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The impact of COVID-19 on transport in Scotland: Should it stay or should it go?

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Lecturer

Lunchtime Research Seminar
16th March 2022

Recent projects in light of COVID-19

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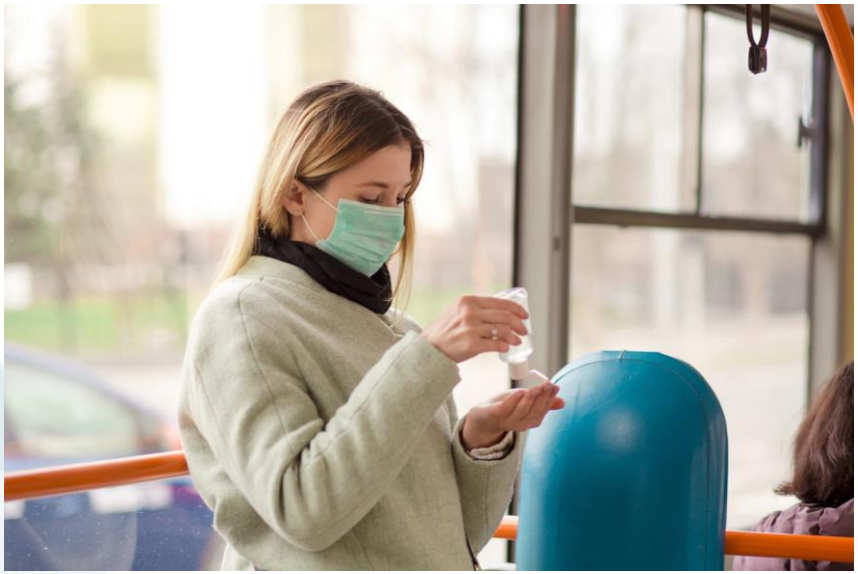
Evaluation of the 20mph trial in Scottish Borders

Impact of COVID-19 on future public transport use



20mph limit as a policy measure

- Mounting evidence on the positive association between 20mph speed limits and mobility and safety of vulnerable road users
- Major cities in the UK have established 20mph speed limits in their residential streets

Source: 20splenty

Source: City of Edinburgh Council

- Wales is about to set the 20mph as the default speed limit
- In Edinburgh, the city-wide 20mph speed limits led to statistically significant reductions of speeds

20mph Trial in Scottish Borders

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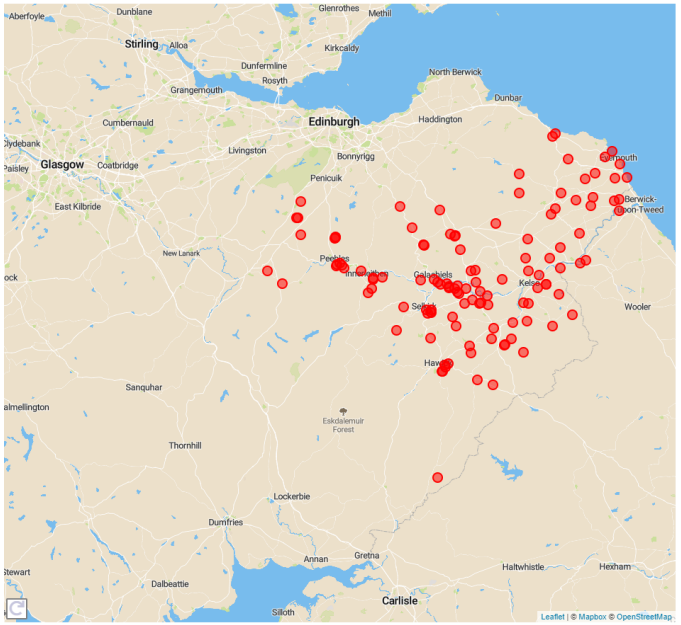
- Introduced in late 2020 to make it safer for people who **walk**, **cycle** or **wheel** during the COVID-19 pandemic.
- Implemented in 97 towns and villages of the Scottish Borders' area
- Installation of new roadside 20mph speed limit signs, & electronic signs in separate stages
- Among the *first-of-its-kind* large-scale speed limit interventions in predominantly **rural** areas



Source: BBC

Quantitative Evaluation

- **Main objective**: To identify whether and how the 20mph speed limit affects speed and driving behaviour
- Traffic and speed data have been collected **before** and **after** the implementation of the scheme
- **Before-after** analysis of various speed-related indicators & speeding metrics (e.g., mean speed; 85th percentile of speed; proportions of vehicles exceeding speed limit)

Data Sources & Processing

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- Several survey waves:
  - **"Before"** survey (in August – September 2020) – **Survey 1**
  - **"After I"** survey (November – December 2020 & early 2021) – **Survey 2**
  - "**After II**" survey (April – May 2021) – **Survey 3**
  - "**After III**" survey (June 2021) – **Survey 4**
- Locations included in the surveys:
  - Survey 1 *vs* Survey 2: 115 locations
  - Survey 1 *vs* Survey 2 *vs* Survey 3: 55 locations
  - Survey 1 vs Survey 2 *vs* Survey 4: 109 locations
- Speed metrics used for the evaluation:
  - Mean speed
  - 85th percentile speed
  - Standard deviation of speeds
  - Speeding metrics (% above speed limit, ACPO threshold, DfT threshold)

