have been introduced in a number of U.S. states along with European countries such as France, Belgium and Spain. A two-year trial of a minimum passing distance rule is underway in Queensland.

The international studies show that while the average passing distance is more than one metre, significant proportions of passes occur at less than this distance. Average passing distances are greater with wider lanes, when bicycle lanes are present, for cars rather than vans or trucks, and (possibly) at higher speed limits. The roadway speed limit appears to influence passing distances but there is limited research with conflicting results. In a UK study, Parkin and Meyers (2010) found that on high-speed roads (>64 km/h), motorists stayed within the boundaries of their lanes, regardless of the presence of cyclists in adjacent lanes. In contrast, an analysis of 1,151 bicycle passing events in rural Wisconsin (Chapman & Noyce, 2012) found only six violations of the state's "3-ft rule", with an average passing distance of 6.3 feet (1.9 metres) without a bicycle lane (6.4 feet with a bicycle lane).

Perceived characteristics of the cyclist (other than gender) appear to have little effect on passing distances. The research questions the ability to judge lateral distance and whether nominated distances predict on-road behaviour. Cyclists have strong concerns about drivers passing too close but the extent to which this behaviour reflects deliberate intimidation versus an inability to judge what is a safe passing distance is not clear. There has been no systematic evaluation of the road safety benefits of minimum passing distance laws. These laws have received little police enforcement but it is unclear whether enforcement is necessary for them to be effective.

Does age have an impact on accuracy of perception?

Perceptual studies of residents were almost wholly as pedestrians in attempting road crossings**.**

Graham, H. et al, 2018. The experiences of everyday travel for older people in rural areas: A systematic review of UK qualitative studies.[15]

The inadequacies of the rural transport system provide the context in which older people's experiences of everyday travel are set. Graham et al (2018) report on qualitative research of the everyday experiences of older people in rural areas. Citing Shergold et al, the researchers report that:

> ***Walking*** was described as an everyday travel mode only by those living in villages with safe pedestrian access to village shops, pubs and clubs. ***… there are loads of clubs in the village … I could walk to any of the ones that I wanted to go to (female, aged in sixties)***.

[15] Graham, H. et al, 2018. The experiences of everyday travel for older people in rural areas: A systematic review of UK qualitative studies, *Journal of Transport & Health*, 11: 141-152.

> ***We've got a really nice pub, exactly a mile down the road but I can't walk to it because it's much too dangerous [to walk]. (male, aged in sixties)*** (Shergold et al., 2012).

The study focused on transport in terms of quality of life. Major building blocks are 'living in a neighbourhood with good community facilities and services, including transport' 'engaging in a large number of social activities and feeling supported' and 'feeling independent, in control over life'. However, like many other studies there was limited attention given to perceived conditions of travel and amenity in the locally but rather the focus was getting to distant services by motorised transport.

Dommes, A., Cavolla, 2011. The role of perceptual, cognitive, and motor abilities in street-crossing decisions of young and older pedestrians. [16]

Crossing the street is a highly difficult task for older people, who make up an extremely vulnerable road-user group. This may be harder and riskier when attempting to cross higher speed roads. In line with earlier findings, Dommes and Cavolla found that seniors made a greater number of incorrect crossing decisions when seeking to cross the road, with many risky decisions when the vehicle was approaching at a high speed and many missed opportunities at a low speed.

Correlation and regression analyses pointed out several functional performance measures as predictors of the way the pedestrians took or did not take information about vehicle speed into account in their decisions. Processing speed and visual attention abilities were shown to play the most important role in explaining the variance in incorrect decisions: these abilities allowed participants to focus their attention on the relevant speed and to make timely, correct decisions.

Fang et al, 2018. Differences in road-crossing decisions between healthy older adults and patients with Alzheimer's disease.[17]

In a study addressing healthy older adults with those with Alzheimer's disease (AD) researchers found that patients with AD were more vulnerable to traffic crash while crossing the road than healthy older adults (Odds Ratio = 2.50, $P < 0.05$).

