iWalk Innovations in Inclusive Walking

To deliver co-benefits in transport and public health

Jess Read and Dr Suzanne Audrey

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About this project

The iWalk project is an exploratory collaboration between Bristol City Council and the University of Bristol to identify innovative transport practices which could enable the large scale uptake of walking for transport.

The project takes an equalities approach by focusing on the needs of children, older adults and disabled people to define the quality standards of these innovations.

The iWalk project was funded by the ESRC Impact Acceleration Account, a grant from the University of Bristol and hosted as a position within the Bristol City Council Transport Team.

About us

Jess Read is a healthy transport engineer with 17 years' experience delivering walking and cycling projects in places like Bristol, London, Copenhagen, Oslo and New York. She holds an MSc. in public health with a focus on healthy transport.

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Disclaimer
The contents of this report do not represent a formal position held by Bristol City Council.

Thank you! This project was developed through collaboration with stakeholders within Bristol City Council, local community groups and national inclusive stakeholders. Many thanks for the time and interest of many individuals who have contributed to this discussion. Apologies to anyone who has be inadvertently forgotten!

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Introduction

These are **10 innovations in inclusive walking**
which could help everybody walk more:

1. Healthy ambition with scaled investment – strategy.
2. Include walking and cycling in transport models – strategy.
3. Ban pavement parking – strategy.
4. Inclusive walking lane widths – infrastructure.
5. Continuous level crossings – infrastructure.
6. Good walking infrastructure, with win-wins for cycling – infrastructure.
7. A child-relevant response to air pollution (PM2.5s) – safety.
8. Amend the highway code to protect people walking – safety.
9. Add near misses and street harassment to Fix-my-Street – safety.
10. Raise the status of walking – culture.

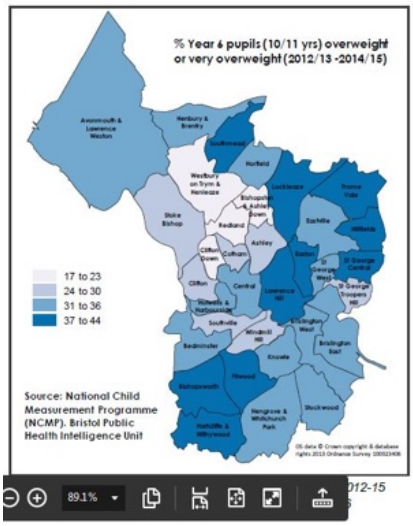
Bristol is a great city!
449,300 people call Bristol home [1]. An additional 20,839 people commute daily into Bristol [2]. 526,000 international visitors come each year as well as around 10 million day visitors [3], that's equivalent to another 28,838 people in the city each day. Our local economy is worth £13.6 bn [4]. And ask anybody, we love living here!

We face big new challenges.
Bristol's population is projected to increase by 23% over the next 20 years [5]. We have dangerously high levels of air pollution [6] [7] and a highly congested traffic system [8]. These are large challenges which will place pressure on health and transport systems [32][33][34].

Our health in Bristol could be better. And fairer. Bristol has high incidence rates for child asthma and child overweight and obesity. These health indicators show strong patterns of inequality, for example, 17% of children 10-11 years old are overweight or obese in Redland compared to 42% of children in Lawrence Hill and 44% of children in Hartcliffe & Withywood [9]. Health data for Bristol show we have high levels of cancer, cardiovascular disease, respiratory disease and premature death [10].

There is nothing good or normal about this. High quality data for Bristol shows that child overweight and obesity is pandemic [9]. This is a is a serious health threat as child overweight is an indication of metabolic disease, with symptoms such as high blood pressure, insulin resistance, dyslipidaemia [37]. Obese children are at high risk of becoming obese adults [38].

Child obesity and overweight have increased nationally by 20% over the past 20 years [39]. Physical activity has protective effect for children regardless of their weight [40] [41], but most children in Bristol are not getting enough physical activity.



We are in the bottom third of the league in terms of premature mortality (103rd from 150) [10].

Our goal is for everybody to live well for longer. There is a large difference between healthy life expectancy and life expectancy in Bristol, 15 years for men and 19 years for women. There is also a big difference in healthy life expectancy between the least and the most deprived areas of Bristol (17 years for women, 16 years for men) [11]. This is a serious health inequality.

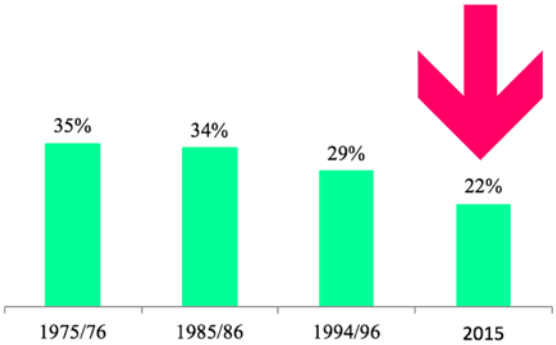
Most children in Bristol are not active enough to get basic health protection. Children aged 15 in Bristol do not meeting the Chief Medical Officer's physical activity guidelines for children of 60 minutes or more of moderate-to-vigorous physical activity per day (girls 90% and boys 76%) [12]. Physical activity is really important for children [13]. Walking to school and playing outside in local streets are important settings where children are active [14].

More than one third of adults in Bristol are not active enough. 43% of women and 34% of men aged ≥16 in Bristol do not meet the Chief Medical Officers' physical activity guidelines of 150 minutes of moderate-to-vigorous physical activity per week which provides basic health protection [15]. Increasing physical activity is one of the high impact targets for improving the health of all people living in Bristol [16].

Luckily, walking is the best. Walking is the best medicine [17]. Walking is the most equitable form of transport in the UK [18] [19]. Walking infrastructure is the best value for money [20]. Great for business and tourism! Great for people! Non polluting!

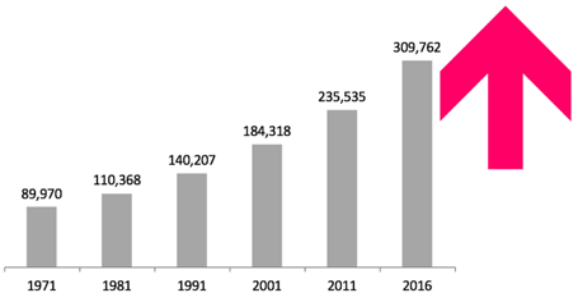
If everyone in Bristol walked just 20 minutes per day, we would save over £900 million in socio-economic costs over the next 10 years [35]. Or, 125 deaths per year [35].

Levels of walking are at a historic low in England.



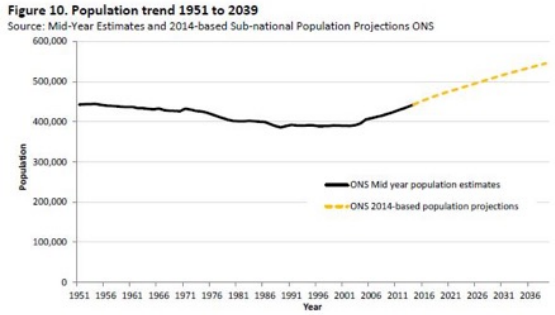
The modal share of walking for transport in England has fallen progressively [23].

Bristol's population in 1971 was 428,089 an in 2015 it was 449,300 [1] [36] - the number of cars and vans owned in Bristol has tripled over the same period [24].