Method: Before-After Analysis

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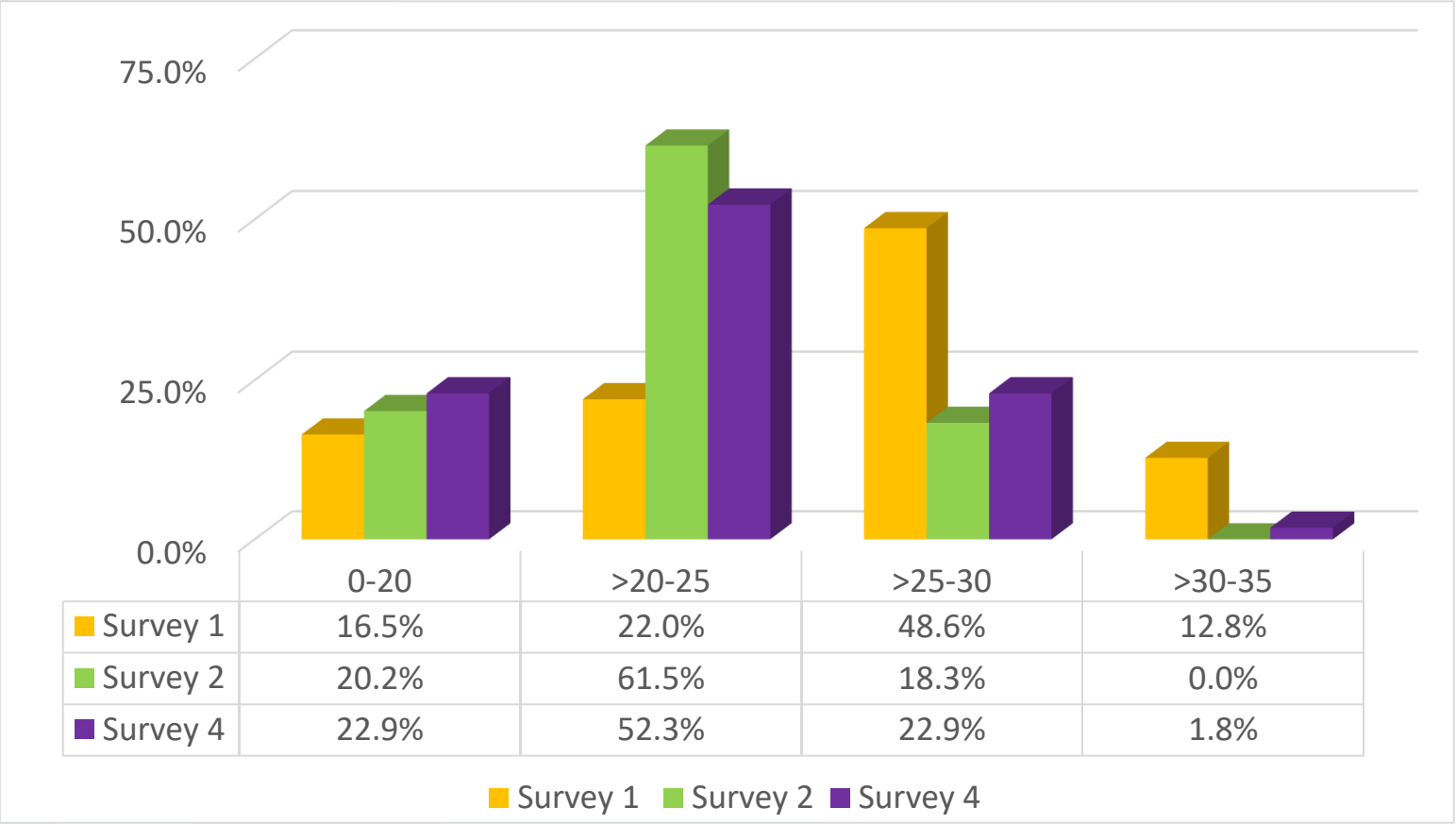
- Comparison of **key speed statistics** across various survey waves
- Extensive **statistical testing** to identify differences in speed metrics (T-tests, Wilcoxon ranked-sign tests)
- **Random Effects Linear regression models** to identify the overall impact of the 20mph speed limit while controlling for the impact of traffic
- **Non-randomised control-case** analyses to identify the impact of supplementary interventions on vehicle speeds (e.g., buffer zones, Vehicle Activated Signs)

Results: Distribution of sites per mean speed range



	0-20	>20-25	>25-30	>30-35
Survey 1	16.5%	22.0%	48.6%	12.8%
Survey 2	20.2%	61.5%	18.3%	0.0%
Survey 4	22.9%	52.3%	22.9%	1.8%