Compared with healthy older adults, patients with AD were more severely affected by daylight conditions, faster vehicle speed, and shorter time gap. Participants in both groups had a significantly higher risk of unsafe crossing behaviour if they had lower scores on a mental health examination conducted by the researchers. Traffic environment factors were associated with worsening of safety errors in patients with Alzheimer's disease. They were

[16] Dommes, A., Cavolla, 2011. The role of perceptual, cognitive, and motor abilities in street-crossing decisions of young and older pedestrians, *Ophthalmic Physiol Opt*, **31**, 292–301 doi: 10.1111/j.1475-1313.2011.00835.x

[17] Fang et al, 2018. Differences in road-crossing decisions between healthy older adults and patients with Alzheimer's disease. *Journal of Safety Research*, 66: 81-88.

more easily affected by dusk environment, faster vehicle speed, and most importantly, shorter time gap. The researchers suggested that their results also provide important suggestions for road design to improve road safety in both cognitively intact and impaired older adults.

Petzoldt, T. 2014. On the relationship between pedestrian gap acceptance and time to arrival estimates. [18]

The identification of safe gaps between passing cars when crossing a street is a task most of us accomplish successfully on a daily basis. Objectively, how safe a specific gap is, is mainly dependent on how long it would take the approaching vehicle to arrive (time to arrival; TTA). Common sense might suggest that TTA is the basis for pedestrians' gap selection. However, it has been shown repeatedly that vehicle approach speed has a substantial influence on the size of chosen gaps. At higher speeds (50kmph /31mph compared to 30kmph/18.6mph), pedestrians tend to accept smaller time gaps, i.e. they initiate riskier crossings. Some researchers have gone so far as to suggest that pedestrians rely more on physical distance of a vehicle in their crossing decisions than TTA. Yet, at the same time, there is evidence that TTA estimates themselves are influenced by object approach speed. It is suspected that pedestrians are more apt to base their decisions on systematically distorted TTA estimates, rather than physical distance.

Two experiments were presented that assessed the relationship between pedestrians' gap acceptance and their estimation of time to arrival (TTA) of approaching vehicles. Both experiments were able to replicate common findings in this field. Participants tended to accept smaller time gaps when the vehicle was approaching at higher speed, with younger participants accepting smaller time gaps than older participants. At the same time, participants provided lower TTA estimates when the vehicle was approaching at a lower speed. When linking TTA estimates to crossing decisions, it became clear that the effect of speed on accepted gap size might be primarily attributable to variations in TTA estimates.

Regardless of the actual causal relationship, this pattern of effects clearly indicates that potentially risky crossing behaviour cannot easily be modified. The repeatedly reported finding that pedestrians appear to rely on physical distance in order to make crossing decisions cannot simply be attributed to the use of an unreliable heuristic or inappropriate strategy. Rather, the distortion in TTA estimates allows for the possibility that pedestrians simply lack the correct information that they need to make a better decision. Even if

[18] Petzoldt, T. 2014. On the relationship between pedestrian gap acceptance and time to arrival estimates. *Accident Analysis and Prevention*, 72: 127-133.

participants used the appropriate strategy (rely on TTA), the systematic errors in TTA estimation would result in more unsafe decisions at higher vehicle approach speeds.

Shaw, L. Lennon, A., King, M. 2012. Qualitative investigation of older pedestrian views of influences on their road crossing safety.[19]

With Australia s population rapidly ageing, older pedestrian safety has begun to receive greater attention from road safety researchers. However, reliance on simulator studies and observational techniques has limited current understanding of why older pedestrians adopt particular crossing behaviours, and how they perceive crossing the road. The current study aimed to investigate the psychological factors that may contribute to older pedestrians crash risk by examining their perceptions of the issues they encounter on the road. Qualitative semi-structured interviews with 18 pedestrians aged 55 years and older were conducted, and the interview transcripts underwent thematic analysis.