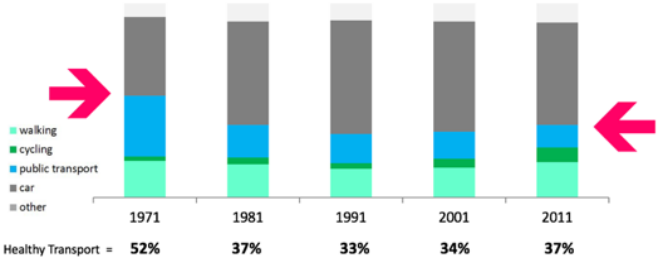
The percentage of households without a car has dropped from 49% to 29% in the same period, well below the core city average of 38% [25].

New frontiers in transport: What will happen next?



Healthy transport has declined over this same period in Bristol from 52% in 1971 to 37% in 2011.

Healthy Transport = combined walking + cycling + public transport



Data for main mode travel to work [26]. Interestingly walking as main mode commute to work is at similar levels today than in 1971 (1971 = 19%, 1981 = 17%, 1991 = 15%, 2001 = 16%, 2011 = 18%). However, we do not have historic data for overall walking for transport levels for Bristol, and this may or may not follow national trends.

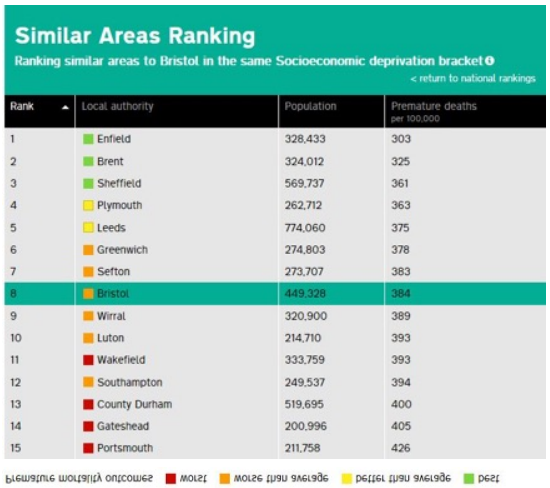
Walking to work in Bristol declines from age 21 years. Currently, 18.5% of commuters walk to work as their main mode [27], this is high compared to other core cities [28]. It is likely that overall levels of walking are higher than this [29] at around 21% [30]. That is still a lot of people who don't walk. Community groups have told us walking isn't easy in Bristol [31].

What can we do to enable walking for transport for everybody?

Inclusive walking means conditions that enable children, older adults and disabled people to choose walking as a viable transport option. These groups typically could benefit most from more physical activity, but are also most vulnerable to the risks associated with walking.

Bristol has some of the worst premature mortality ratings nationally and compared to other local authorities with similar levels of deprivation.

Data from Public Health England (2017) Mortality Ranking. Available at: http://healthierlives.phe.org.uk/topic/mortality/area-details#are/E06000023/par/E92000001/ati/102/pat/



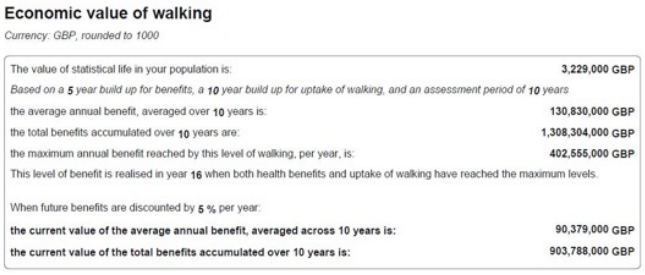
Similar Areas Ranking

Ranking similar areas to Bristol in the same Socioeconomic deprivation bracket

< return to national rankings

Rank	Local authority	Population	Premature deaths per 100,000
1	Enfield	328,433	303
2	Brent	324,012	325
3	Sheffield	569,737	361
4	Plymouth	262,712	363
5	Leeds	774,060	375
6	Greenwich	274,803	378
7	Sefton	273,707	383
8	Bristol	449,328	384
9	Wirral	320,900	389
10	Luton	214,710	393
11	Wakefield	333,759	393
12	Southampton	249,537	394
13	County Durham	519,695	400
14	Gateshead	200,996	405
15	Portsmouth	211,758	426

Data from Public Health England (2017) Mortality Ranking. Available at: http://healthierlives.phe.org.uk/topic/mortality/area-details#are/E06000023/par/E92000001/ati/102/pat/



Economic value of walking

Currency: GBP, rounded to 1000

The value of statistical life in your population is:	3,229,000 GBP
*Based on a **5** year build up for benefits, a **10** year build up for uptake of walking, and an assessment period of **10** years*	
the average annual benefit, averaged over **10** years is:	130,830,000 GBP
the total benefits accumulated over **10** years are:	1,308,304,000 GBP
the maximum annual benefit reached by this level of walking, per year, is:	402,555,000 GBP
This level of benefit is realised in year **16** when both health benefits and uptake of walking have reached the maximum levels.	
When future benefits are discounted by **5** % per year:	
the current value of the average annual benefit, averaged across 10 years is:	90,379,000 GBP
the current value of the total benefits accumulated over 10 years is:	903,788,000 GBP

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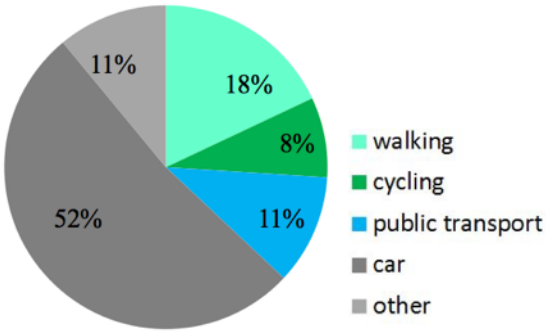
Chapter one

Healthy ambitions for transport

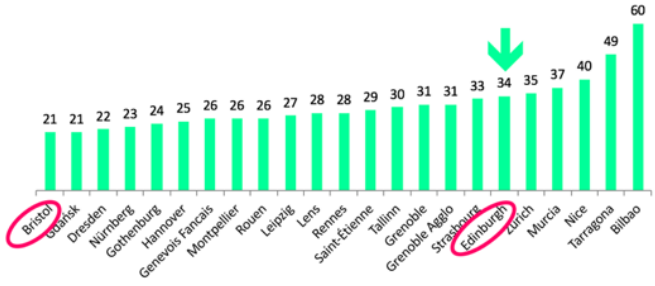
- How much walking for transport is achievable?
- What level of ambition will deliver impacts for health and transport?
- Is healthy change possible?

"Healthy transport is defined as walking, cycling and public transport." This definition is based on the number of minutes of healthy physical activity and health outcomes associated with these forms of transport [1][2][3].

How are we doing in Bristol? Can we do better?