- *Shift towards the left side of the distribution*: >75% have **low mean speeds** 8 months after the trial
- The trial almost **doubled** the proportion of locations with <u>speeds lower than 25 mph</u>

Results:
Mean & 85th percentile speed

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For **all sites** (with 30mph speed limit "before"):

Mean speed (mph)	N	Average	Std. Deviation
Survey 1 ("Before")	109	25.33	4.56
Survey 2 ("After I")	109	22.22	3.02
Survey 4 ("After III")	109	22.64	3.27

85th percentile speed (mph)	N	Average	Std. Deviation
Survey 1 ("Before")	109	30.21	4.90
Survey 2 ("After I")	109	27.03	3.75
Survey 4 ("After III")	109	27.59	3.93

Mean speed:
>25 mph

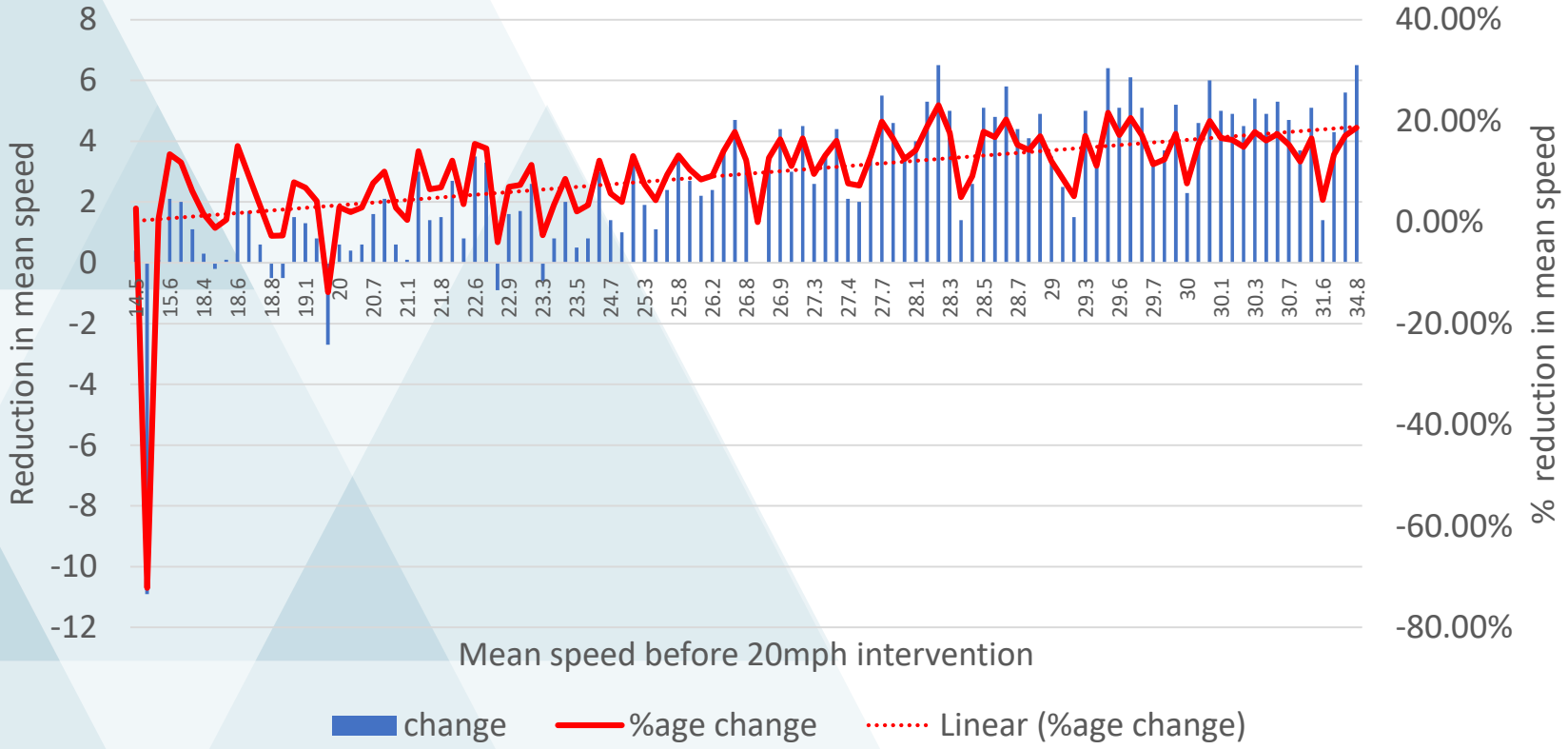
Before

Mean speed:
>22 mph

After

Mean speed:
- 2.7 mph

Results: Relative & absolute speed change



- Overall finding: the higher the mean speed "before" (as can be seen in the horizontal axis), the higher the speed decrease in the "After III" survey (as can be seen in the vertical axis)