From this analysis, four key themes emerged. Firstly, the physical design of the road was perceived as posing a significant threat for older pedestrians, particularly sloped, semi-mountable kerbs and designated crossings. Secondly, declines in older pedestrians confidence in their ability to cross the road were evident through fewer reported risks being taken. Additionally, older pedestrians sensed an increased threat from other road users when crossing the road, particularly from drivers and cyclists. Finally, older pedestrians referred to the informal rules and strategies used to guide their road crossing. The results suggest that the road environment is perceived as increasingly dangerous and hazardous environment for older pedestrians. [abstract only available]

Ravishankar, K., Nair, P. 2018. Pedestrian risk analysis at uncontrolled midblock and unsignalised intersections.[20]

In one of many papers addressing pedestrian crossing and gap acceptance variability in two Indian city environments it was observed that the size of the vehicle has a significant influence on gap acceptance and crossing behaviour of pedestrians. Male pedestrians take more risks than female pedestrians in crossing unsignalized intersections. Elders were also less likely to take risks in crossing and this may reflect their crossing speed and slower reaction times.

Does personal situation have an impact such as disability or having dependents?

Oxley, J., Charlton, J., Fildes, B. 2005. The effect of cognitive impairment on older pedestrian behaviour and crash risk.[21]

[19] Shaw, L. Lennon, A., King, M. 2012. Qualitative investigation of older pedestrian views of influences on their road crossing safety. Australasian Road Safety Research Policing Education Conference, Wellington, New Zealand.

[20] Ravishankar, K., Nair, P. 2018. Pedestrian risk analysis at uncontrolled midblock and unsignalised intersections. *Journal of Traffic and Transportation Engineering*, 5(2): 137-147.

[21] Oxley, J., Charlton, J., Fildes, B. 2005. The effect of cognitive impairment on older pedestrian behaviour and crash risk, Monash University.

This report assesses the current state of knowledge in regard to the key issues affecting older pedestrian safety, particularly the effect of cognitive impairment on behaviour and crash risk. The association between normal age-related cognitive decline and pedestrian performance and crash risk seems to be fairly moderate.

In contrast, more substantial evidence was found of an effect of medical conditions that result in cognitive impairment on pedestrian performance and crash risk. This was particularly so for impairments associated with moderate to severe dementia, moderate to severe Parkinson's Disease, cerebrovascular disease (particularly stroke), and multiple sclerosis. The review highlighted the need for better knowledge with regard to the effect and extent of cognitive decline and impairment on pedestrian safety and provides a number of recommendations for research priorities. [abstract only available]

Anciaes, P., Metcalfe, P., Heywood, C. 2017. Social impacts of road traffic: perceptions and priorities of local residents.[22]

In a study to gain a general understanding about local views regarding the planned construction of the Sizewell C power station, in Suffolk, UK, traffic speed was identified as often as traffic volumes as the main concern of local residents. The increased volume of traffic, especially lorries was a major concern of residents.

The study also found significant variations in the impacts perceived by different groups within the same community. Individuals in households with children were more concerned with accident risk, air pollution and suppressed cycling trips, which is explained by the fact that children are particularly vulnerable to air pollution and at risk of being involved in road accidents while walking or playing outside. Although the differences between the impacts perceived by younger and older adults were not as marked as those found in previous literature, the present study found that the main priority for older participants was the enforcement of speed limits, which may reflect their concern about not being able to cross the road safely. Employment status is also relevant, as individuals in fulltime employment were particularly supportive of traffic restrictions on weekends (when they are more likely to spend time at home) and on peak hours (when they are more likely to drive or use buses).

This qualitative study found that local residents were concerned not only with overall motor traffic levels but also with the characteristics of both traffic and roads. In addition, there was no consensus regarding the most effective measures to mitigate the negative impacts. The main stated preference survey revealed that the most impactful aspects were noise, vibration and increased car or bus travel times, but there were differences according to distance from the road, and individual characteristics (especially household composition and

[22] Anciaes, P., Metcalfe, P., Heywood, C. 2017. Social impacts of road traffic: perceptions and priorities of local residents, *Impact Assessment and Project Appraisal*, 35:2, 172-183, DOI: 10.1080/14615517.2016.1269464

income). The mitigation measures given highest priority were night-time restrictions to HGVs, provision of less onsite parking, and provision of safety measures for pedestrians and cyclists. Gender and household composition were the main factors differentiating preferences.