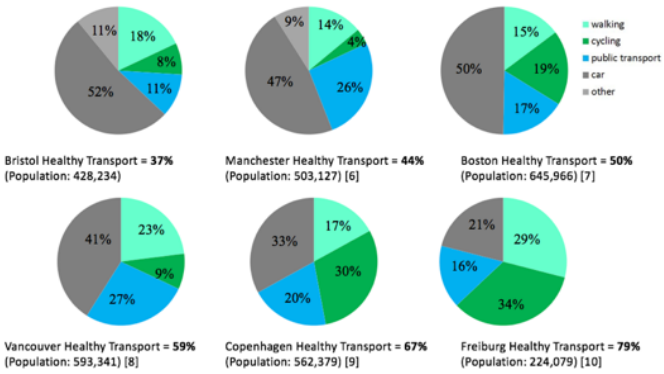


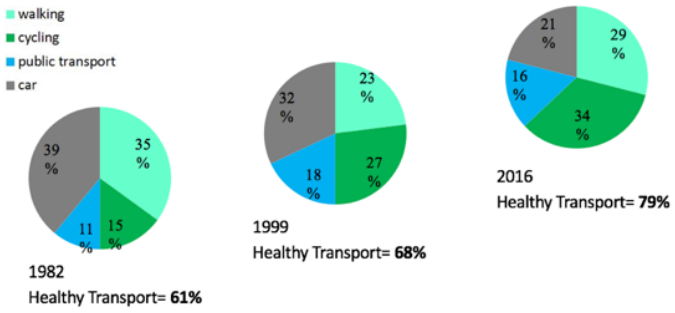
Modal share of main travel mode to work in Bristol [4] - Healthy Transport = 37%



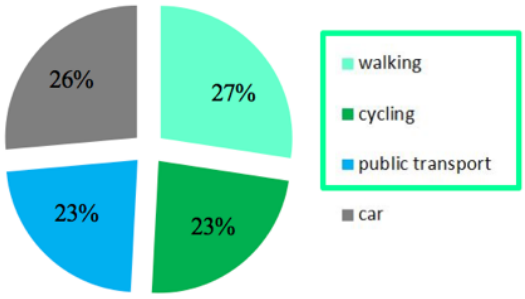
Modal share percentage of walking for transport in other European cities with populations between 350,000 and 550,000 and comparable to Bristol [5]. Other cities are doing better, for example in Edinburgh walking is 34%.

Healthy Transport = combined walking + cycling + public transport





In Freiburg (population = 224,079), healthy transport has increased steadily since first prioritised in 1979 [11].



Healthy Transport target **= 75%**
This is a healthy city average from cities of roughly similar size to Bristol including Copenhagen, Freiburg and Zurich [12]. Of note is that the new Draft London Transport Strategy has ambitions for an 80% healthy transport modal share [13].

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Chapter two

Include walking and cycling in transport models

Traditional transport modelling software does not count walking and cycling. Counting vehicles and not people results in inefficient junctions with road geometries which focus on the movement of vehicles. This often does not improve congestion. Such junctions are typically unpleasant and challenging for people walking, creating more congestion as people prefer to drive than walk.

1950s motorway design style [1].

Is this approach valid for city and residential junctions?

Newer software models people in all modes of transport, including walking, cycling and public transport [2].

This allows for full exploration of increasing network capacity, and fine-tuning realistic crossing times for people walking [3].

Oxford Circus Congestion Improvements. Image: Atkins [4].

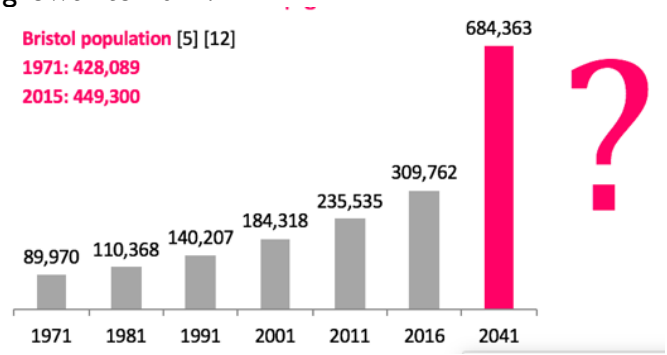
When people are counted instead of vehicles in transport models, junctions look and feel different. Overall network capacity is increased, meaning there are more people – in all modes of transport

- moving through the junction per hour, with potential to reduce congestion.

Euston Road – Warren Street Junction, London. Image: googlemaps.

We need <u>> 25% increase in network efficiency</u> to maintain current levels of congestion in Bristol, related to population projections [5]. This could be an underestimate based on historic increase in car/van ownership. We want to see an increase in the number of people using healthy transport to gain full health and economic benefits [6]. We need smart road design to achieve this.

Or <u>> 200% increase in network efficiency</u> to maintain current trends in car & van ownership growth to 2041.

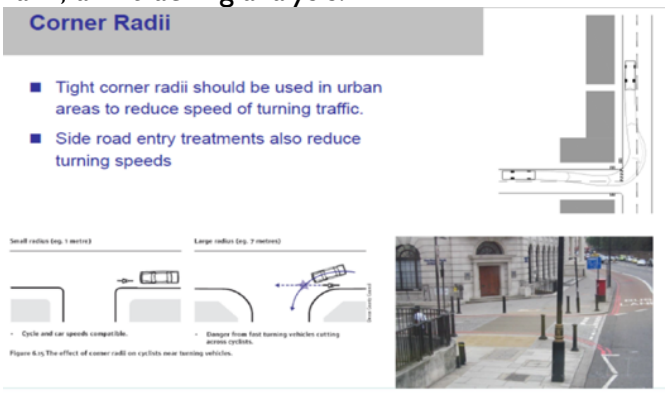


This is a projection for an increase in the number of cars & vans owned in Bristol based on the same rate of increase since 1991 (220%) [11]. This trend shows that increases in car & van ownership were independent of population increases.

New transport modelling software count people, rather than vehicles, and can model all transport users in one model. Examples:

- VISSIM with walking and cycling coded [7]
- Commuter (AutoDesk compatible) [7]
- Legion [8], (less preferable as pedestrian only)

Models should be run with up-to-date road geometries, including carriageway widths, turning radii, and tracking analysis.



Example from TfL about tightening corner radii while still achieving required tracking [8].

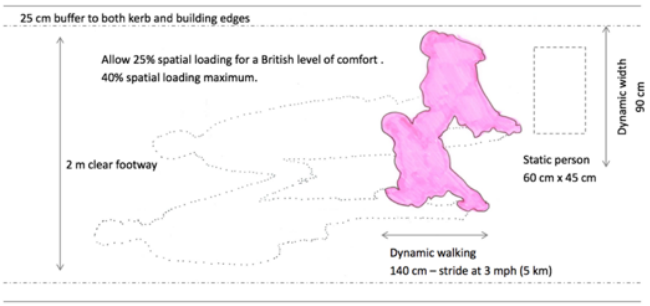
Based on age (<15, >65 years) >30% of the population of will need a crossing speed of 0.9 m sec (based on 2mph) as per new NICE guidance [3]. Controlled crossings need to be programmed and optimised to allow for this.

Walking has the highest network efficiency of all forms of transport.

Spatial loading [10]	2m clear footway 1 m section (2.4 m total)	Calculation (based on 3mi/hr)
25%	1800 people per hour	= 2*.25*60*60
40%	2880 people per hour	= 2*.4*60*60

A British level of comfort, we prefer not to brush against people as we pass.

But closer is possible for peak periods.



Quick wins:
Identify **<u>healthy transport corridors</u>** where walking, cycling and bus are prioritised and through vehicular traffic is excluded during transport peaks. This would give us high capacity arteries, which are pleasant, and safe to walk and cycle, and where many of the negative effects of car transport such as air pollution and traffic risk are neutralised.

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Chapter Three
Ban pavement parking

1 car storage = 10 m^2 or 15 m^3. Equivalent to storage for >500 pairs of shoes [1].

Cars and vans are stationary more than 95% of the time [2]. That is equivalent to >300,000 cars and vans parked in Bristol at any given time [3]. Or 420 football pitches worth of car parking or 14 Victoria Parks worth of car parking [4].




Potentially >100,000 cars parked on the pavement in Bristol at any given moment?

Pavement parking is recognised by Bristol Walking Alliance, Guide Dogs and Living Street as a major deterrent to walking [5] [6] [7] [8].