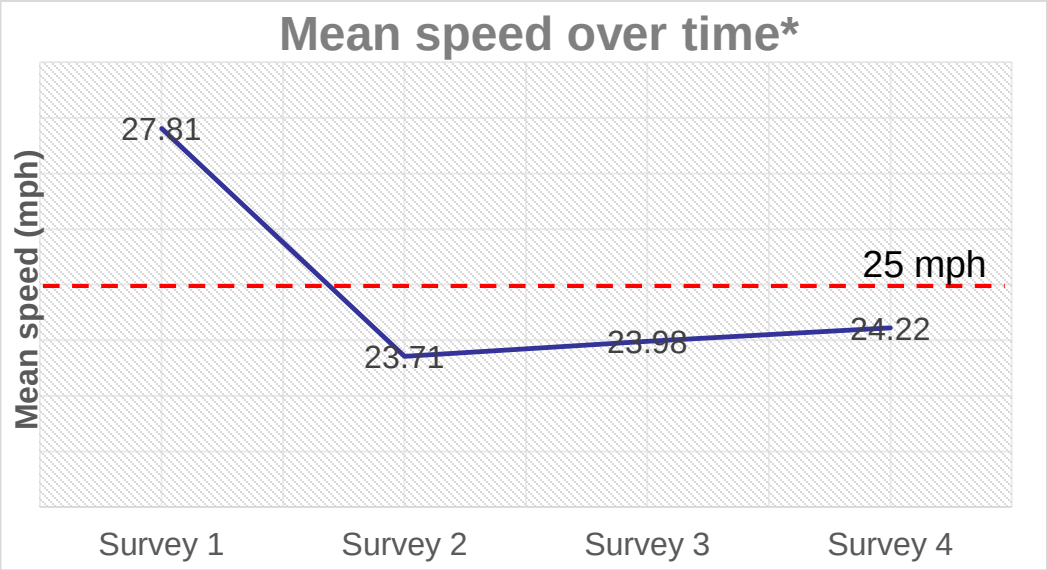
Results: Difference per mean speed range

- **Speed differences** between “Before” & “After III”

Mean speed range (mph)	“Before” speeds	“After III” speeds	“Before” – “After III” difference
0-20	18.06	18.01	-0.05
>20-25	22.58	21.12	-1.46
>25-30	27.94	24.17	**-3.77**
>30-35	31.17	26.45	**-4.72**

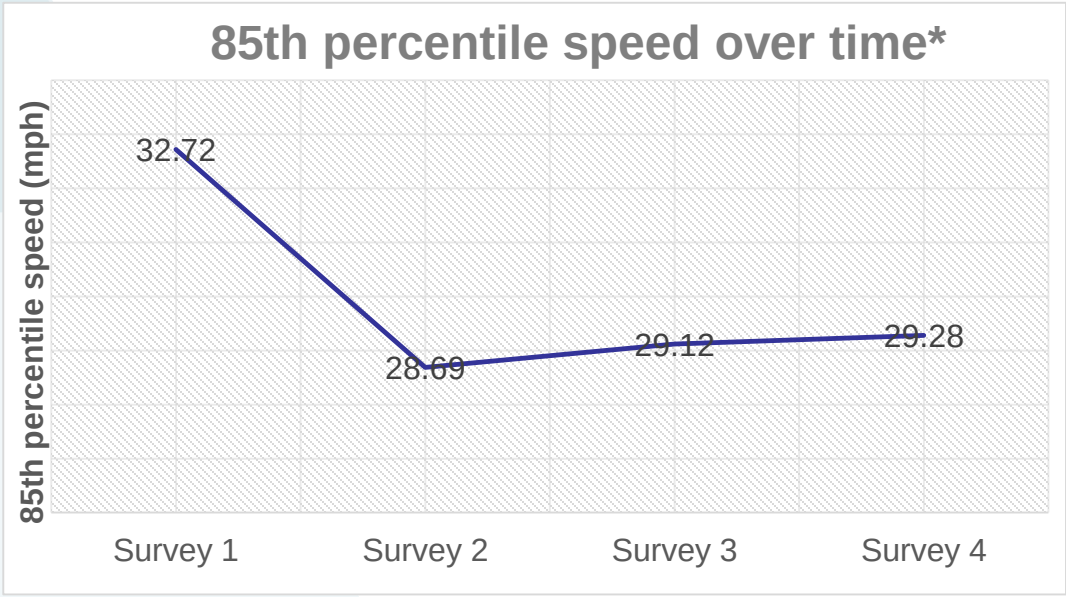
- Speed reductions are more pronounced for locations with “before” mean speeds **greater than 25 mph**.
- T-tests revealed that “before-after” differences in speeds were statistically significant at a >99% level of confidence for >92% of locations

Results: Evolution of speed over time



- Reductions in **mean speed** are largely **maintained** even 8 months after the introduction of the 20mph limit

- Reductions in **85th percentile speed** are largely **maintained** even 8 months after the introduction of the 20mph limit