Does level of lighting (daytime/night-time have an impact?

No studies were found addressing perceptions of motor traffic speed and safety and the influence of street lighting.

Other items in the literature

There is evidence that factors other than the above could have an impact on perceptions regarding aspects of the local environment.

Yamazaki, S., Sokejima, S., Nitta , H., Nakayama, T., Fukuhara, F. 2005. Living close to automobile traffic and quality of life in Japan.

Research has reported that living close to roads with heavy traffic is significantly associated with low Health Related Quality of Life than living in areas where there is little or no traffic noise intrusion (Yamazaki, et al, 2005).[23] The study area was a rural district with a traffic volume of about 15,000 motor vehicles per day on the arterial road.

Multiple comparisons of the subscales of the SF-36 indicator[24] showed significant differences in ‘‘Vitality’’ and ‘‘Mental health’’ between the ‘‘group of people whose bedroom were located to arterial road’’ and the ‘‘group of people whose bedroom were not located to national roads or other roads’’ even if adjusted for disease status. These subscales closely reflect the mental state, and the present findings demonstrated an association between traffic noise and mental health, consistent with previous studies.

Key findings and assessment of strength of evidence

Below are listed the key findings from the Literature with an assessment as to the strength of the evidence for each finding. This is drawn from a total of 14 studies meeting the inclusion criteria. These studies are cited in full in Appendix 2.

There is a paucity of research addressing resident ‘roadside’ perceptions of traffic speed, not least in rural settings.	**Strong**

[23] Yamazaki, S., Sokejima, S., Nitta , H., Nakayama, T., Fukuhara, F. 2005. Living close to automobile traffic and quality of life in Japan: A population-based survey, *International Journal of Environmental Health Research*, 15:1, 1-9, DOI: 10.1080/09603120400018709

[24] Medical Outcomes Study Short-Form 36-Item Health Survey (SF-36 is a 36-item, patient-reported survey of patient health. The SF-36 is a measure of health status and an abbreviated variant of it, the SF-6D, is commonly used in health economics as a variable in the quality-adjusted life year calculation to determine the cost-effectiveness of a health treatment.

Research and public policy within the past few decades have focused on drivers, thereby neglecting pedestrians e.g. older pedestrians and their travel requirements.	**Strong**
Healthy older pedestrians find higher speed traffic challenging to road crossing and this relates both to their attention and speed of walking. Moreover, at higher speeds, pedestrians tend to accept smaller time gaps, i.e. they initiate riskier crossings. Adding cognitive decline and disease such as Alzheimer's or Parkinsons and the road crossing task on such roads is much harder and may not be attempted.	**Strong**
Perceptions of vulnerable road users of 'heavy' traffic volume and the traffic speed as 'fast' also perceived a higher proportion of road traffic being HGVs.	**Medium**
"Self explaining roads" focuses on functionality, homogeneity and predictability to make roads safer. Roads designed in this way are also more user-friendly and are designed for pedestrians and cyclists as well as motorists. It combines objective data with resident speed choice ratings	**Medium**
For cycle users being overtaken by motor vehicles, lateral clearance does not appear to be the only factor that influenced rider's risk perception, although current standards are only related to it. A combined factor of lateral clearance, vehicle type and vehicle speed had a more significant correlation with the perceived risk. High speed roads may also present greater risk to cycle users.	**Medium**
Research specifically addressing traffic and health and quality of life finds that close proximity to main road traffic reduces this, not least through reduced walking, although there is no evidence regarding impacts of speed of traffic per se.	**Medium**
With the caveat of evidence from urban settings, perceptions of vulnerable road users of 'heavy' traffic volume and the traffic speed as 'fast', led to some reporting these as a factor affecting their ability to walk locally and that they avoided using the busiest road due to those conditions. Such vulnerable road users also had a significantly lower wellbeing score than those who did not report these perceptions.	**Weak**

Conclusions

Perceived speed and speed violations:

1. There is a limited literature on these issues from the perspective of the vulnerable road user and/or resident which highlights the need for a research lens to focus on the topic.
2. Volume, speed, composition and direction were found to be important variables in terms of community severance.
3. There is evidence that roads with 'heavy' volumes of motorised traffic are associated with lower health-related quality of life.
4. Evidence from a Self Explaining Roads intervention signalled the value of combining objective survey data with resident perceptions data.