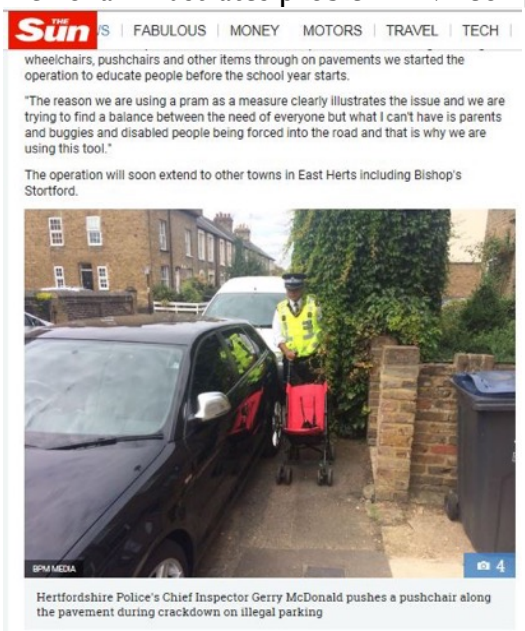
Locally activate TROs don't work [9]:

- They are time consuming to implement.
- Typically local residents are not the ones being obstructed, rather it is other people who pass through particular street as part of their journey.

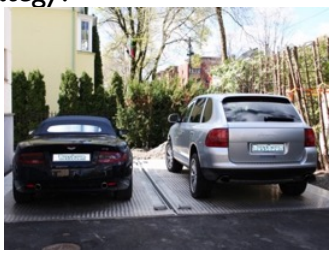
"While it is not illegal to park on pavements, it is against the law to block the pavement with a vehicle". – Police can enforce this as an obstruction [10].
– It is illegal to drive on the footway, there is residual confusion about police enforcing this needing a witness.

- A narrow pram 60 cm is a super direct action, but is not an adequate measure of accessibility (see Innovation 4).
- Clarity is needed with regards to both the footway and the road.

Operation Pram
"Hertfordshire Force's Chief Inspector Gerry McDonald illustrates problem in video" [11].



Can we be more creative about how and where we store cars? Do we need to develop a parking management strategy?

Car stacks can increase the density of parking with less negative visual impact [12].

Need to rethinking parking, and how we use this space in cities to support our mental and physical health:

- Re-allocate 20% modal share of "park" ing space to walking assets e.g. benches, trees, social areas/cafes.

Or

- 1 tree and 1 bench per 100 inhabitants.

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Chapter Four
Inclusive widths for walking lanes

Should two people be able to pass each other on the footway without stepping into the road? Stepping into the road to let someone else pass, or crossing the road to let someone else pass could be described as "doing a Bristol". This "give and take" is indicative of poor walking infrastructure [1].

What supports people walking?

- Walking with a dog [2]
- Walking with a friend [3]
- Modelling walking as a normal behaviour to a child [4]
- Mobility aids such as a guide dog, a stick, walking frame, wheelchair, scooter, personal accompaniment etc. [5]
- Good infrastructure [6]

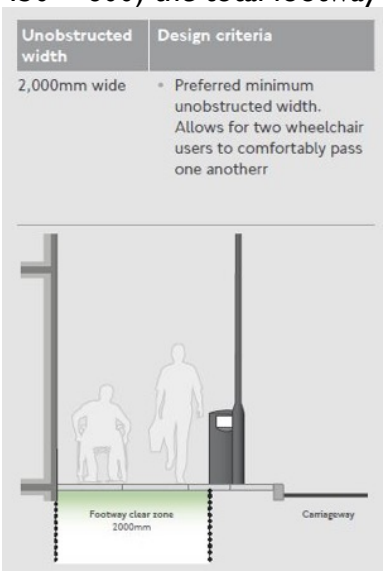
What **stuff** do you need to support different journey types?

- Shopping - shopping bag, sholley or shopping caddy
- Work - computer bag, change of clothes/shoes
- School journeys - with children, possibly on scooters
- Recreational - sports bag, other equipment

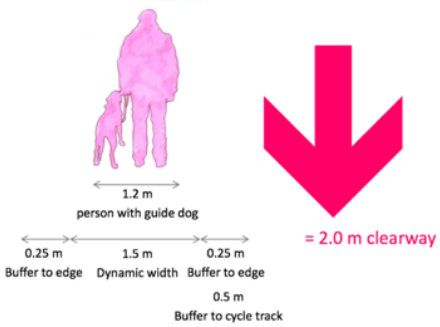
Tw metres is typically cited as a basic inclusive footway width by the Department for Transport (2005) Inclusive Mobility Guidance, section 3.1 [7] and Manual for Streets (2007) page 68 [8]. This is based on two wheel chairs being able to pass one another. The two metres refers explicitly to two metres of clear footway [7] [8].
This dimension describes a minimum not a target, and additional allowances need to be made based on pedestrian flow, carriageway flow, frontage, and placement of street assets.
A cyclist travelling at 12mph can kill a pedestrian if they collide [9]. If a cycle lane is adjacent to the footway a minimum 50 cm additional clearance is needed.

This is consistent with new TfL Street Guidance [10]. Again, 2m represents a clear zone, not the overall footway width. As shown at below, additional allowance needs to be made for a curb set-back (450 mm in Bristol) and slimline street assets. (150 – 400mm).

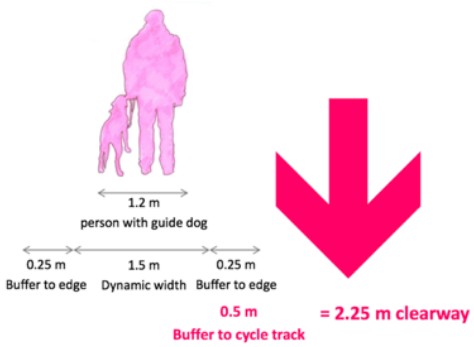
For example, to accommodate a lamp post (150 + 450 = 600) the total footway width is 2.6m.



What is our bottom line for inclusive walking lane widths? A basic minimum provision should include someone walking with a guide dog or with a child. Being able to walk beside someone you love or a friend would help make walking a more realistic choice for everybody. For many people, accompaniment might be essential to getting out.



This means 2.0 m wide is the needed clearway, and makes no allowance for street assets or a curb setback which in Bristol is a 450 mm.



A cyclist travelling at 12 mph can kill a pedestrian [7]. Spatial allowance must be made due to the speed differential between walking (2mph) and cycling (12 mph).

A large proportion of the Bristol population have an inclusive lane requirement to be able to get out and about:

- 17% of Bristolians have a health problem or disability which limits day-to-day activity [11].
- 4% population < 3 years (need pushchair) [12].
- 15% of Bristol population < 12 years, need to walk with an adult [12].
- 13% of population > 65 years; this is projected to increase by 2039 to 16% of population > 65 years [12].
- 9.4% of the population are carers [13].
- There will be a certain amount of overlap in these groups.

Based on demographic data for Bristol [11] [12] [13]
>49% of walking journeys likely accompanied
>49% of walking journeys likely at <2mph (0.9 m/s)
→High mobility diversity is standard

Calculation for accompanied journeys:

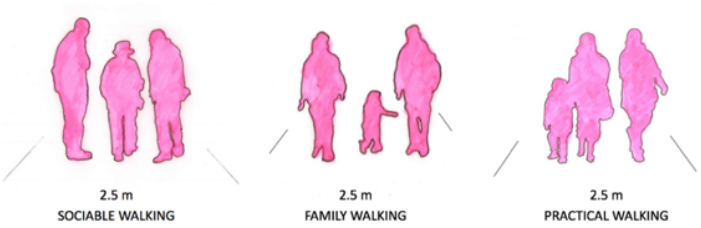
- 15% of Bristol population < 12 years, need to walk with an adult.
- 9.4% of the population are carers, will accompany an adult.
- 15% x 2 = 30%
- 9.4% x 2 = 18.8%

Total = 48.8% accompanied

- In addition, 17% of Bristolians have a health problem or disability which limits day-to-day activity, allowing for some overlap this is nonetheless likely an underestimate.