* From the analysis of **55 sites** with available data across all 4 survey waves

Results: Other safety interventions

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Mean speeds where electronic signs (VAS) **in place** after Survey 3

Mean speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	23	19.1	28.7	24.64	2.20
Survey 4	23	20.7	29.2	24.33	2.12

Mean speeds at sites **without** electronic signs (VAS)

Mean speed (mph)	N	Minimum	Maximum	Average	Std. Deviation
Survey 3	46	17.8	30.1	24.04	2.35
Survey 4	46	18.4	32	24.80	2.77

- Mild evidence on the impact of electronic signs on vehicle speeds
- Slight speed reductions (<0.5 mph) at sites with electronic signs
- Slight speed increases (<0.8 mph) at sites without electronic signs
- No observable impact of other interventions (such as buffer zones and repeater signs) on vehicle speeds

Results: Traffic volumes & speed differences

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- Traffic volume fluctuations across survey waves:

	N	Average traffic (vehicles/day)	% Difference with "Before"
Survey 1 ("Before")	109	2383	
Survey 2 ("After I")	109	1820	-31%
Survey 4 ("After III")	109	2506	+5%

- **Random effects linear regression** model of daily mean speeds:

Independent variables	N	Coefficient	t-stat	p-value
Constant	327	24.6932	64.46	0.00
Traffic volume (veh/day)		0.0003	3.71	0.00
20mph speed limit		-2.8675	-19.31	0.00

- Statistical analysis revealed:
  - The impact of traffic volume fluctuations (due to COVID-19) on speeds is statistically observable, but **low**
  - Similar results for the model of 85th percentile speeds
  - Long-linear transformations and other controlling factors were also considered without resulting in further insights

Overall findings

- Significant **speed reductions** after the introduction of the 20 mph speed limit
- Speed reductions seem to be maintained 7 to 8 months after the intervention
- The extent of reductions is observed to be **greater** in locations having higher mean speeds pre-intervention
- Numerous statistical tests have been conducted showing that speed changes are indeed **statistically significant** with greater than 99% level of confidence for most locations
- Random effect linear regression model showed that the 20mph limit triggered an average **2.9mph reduction** in vehicle speeds area-wide

Is this good news?

- Science-based evidence has previously reported internationally of a **1mph** average speed reduction resulting in a **5% casualty reduction**
- From this study we report circa **3 mph** mean speed reduction
- Significant findings which help fill the ‘rural settlements’ evidence gap on 20mph speed limits
- December 2021: The SBC Council approved a plan to **permanently** set the 20mph limit as default
- Scotland is likely to establish 20mph limit as default to all built-up areas – a lot to learn from SBC’s experience

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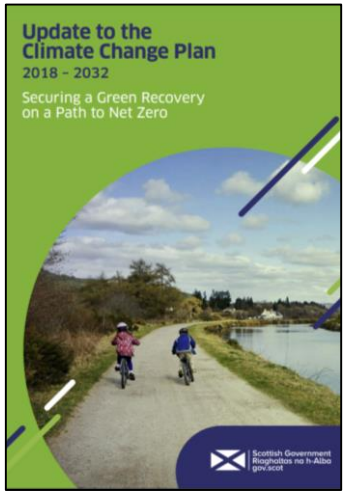
The Impact of COVID-19 on Future Public Transport Use in Scotland



Lucy Downey, Achille Fonzone, Greg Fountas, Torran Semple

Background

- March 2020 lockdown[1]
  - Bus (-85%) & rail (-92%) patronage decreased
  - Volume of car traffic fell 75%
- Transport Scotland[2] (May 2021)
  - 67% concerned about contracting the virus while using PT
  - 60% concerned about people having enough space to observe physical distancing on PT
  - 41% “I will avoid PT and use my car more than I did before when restrictions on transport are lifted”
  - 61% “I will walk or cycle more’
- Climate Change Plan 2018 – 2032
  - Greenhouse gas emissions net-zero by 2045
  - Reduce car kms on Scottish roads 20% by 2030



[1]Transport Scotland (2021) COVID-19: Scotland’s transport and travel trends during the first six months of the pandemic
[2]Transport Scotland (2021) COVID-19 Public attitudes survey data: Wave 17

!!! Irrelevant Alert !!!

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Trips for outdoor exercise at different stages of the COVID-19 pandemic in Scotland

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ABSTRACT

Introduction: The COVID-19 pandemic has had exceptional effects on travel behaviour in the UK. This paper focuses specifically on the outdoor exercise trips of Scottish residents at several distinct points of the COVID-19 pandemic. Given the negative health consequences of limited exercise, this study aims to determine the sociodemographic and behavioural factors affecting frequency of outdoor exercise trips.

Methods: Using recent public survey data (n=6000), random parameters ordered probit models (with allowances for heterogeneity in the means of random parameters) are estimated for three points during the pandemic: the most stringent lockdown, modest restriction easing and further easing of restrictions.