Pedestrian self-regulation:

1. The most appropriate papers found for this Literature Review were ones which formed part of a larger study led by UCL focused on community severance and this did address perceived speed of motorised traffic, albeit in urban areas. However, the authors have stated (Higgsmith et al, 2002) that their results suggest that community severance can occur in a variety of environment types and is not limited to busy city roads.
2. The main finding from the UCL project was that the survey participants who perceived the traffic volume as 'heavy' and the traffic speed as 'fast', and who reported these as a factor affecting their ability to walk locally and that they avoided using the busiest road due to those conditions, had a significantly lower wellbeing score than those who did not report these perceptions.
3. In addition, significantly higher odds of participants perceiving the traffic volume on the busiest road as 'heavy' and the traffic speed as 'fast' (versus not heavy and not fast) were associated with three objectively measured attributes of speed: higher ratios between current/historical and historical/reference median speeds; and a larger difference between the current maximum and median speeds. Higher odds were also associated with one attribute of traffic volume: the proportion of road traffic being HGVs.
4. There was no evidence reporting on the set-back of dwellings from carriageways other than concerns for general liveability set against issues of speed and widths of carriageways nor a literature addressing levels of lighting from the roadside user/ resident perspective.
5. Concerning vehicle types and perceptions of speed and risk, the limited evidence found suggests that larger vehicles such as HGVs and bus pose a disproportionate higher level of perceived risk.
6. Pedestrian gap acceptance literature found identifies that where there are higher traffic speeds (50kmph /31mph) pedestrians tend to accept smaller gaps i.e. they have riskier crossing behaviour
7. Ageing clearly has an impact on perceptions of gaps in the motorised traffic and in general on gap acceptance by pedestrians. Together with cognitive impairments and slower gait crossing becomes riskier with ageing and there was evidence from some studies of a reluctance to risk walking alongside busy roads. As one study summarised: seniors made a greater number of incorrect crossing decisions when seeking to cross the road, with many risky decisions when the vehicle was approaching at a high speed and many missed opportunities at a low speed.

Limitations

One limiting factor in this Literature Review is that the five search engines selected and agreed produced a limited find in terms of included studies and this raises the question as to the value of investing in a more exhaustive search. A more exhaustive search might also involve expanding the inclusion criteria as well as search terms. Secondly, the paucity of the find and the focus on most of the included studies on urban areas might suggest the need for a different research approach e.g. a focus on rural studies. In addition, focusing only on studies reporting in the English language is clearly another limitation.

Appendix 1

Illustration of searches and finds

TRIDS		TRB* (NB all finds from Highway Capacity Manual)
• rural traffic speed resident perception	0 from 1	0 from 0
• traffic speed and severance	0 from 13	0 from 1
• rural resident assessment traffic speed	0 from 1	0 from 2
• resident speed perception wellbeing	0 from 0	0 from 0
• rural resident annoyance traffic speed	0 from 0	0 from 0
• rural roadside Level of Service	0 from 23	0 from 14
• community perception traffic speed	1 of 39	0 from 20
• (Mackie et al, 2010)		
• pedestrian gap accept (Haworth, N., Schramm, A. 2014)	1 of 18	0 from 48
• pedestrian ageing and perception	2 of 10	0 from 13
• (Shaw et al, 2012; Oxley et al, 2005).		
• street lighting pedestrian speed perception	0 of 7	0 from 26
Totals	**4 from 112**	**0 from 124**

Search engines	Find	Met Inclusion criteria	Author and year
TRIDS	112	4	Oxley, J., Charlton, J., Fildes, B. 2005; Mackie et al 2010; Shaw, L. Lennon, A., King, M. 2012; Haworth, N., Schramm, A. 2014.
TRB	124	0	