Mobility Aids	Static width
Sholley	45 to 62 cm
Mobility scooter	70 cm
Wheelchair	75 cm
Cargo bike	90 cm
Double pushchair	72 to 90 cm
Wheelchair bike	90 to 110 cm

Mobility aids can help more vulnerable users get out walking, and also to facilitate trip types which replace car use. This includes being able to carry goods, shopping, personal effects and children. These dimensions must be taken into account, particularly at interchanges with public transport.



A basic minimum provision should allow sociable walking so that we can walk with friends, family and children because we know this helps us walk more. Practical walking is important for both safety and comfort so that we can pass other people on the footway without having to step into the road. A footway width of 2.5m is a basic, robust standard to achieve this.

2.5 m - basic standard footway
2 m – minimum clear footway, no assets in footway.

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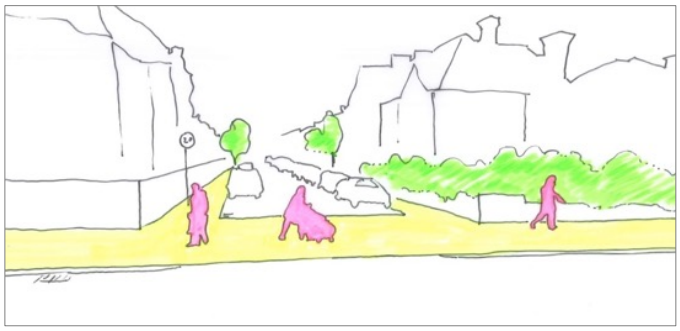
Chapter Five
Continuous level crossings

Traffic remains the leading cause of death for children aged 5 to 19 in the UK [1][2]. How can we make walking safe for everybody?



- Footway is continuous, and load-bearing at junction.
- Increased safety – 2 step yield for drivers.
- Supports slower turning at junctions.
- Use at secondary road junctions.
- Rolled out across London in variations, and individual cases in Bristol.
- Used internationally e.g. Boston, Copenhagen, Amsterdam, Melbourne.

- Footway material is continuous, and load-bearing at junction.
- Increased safety – 2 step yield for drivers.
- Supports slower turning at junctions.
- Use at secondary road junctions.

In Bristol, most pedestrian and cyclist traffic risk, but also risk for motorcycle and car occupants occurs at secondary junctions [3,4], similar to national patterns [12]. Improving safety here would be a targeted approach to reducing traffic risk at these key danger spots. Traffic deaths are the leading cause of death for children nationally [1] [2].

Great Britain	KSI/bn miles		Denmark	KSI/bn miles	
All Ages [5]			*All 10-84 years – 2010 [6]*		
Pedestrians	463	→	Pedestrians	99	X 5
Cyclists	1036	→	Cyclists	99	X 15

Comparison of absolute traffic risk as killed or seriously injured per billion miles for adults. Data from Denmark [6], the Netherlands and Sweden [7] [8] show that greater safety for walking and cycling per mile travelled is possible, particularly for children. Continuous level crossings are a standard feature in Copenhagen and Amsterdam.

Absolute traffic risk as killed or seriously injured (KSI) per billion miles

CHILDREN

Great Britain	KSI/bn miles	
Girls 0-16 years [11]		
Pedestrians	352	
Cyclists	595	
Car occupants	9	X 39
Boys 0-16 years [11]		
Pedestrians	641	
Cyclists	1411	
Car occupants	8	X 80

Being driven is 39 times safer per mile travelled for girls, and 80 times safer per mile travelled for boys.

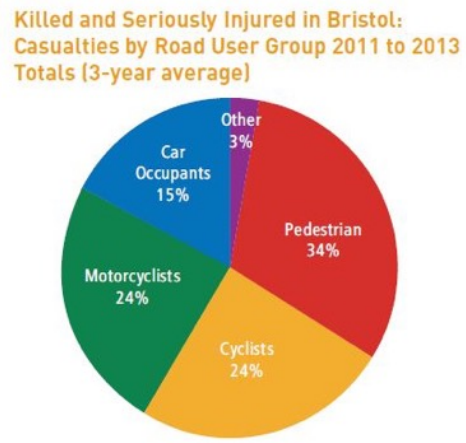
Absolute traffic risk as killed or seriously injured (KSI) per billion miles

CHILDREN

Great Britain	KSI/bn miles		Denmark	KSI/bn miles	
Girls 0-16 years [11]			*Girls 10-15 years [6]*		
Pedestrians	352	→	Pedestrians	75	X 5
Cyclists	595	→	Cyclists	54	X 11
Car occupants	9				
Boys 0-16 years [11]			*Boys 10-15 years [6]*		
Pedestrians	641	→	Pedestrians	127	X 5
Cyclists	1411	→	Cyclists	73	X 19
Car occupants	8				

Walking and cycling is much safer in Denmark, the Netherlands and Sweden, particularly for children.

In Bristol, walking and cycling share a disproportionate level of traffic risk measured in killed or seriously injured (KSIs) [13]
Walking modal share = 20%, for 34% of KSIs for walking disproportionate by factor 1.7
or
Typically 2.8% of distance for 34% of KSIs for walking are disproportionate by factor 12 [14]
This is likely further disproportionate across areas of higher deprivation [13].



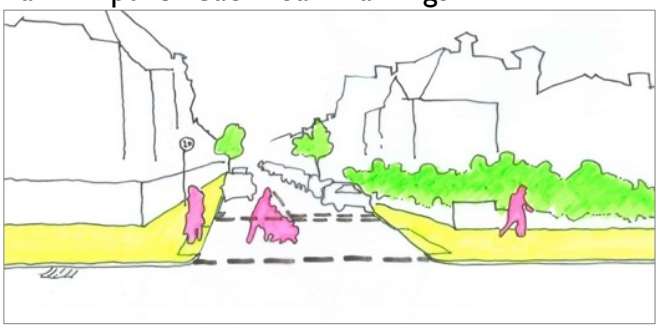
Drop curbs are challenging to install with positive drainage. Wet hands for wheel chair users is unpleasant but also dangerous as it makes braking slippery.

Copenhagen, Gammel Kongevej is a major road artery into the city centre. The continuous level crossing was developed in response to the question "how can my child walk to school without crossing the road?". The use of a load-bearing footway material preserves the linear integrity of the footway, and also gives a clear threshold treatment to the quiet residential street beyond. Image: googlemaps.

Bristol, Great George Street – an historic precedent showing continuous footway treatment. Image: googlemaps

Waltham Forest, London– 48 continuous level crossings have been installed in the borough [9]. Image: Waltham Forest.

Plan B – pulled back road markings



- Can be rolled out during micro-asphalting.
- Strengthens the legal duty of care to give way to people walking.
- In use across UK in individual contexts, e.g. Bristol, Weston-super-Mare, Hove, Oxford etc.
- Cited in Irish National Cycle Manual.

Stop line for pedestrians are common across the USA. Washington D.C., USA. Image: googlemaps.

Weston-super-Mare, High Street. Image: googlemaps.

The Brunel Mile, Welshback, Bristol.

Irish National Cycle Manual [10]

- Can be rolled out during micro-asphalting.
- Strengthens the legal duty of care to give way to people walking.

- Added protection for cyclists at side junctions.
- Reduction of all collision types.

Gloucester Road, Bristol. Image: J Read.