Results: The survey data show frequent outdoor exercise in the early stages of the pandemic, with ~46% making six or more weekly trips during lockdown, reducing to ~39% during the first phase of restriction easing, and further to ~34% during the following phase of easing. The model estimations show that common factors, dominated by socioeconomic and demographic variables, influenced the frequency of outdoor exercise trips across most survey groups. The modelling framework also allowed insights into the impact of unobserved characteristics within several independent variables; for example, the lockdown exercise trip rates of those with a health problem or disability, and those over 65, were both found to be dependent on personal vehicle access.

Conclusions: The findings suggest that those with a health problem or disability, those who live in households' where the main income earner is employed in a semi-skilled/unskilled manual occupation or is unemployed and ethnic minority groups (i.e., any mixed, Asian, or Black background) were significantly more likely to complete no weekly outdoor exercise trips throughout the pandemic. As a result, we suggest that these groups are at higher risk of the negative health consequences associated with limited physical activity. Policy implications are discussed in terms of mitigating this effect, as well as reducing transport inequity related to vehicle access.

Data from 6,000 respondents in Scotland showed:

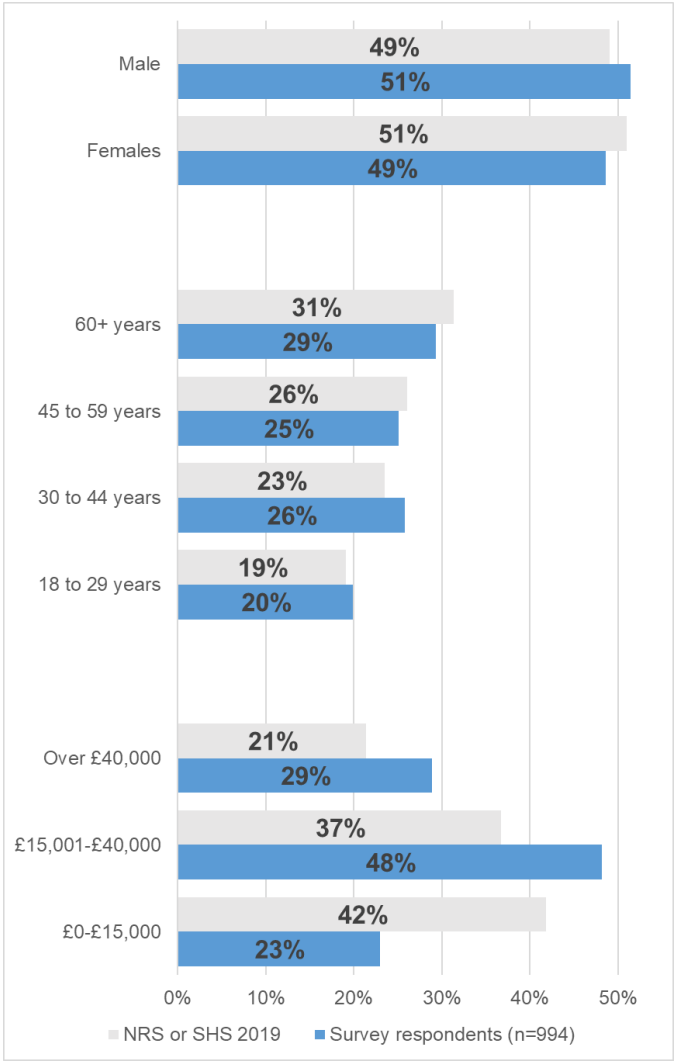
- 46% of the sample made six or more weekly trips for outdoor exercise.
- This proportion reduced to 34% after the ease of the restrictions.
- People with varying levels of capabilities, low-income individuals and ethnic minority groups were associated with limited physical activity during the various stages of the COVID-19.

Current Research

- Understand patterns of **travel choices and behaviour** during the various stages of the pandemic
- Explore **future intentions** with regard to mode choice post-pandemic, especially for public transport
- Identify the **socio-demographic**, **behavioural** and **perceptual** factors which might affect future public transport usage
- Contribute to understanding the potential loss of demand for public transport and the consequences for future **equitable** and **sustainable** mobility

Methodology

- Online Qualtrics Survey
  - Response panel (quota set for age, gender, income)
  - 3rd to 17th February 2021
  - 994 responses
- Survey topics
  - Perceptions of COVID-19
  - Mode choice
  - Travel related activities (WFH)
  - Effectiveness of PT measures
  - Socio-demographics