2022 Search

Search engines	Find	Met Inclusion criteria	Author and year
TRIDS	4	1	Ancaies, P., Jones, P. 2020
TRB	0	0	
ICE Virtual Library	0	0	
ScienceDirect	4	1	Higgsmith, M. et al, 2022

Google Scholar	1	1	Smith, C. et al, 2022

Appendix 2

Included studies (17)

Anciaes, P., Jones, P. 2020. A comprehensive approach for the appraisal of the barrier effect of roads on pedestrians, *Transportation Research Part A*, 134: 227-250.

Anciaes, P., Jones, P., Mindell, J. 2016. Community Severance: Where Is It Found and at What Cost? *Transport Reviews*, 36:3, 293-317, DOI: 10.1080/01441647.2015.1077286

Anciaes, P., Metcalfe, P., Heywood, C. 2017. Social impacts of road traffic: perceptions and priorities of local residents, *Impact Assessment and Project Appraisal*, 35:2, 172-183, DOI: 10.1080/14615517.2016.1269464

Anciaes, P. et al, 2019. Perceptions of road traffic conditions along with their reported impacts on walking are associated with wellbeing, *Travel Behaviour & Society*, 15: 88-102.

Dommes, A., Cavolla, 2011. The role of perceptual, cognitive, and motor abilities in street-crossing decisions of young and older pedestrians, *Ophthalmic Physiol Opt*, **31**, 292–301 doi: 10.1111/j.1475-1313.2011.00835.x

Fang et al, 2018. Differences in road-crossing decisions between healthy older adults and patients with Alzheimer's disease. *Journal of Safety Research*, 66: 81-88.

Graham, H. et al, 2018. The experiences of everyday travel for older people in rural areas: A systematic review of UK qualitative studies, *Journal of Transport & Health*, 11: 141-152.

Haworth, N., Schramm, A. 2014. The safety of bicycles being overtaken by cars: what do we know and what do we need to know? Australian Road Safety Research Policing Education Conference. https://acrs.org.au/publications/conference-papers/database/

Higgsmith, M., Stockton, J., Anciaes, P., Scholes, S., Mindell, J. 2022. Community severance and health – A novel approach to measuring community severance and examining its impact on the health of adults in Great Britain, *Journal of Transport & Health*, 101368

Llorca, C. et al, 2017. Motor vehicles overtaking cyclists on two-lane rural roads: Analysis on speed and lateral clearance, *Safety Science*, 92: 302-310.

Mackie, H. Charlton, S., Baas, P. 2010. Lower speeds and more user-friendly streets from a self- explaining roads trial in New Zealand, ARRB Conference. http://worldcat.org/isbn/187659263X

Oxley, J., Charlton, J., Fildes, B. 2005. The effect of cognitive impairment on older pedestrian behaviour and crash risk, Monash University.

Petzoldt, T. 2014. On the relationship between pedestrian gap acceptance and time to arrival estimates, *Accident Analysis and Prevention*, 72: 127-133.

Ravishankar, K., Nair, P. 2018. Pedestrian risk analysis at uncontrolled midblock and unsignalised intersections. *Journal of Traffic and Transportation Engineering*, 5(2): 137-147.

Shaw, L. Lennon, A., King, M. 2012. Qualitative investigation of older pedestrian views of influences on their road crossing safety. Australasian Road Safety Research Policing Education Conference, Wellington, New Zealand.

Smith, C., Owen, R., Fosdick, T. 2202 How effective is reducing speed limits on rural roads? Phase 1 final report How effective is reducing speed limits on rural roads? Phase 1 final report – Road Safety Knowledge Centre

Yamazaki, S., Sokejima, S., Nitta , H., Nakayama, T., Fukuhara, F. 2005. Living close to automobile traffic and quality of life in Japan: A population-based survey, *International Journal of Environmental Health Research*, 15:1, 1-9, DOI: 10.1080/09603120400018709

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