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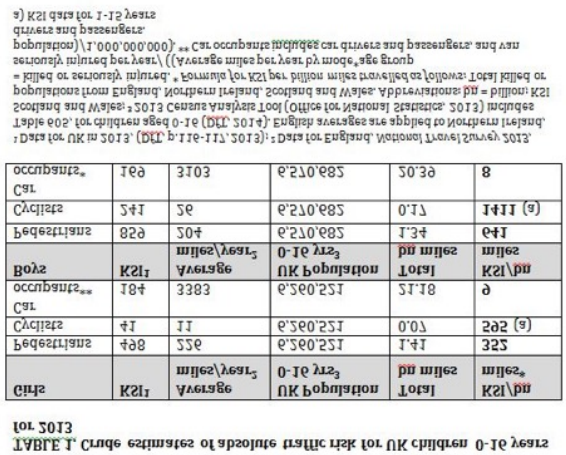

TABLE 2. Crude estimates of absolute traffic risk for all ages in UK for 2013

All ages	KSI[1]	Average miles/year[2]	Population[3]	Total bn miles	KSI/bn miles*
Pedestrians	5396	187	64,105,654	11.99	**450**
Cyclists	3252	49	64,105,654	3.14	**1035** ***
Car occupant**	8797	5155	64,105,654	330.46	**27**

[1] Data for UK in 2013 (Department for Transport (DfT), p.115, 2013), also in Table RAS30005 (DfT, 2013b); [2] Data for England *National Travel Survey 2013*, Table 605 (DfT, 2014) therefore English averages are applied to Northern Ireland, Scotland and Wales; [3] Census Analysis Tool, (Office for National Statistics, 2013) includes populations from England, Northern Ireland, Scotland and Wales. Abbreviations: bn = billion; KSI = killed or seriously injured. * *Formula for KSI per billion miles travelled as follows:* Total killed or seriously injured per year/ ((Average miles per year by mode*age group population)/1,000,000,000). **Car occupants includes car drivers and passengers, and van drivers and passengers. *** Data consistent with findings from *Road Cycling: Statistics* (House of Commons, p.4, 2013) which reported 1005 seriously injured per billion miles and approximately 35 killed per billion miles = 1040 KSI/bn miles for 2011.

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Chapter six
Good walking infrastructure with win-wins with cycling

How can we upgrade walking infrastructure to enable more people to walk for transport? Good infrastructure supports more walking [1][2]. The development of Local Cycling and Walking Investment Plans (LCWIPs) is an opportunity to think strategically about how to deliver better, enabling conditions for walking at a network level relevant for commuting and local level walking. The following 10 key walking infrastructure upgrades could be transformational in making walking for transport a genuine transport choice for more people.

National data shows us clearly walking is transport [3] [4]. Walking isn't free, but walking infrastructure does have the greatest return on investment [5]. Schemes like the Camden Town High Street Regeneration show that improving walking infrastructure works for businesses: *"The result was transformative – from a vehicle-centric road layout in to wide pavements that could accommodate the huge footfall, allowing visitors to stroll along the numerous independent businesses that line our high street."* [6].

Transfer market:

walk → cycle 😐
walk → public transport 😐 ☺
walk → car ☹
car → walk ☺
car → cycle ☺
car → public transport ☺

10 Key Walking Infrastructure Upgrades:

1. Inclusive footway widths - widen where necessary/possible.
2. Continuous level crossings - pulled back road markings as a transitional solution.
3. Reduce road lane widths and turning radii to support slower vehicles, and increased efficiency.
4. Continuous level footway cross-overs for driveways.
5. Raised level loading/parking bays.
6. Decluttering – e.g. preserve integrity of walking lanes consolidate road signage on lighting, place road signage in highway, remove unnecessary assets/poles, consistent placement of assets on back of footway in residential, front of footway in highstreets/high volume roads, slimline assets .
7. Special treatment of narrow footways (≤2m) – e.g. footway widening, elongated crossings, removal of all street assets (placement in roadway, signage on buildings), people streets.
8. Inclusive bus shelters– e.g. priority waiting areas, reverse shelter placement or no shelter for narrow footways, accessible footways to bus stop, safe cycle lane bypasses.
9. Provide benches and seating opportunities @ 1% of population.
10. Place streets assets in carriageway – e.g. parking ticket machines, benches, trees, signage etc.

Raised level loading/parking bays Camden High Street. Vans unload here early morning, rest of the time available for people/customers.

Raised level footway crossovers Roderick Road, London. No adverse camber for people! Cars can handle this.

Improved crossings – reduced lane widths Camden High Street, London. Tightened turning radius supports slower speed for vehicular traffic, and more useable space for pedestrians

Good inclusive cycling infrastructure – must deliver win-wins with walking. New cycling infrastructure must deliver these 10 walking infrastructure upgrades to deliver a net contribution to the network. New cycling infrastructure must be inclusive – that is enabling to all transport users, including people in cargo bikes, wheelchair bikes, mobility scooters and other mobility forms whose journeys start and end on the footway.

A cyclist travelling at 12 mph can kill a pedestrian if they collide [7].

Person Walking	Walking speed	Walking Momentum	Cyclist	Cycling speed	Cycling Momentum	Momentum differential
Adult 75 kg	3 mi/hr (1.39 m/sec)	75*1.39= 104 kg m/s	Adult 75kg	12 mi/hr (5.56 m/sec)	75*5.56= 417 kg m/s	Factor 4
Adult 75 kg	2 mi/hr (0.9 m/sec)	75*0.9= 68 kg m/s	Adult 75kg	12 mi/hr (5.56 m/sec)	75*5.56= 417 kg m/s	Factor 6
Child 30 kg	2 mi/hr (0.9 m/sec)	30*0.9= 27 kg m/s	Adult 75kg	12 mi/hr (5.56 m/sec)	75*5.56= 417 kg m/s	Factor 15

Traffic collision are the leading cause of death for children. Older adults experience worse outcomes from traffic collisions than younger adults

Person Walking	Walking speed	Walking Momentum	Vehicle	Vehicle speed	Vehicle Momentum	Momentum differential
Adult 75 kg	2 mi/hr (0.9 m/sec)	75*0.9= 68 kg m/s	Mid-size car 1600kg	20 mi/hr (8.89 m/sec)	1600*8.89= 14,224 kg m/s	Factor 209
Adult 75 kg	2 mi/hr (0.9 m/sec)	75*0.9= 68 kg m/s	Bus 12,650 kg	20 mi/hr (8.89m/sec)	12,650*8.89= 112,459 kg m/s	Factor 1654
Child 30 kg	2 mi/hr (0.9 m/sec)	30*0.9= 27 kg m/s	Mid-size car 1600kg	20 mi/hr (8.89 m/sec)	1600*8.89= 14,224 kg m/s	Factor 527
Child 30 kg	2 mi/hr (0.9 m/sec)	30*0.9= 27 kg m/s	Bus 12,650 kg	20 mi/hr (8.89m/sec)	12,650*8.89= 112,459 kg m/s	Factor 4165

Inclusive walking content must be embedded in standard transport design tables to deliver a consistent and reliable network.

Currently walking content is typically absent in standard transport engineering tables, or refers to non-inclusive design standard for footway widths.