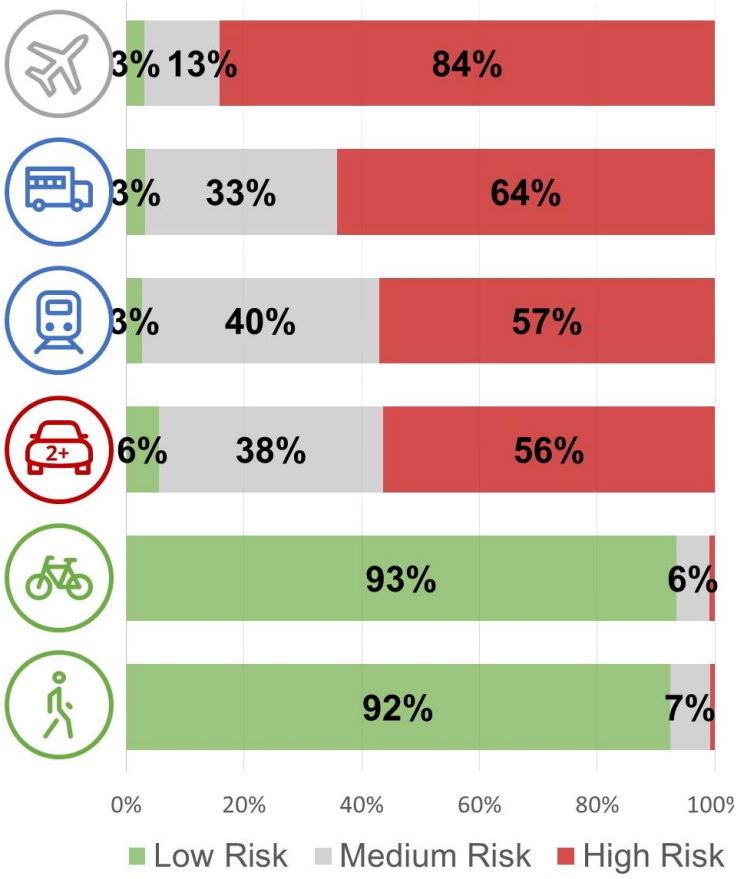


Travel Modes and Risk Perception

- Percentage of respondents travelling at least once a week by mode

Mode	Pre-covid	lockdown
Bus	27%	9%
Train	12%	4%
Car	69%	55%
Share	15%	5%
Bike	13%	13%
Walk	75%	81%

- Perceived risk of different types of transport in terms of contracting/spreading the virus



Anticipated Future Mode Use

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- Thinking ahead, some 12 to 18 months from now, how often will you travel using the following types of transport compared to what you did before the COVID-19 pandemic?

Transport Mode	Less	Same	More	Diff
Walk	5%	50%	45%	40%
Bike	14%	58%	39%	25%
Driving HH car	13%	63%	25%	12%
Passenger in HH car	14%	67%	19%	4%
Passenger other car	25%	56%	18%	-7%
Train	34%	47%	19%	-15%
Plane	42%	35%	23%	-19%
Taxi	33%	54%	13%	-20%
Bus	36%	49%	15%	-21%

Scottish transport trends by mode 2014 to 2019[1]

Car traffic increased 8%

Train passengers increased 13%

Bus passengers decreased 10%

[1]Transport Scotland (2019) Scottish Transport Statistics No 38

Reduced Public Transport Use

- Thinking ahead, some 12 to 18 months from now, why do you intend to use public transport (buses and/or trains) less often than before the COVID-19 pandemic? (Multiple Response n=333)

Reason	Number of Responses*	Percentage* (n=333)
Possibility of getting infections (e.g. COVID-19) carried by other passengers	210	63%
Lack of cleanliness/hygiene on board PT	163	49%
PT is too crowded	151	45%
I do not like travelling with strangers	72	22%
PT is too slow and/or takes too long	71	21%
PT is too expensive	64	19%
PT is unreliable	60	18%
PT not regular enough (infrequent)	50	15%
PT is too polluting	49	15%
PT is not available for my usual trips	47	14%
PT service starts too late or finish too early	36	11%
Health condition - difficult walking to/from the stop, get on and/or off the vehicle	27	8%

Future PT Use – RPBPHM Model

- Which factors characterize travelers intending to *use less PT in the future*?
- Future intentions for **bus** and **train** use were modeled in a bivariate binary context (Use **same or more** *vs* use **less**)
- **Random Parameters Bivariate Probit with Heterogeneity in the Means of Random Parameters** (RPBPHM):

$$\Upsilon_{n,1} = \boldsymbol{\beta}_{n,1}\, \mathbf{X}_{n,1} + \varepsilon_{n,1},\ y_{n,1} = 1 \text{ if } \Upsilon_{n,1} > 0, \text{and } y_{n,1} = 0 \text{ otherwise}$$

$$\Upsilon_{n,2} = \boldsymbol{\beta}_{n,2}\, \mathbf{X}_{n,2} + \varepsilon_{n,2},\ \ y_{n,2} = 1 \text{ if } \Upsilon_{n,2} > 0, \text{and } y_{n,2} = 0 \text{ otherwise.}$$

- Cross-equation error term correlation of the bivariate model:

$$\begin{pmatrix} \varepsilon_{n,1} \\ \varepsilon_{n,2} \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}\right]$$

- Correlation of error terms may pick up perceptual interrelationships between two different forms of public transport.
- To account for different layers of **unobserved heterogeneity**, random parameters with heterogeneity in the means:

$$\boldsymbol{\beta}_i = \beta + \boldsymbol{\lambda}\boldsymbol{\Theta}_{\mathrm{i}} + \boldsymbol{\delta}_{\boldsymbol{i}}$$

Is there such thing as "Unobserved Heterogeneity"?