Table 3: Flow/Speed lookup table

Flow	85th percentile speed			
	Very Low (<20 mph)	Low (20 to 30 mph)	Medium (30 to 40 mph)	High (>40 mph)
Very Low (<1,500 vpd, or 150 vph)	Quiet Street	Quiet Street	Cycle lanes	Cycle lanes or tracks
Low (1,500-3,000 vpd, or 150-300 vph)	Quiet Street	Quiet Street or Shared Use	Cycle tracks or lanes	Cycle lane or tracks
Medium (3,000-8,000 vpd, or 300-800 vph)	Cycle tracks or lanes	Cycle tracks or lanes	Cycle tracks or lanes	Cycle tracks
High (8,000-10,000 vpd, or 800-1,000 vph)	Cycle tracks or lanes	Cycle tracks or lanes	Cycle tracks or lanes	Cycle tracks
Very High (> 10,000 vpd)	Cycle tracks or lanes	Cycle tracks or lanes	Cycle tracks or lanes	Cycle tracks

Source: Adapted from London Cycle Design Standards (TfL, 2005)

Greater Manchester Cycling Design Guidelines [8]. This is almost right, the footway is included, but refers to non-inclusive design standard for footway widths. Also, no buffer treatment is given to the footway.

Table 5: Width requirements for different cycle link facilities

	Footway	Cycle Facility	Buffer	Traffic Lane [6]	Half Width [7]	Full Width [7]
CYCLE TRACK (1-way)						
Target	>2.0m	2.5m	>0.5m	3.5m	>8.5m	>17m
Desirable min	2.0m [1]	2.0m [3]	0.5m [5]	3.25m	7.75m	15.5m
Absolute min	1.8m [2]	1.5m [4]	0.3m	3.0m	6.6m	13.2m
CYCLE TRACK (2-way; on one side of the road only)						
Target	>2.0m	4.0m	>0.5m	3.5m	>10.0m	>15.5m
Desirable min	2.0m [1]	3.0m	0.5m [5]	3.25m	8.75m	14.0m
Absolute min	1.8m [2]	2.0m	0.3m	3.0m	7.1m	11.9m
HYBRID (TERRACED) CYCLE TRACK						
Target	>2.0m	2.5m	n/a	3.5m	>8.0m	>16.0m
Desirable min	2.0m [1]	2.0m [3]	n/a	3.25m	7.25m	14.5m
Absolute min	1.8m [2]	1.5m [4]	n/a	3.0m	6.3m	12.6m
MANDATORY OR ADVISORY CYCLE LANE						
Target	>2.0m	2.0m [3]	n/a	3.5m	>7.5m	>15.0m
Desirable min	2.0m [1]	1.75m	n/a	3.25m	7.0m	14.0m
Absolute min	1.8m [2]	1.5m [4]	n/a	3.0m	6.3m	12.6m
'LIGHT' SEGREGATION						
Target	>2.0m	>2.0m	0.7m [5]	3.5m	>8.2m	>16.4m
Desirable min	2.0m [1]	2.0m [3]	0.5m [5]	3.25m	7.95m	15.9m
Absolute min	1.8m [2]	1.5m [4]	0.3m	3.0m	6.6m	13.2m
SHARED FOOTWAY/CYCLEWAY (segregated)						
Target	>5.0m		>0.5m	3.5m	>8.5m	>17.0m
Desirable min	5.0m [1,2]		0.5m	3.25m	8.25m	16.5m
Absolute min	4.0m		0.5m	3.0m	7.0m	14.0m
SHARED FOOTWAY/CYCLEWAY (unsegregated)						
Target	>3.0m		>0.5m	3.5m	>6.5m	>13.0m
Desirable min	3.0m [1]		0.5m	3.25m	6.25m	12.5m
Absolute min	2.5m [2]		0.5m	3.0m	5.5m	11.0m

Notes:

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Chapter seven
A child-relevant response to air pollution

Air pollution is a big challenge in Bristol.

An estimated 300 death per year are attributable to air pollution in Bristol [1]. By comparison, 601 deaths are attributable to smoking [2]. Using the World Health Organisation's data for a ratio between deaths attributable to smoking and to passive smoking (1 to 0.145) [3], air pollution in Bristol is greater than passive smoking by a factor of 3.5.

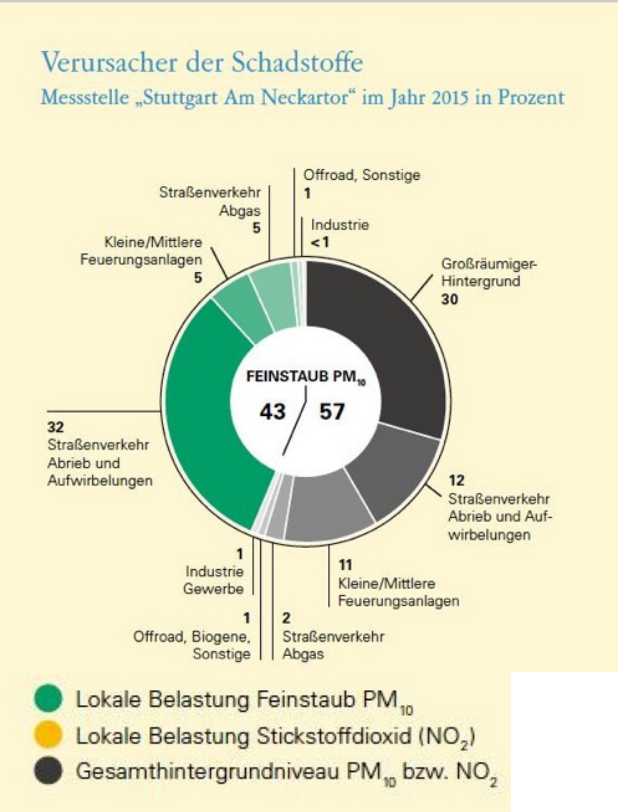
Air pollution in Bristol is equivalent to: On an average day, Bristol is a 1-2 cigarette/day city. On peak days, we are 4-7 cigarette/day city. For children & babies too.

It has taken a long time to accept the damage that smoking causes. Like smoking, damage from air pollution starts at low doses [20]. It is important to understand that the data for Bristol for $PM_{2.5}$ comes from a single off street monitor [21]. We know that air pollution is much worse along main roads and in vulnerable parts of the city [23].

Community groups say air pollution in Bristol puts them off walking [4] [5] [6] [7].

Less walking means more driving and more pollution. Recent research shows that in city and road settings, most fine particulate pollution (PM_{10} and $PM_{2.5}$) originates from brakes, tyres and road wear as well as from vehicle exhausts, and this all gets re-suspended again and again [8][9].

$PM_{2.5}$ are an important type of air pollution [8] [10] [11]. PM stands for particulate matter, meaning fine dust particles with an aerodynamic diameter of less than 2.5μm (or 0.0025mm). That means $PM_{2.5}$ are so small they enter our blood stream, heart and brain directly [8]. The public health evidence base for the negative health effects is well established and strong [11]. In a city like Bristol, $PM_{2.5}$ largely originate from wear and tear of vehicle tyres, brakes and the road which is re-suspended again and again [8] [9].



This is a graph from a recent study in Stuttgart, home of the car. This study found that 43% of particulate matter (PM10s) originated from re-suspension of wear and tear on roads, tyres and breaks from the local road and background greater city level [9]. Only 7% in total of PMs originated from exhaust.

Key statements from the Royal College of Physicians (2016) about air pollution [8]:

- "The most vulnerable suffer the most harm", this is particularly true for children and older adults in regards to air pollution.
- Children need clean air to develop their full lung capacity, and so do the rest of us.
- Air pollution is unfair, typically affecting those living in areas of deprivation who produce the least air pollution and have no choice in the matter.

The regulatory background around air pollution is evolving nationally and locally [12] [13] [14]. In addition to this, it is likely that the Health and Social Care Act 2012 places duties on local authorities to take a health-led approach to air pollution. In Bristol, this may particularly relate to

how we monitor $PM_{2.5}$ and manage short term peaks in $PM_{2.5}$.