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- Unobserved factors vary systematically across aspects of the data set.
- If not accounted for: model specification errors and erroneous inferences on model outcomes.
- Unaccounted effects may influence parameter estimation and inferences: *possible bias*.
- With the unobserved heterogeneity models, the main goal is to **account for something you cannot see!**

Basic sources of unobserved heterogeneity:

- ✓ Missing / outdated information
- ✓ Limitations due to cost of data collection
- ✓ Partial observability

Inaccurate Predictors

↓

"Poor" Reliability

RPBPHM model results

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Factors	Future use of Bus	Future use of Train
	Effect	Effect
Age (18 -24)	–	[↑] (75.05%)
Unable to work (long-term illness or disabled)	[↑] (87.60%)	–
Resides in Lothian	[↑] (77.19%)	–
Household size (>= 3 or more)	–	↑
PT use prior to COVID-19 (>= 1 day per week)	[↓] (62.97%)	–
Car use prior to COVID-19 (>= 3 days per week)	↓	↓
COVID-19 bus risk perception (high)	↓	–
COVID-19 train risk perception (high)	–	↓
Cross-equation error correlation (t-stat)	0.988 (180.50)	

[…]: Random Parameter ↑ : Use same or more ↓ : Use less

RPBPHM model results (Cont.)

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Heterogeneity in the means of Random Parameters (RP) for the future use of bus

Random parameter : **heterogeneity-in-the-means**	**Overall effect of the RP**	**Impact on the mean of the RP**
Resides in Lothian : **Highest Education level (Higher, HNC or HND)**	[↑]	↓
PT use prior to COVID-19 (>= 1 day per week) : **Social media COVID-19 information (frequent)**	[↓]	↓
PT use prior to COVID-19 (>= 1 day per week) : **Resides in Central Belt of Scotland**	[↓]	↑
Unable to work (long-term illness or disabled) : **Websites or online news pages for COVID-19 information (frequent)**	[↑]	↓

RPBPHM Findings

- Perceptual factors
  - High bus or train risk perception = reduced travel by these modes in the future
  - Restore confidence in safety of PT through reducing risk perception (e.g. continue measures such as mask wearing, hand sanitising etc.)
- Behavioural factors
  - Frequent car users (3+days pw) significantly more likely to anticipate reducing PT use. Potential for increased car dependency
  - For frequent urban bus users, public transport will continue to offer a competitive alternative to other modes
- Socio-demographic factors
  - Lothian residents significantly more likely to travel by bus in the future. (region has high pre-pandemic bus use + high levels of satisfaction with bus operations).
  - Those from larger households (3 or more) significantly more likely to travel by train in future (greater car competition in larger households?)

Conclusions

- If car use can be discouraged, the pandemic presents an opportunity to alter travel patterns which were detrimental to health, physical activity, road traffic incidents and climate change[3].
- However, potential for increased car dependency in the post-pandemic era is still evident.
- Future research to:
  - Explore if and how future intentions translate into **actual behaviour**
  - Understand how intentions may vary with **changing perceptions** (not only related to COVID-19)
  - Identify the impact of altered **commute and other activity patterns**

Working from home
54%

Using IT to communicate
Work **64%**
Family/friends **51%**

Shopping online
Grocery **36%**
Non-grocery **45%**

Exercising outside
58%

[3]Laverty, A.A., Millett, C., Majeed, A., Vamos, E.P., 2020. COVID-19 presents opportunities and threats to transport and health. Journal of the Royal Society of Medicine 113.

And the final Question is…

- **Should it stay or should it go?**
  - ✓ Reduced speeds? **Stay**
  - ✓ Traffic calming measures? **Stay**
  - ✓ More space for active travellers? **Stay**
  - ✓ Non-compliance with speed limits? **GO**
  - ✓ Perception of infection risk in public transport? **GO**
  - ✓ Reduced use of public transport? **GO**
  - ✓ Higher dependence on cars? **GO**
  - ✓ Uplift in walking and cycling? **Stay**
  - ✓ Protective measures in mass transport? …

Media presence

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CORONAVIRUS

Coronavirus in Scotland: Scots feel drive to shun public transport

An empty Edinburgh airport. Fewer members of the public anticipate using aeroplanes and other forms of public transport, a study finds
JANE BARLOW/PA

The Times

Fewer people 'anticipate using public transport' in future

Survey suggests the coronavirus pandemic may have long-term repercussions for the country's public transport.

STV

Trial 20mph speed limits in Borders set to become permanent

The signs went up across the Borders in October last year

BBC

Acknowledgments

- 20mph trial in Scottish Borders:
  - Professor Adrian Davis
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Thank you!