Recommended Actions and Health Advice

Air Pollution Banding	Value	Accompanying health messages for at-risk individuals*	Accompanying health messages for the general population
Low	1-3	**Enjoy** your usual outdoor activities.	**Enjoy** your usual outdoor activities.
Moderate	4-6	Adults and children with lung problems, and adults with heart problems, **who experience symptoms**, should **consider reducing** strenuous physical activity, particularly outdoors.	**Enjoy** your usual outdoor activities.
High	7-9	Adults and children with lung problems, and adults with heart problems, should **reduce** strenuous physical exertion, particularly outdoors, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhaler more often. Older people should also **reduce** physical exertion.	Anyone experiencing discomfort such as sore eyes, cough or sore throat should **consider reducing** activity, particularly outdoors.
Very High	10	Adults and children with lung problems, adults with heart problems, and older people, should **avoid** strenuous physical activity. People with asthma may find they need to use their reliever inhaler more often.	**Reduce** physical exertion, particularly outdoors, especially if you experience symptoms such as cough or sore throat.

*Adults and children with heart or lung problems are at greater risk of symptoms. Follow your doctor's usual advice about exercising and managing your condition. It is possible that very sensitive individuals may experience health effects even on Low air pollution days. Anyone experiencing symptoms should follow the guidance provided below.

DEFRA'S health advice [15].

But DEFRA'S air quality index [24] does not relate to established health thresholds:

Air Pollution Banding	Value
Low	1-3
Moderate	4-6
High	7-9
Very High	10

$PM_{2.5}$ Particles

Based on the daily mean concentration for historical data, latest 24 hour running mean for the current day.

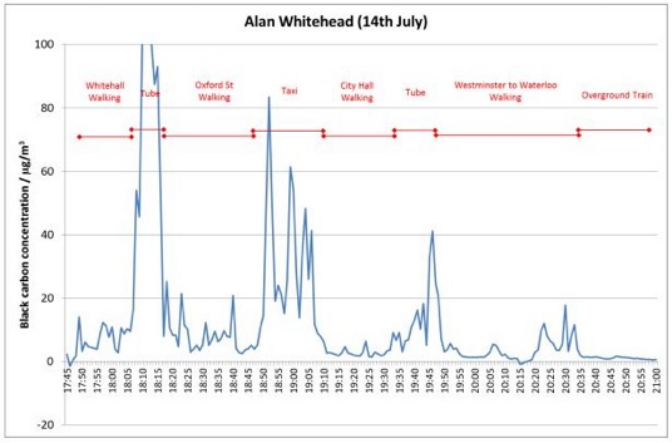
Index	1	2	3	4	5	6	7	8	9	10
Band	Low	Low	Low	Moderate	Moderate	Moderate	High	High	High	Very High
µgm^{-3}	0-11	12-23	24-35	>36-41	>42-47	>48-53	54-58	59-64	65-70	71 or more

WHO threshold 25 µg/m^3 24 hour running mean [25] or ≤3 cigarettes per day [20]

Exposure to air pollution can be highest in cars or vans as they are in the centre of the road [16] [17] [18] [19]. Professional drivers such as taxi, ambulance and van drivers can have some of the highest exposure to $PM_{2.5}$

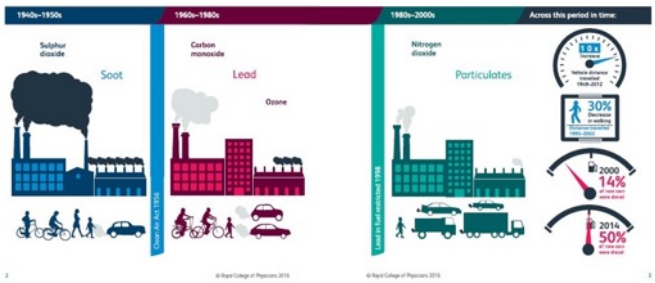
Alan Whitehead

The time series chart below shows measured black carbon pollution concentrations on the 14th July. The two tube Oxford Street and Whitehall are far higher than those around City Hall. The lowest levels were on the over ground

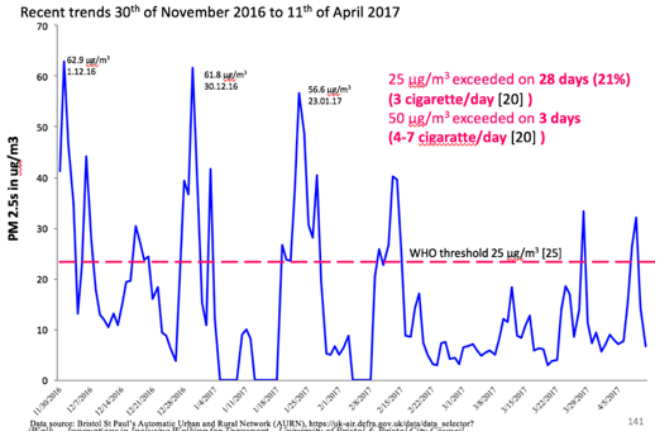


Daily journey of MP Alan Whitehead using a personal exposure monitor to measure black carbon (PM_6), highest exposure was on the tube and in a taxi [19]

There is no safe level of $PM_{2.5}$ [8] [10] [11]. Measurable health effects of $PM_{2.5}$ start from an annual mean of 2.4 µg/m^3 [8] [10] [11]. The current World Health Organisation (WHO) guidance recommends an annual mean of 10 µg/m^3, this value does not represent clean air but rather an achievable target [25]. UK guidelines for $PM_{2.5}$ are an annual mean of 25 µg/m^3 [36]. WHO guidance recommends not exceeding a 24-hour mean of 25 µg/m^3 on more than three days per year [25].



Air pollution is an ever shifting battle [8].



Bristol $PM_{2.5}$ – daily 24 hour averages of 24 hour running means [21]

These values are likely underestimates for main roads and vulnerable locations.

There is a single ambient air pollution monitor in St Pauls as part of DEFRAs Automatic Urban and Rural Network (AURN) [20]. A single, off road monitor for PM2.5s results in large discrepancy with readings in on-road and vulnerable settings. Using NO^2 as a comparison, annual NO^2 $\mu g/m^3$ for the St Pauls DEFRA monitor was 26.3 $\mu g/m^3$ in 2015 [22]. In contrast, readings for outside the Bristol Royal Infirmary show >90 $\mu g/m^3$ for the same year [23].

Figure 3.1 - Annual Nitrogen Dioxide at City Centre Locations

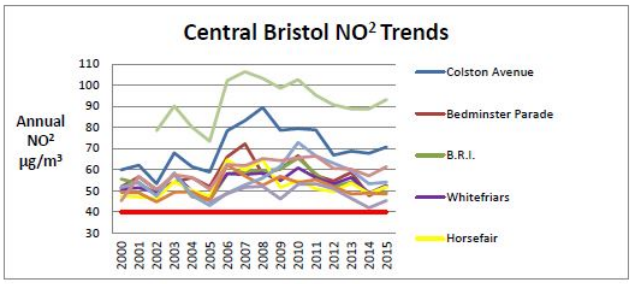


Table 2

WHO air quality guidelines and interim targets for particulate matter: 24-hour concentrations[a]

	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	Basis for the selected level
Interim target-1 (IT-1)	150	75	Based on published risk coefficients from multi-centre studies and meta-analyses (about 5% increase of short-term mortality over the AQG value).
Interim target-2 (IT-2)	100	50	Based on published risk coefficients from multi-centre studies and meta-analyses (about 2.5% increase of short-term mortality over the AQG value).
Interim target-3 (IT-3)[b]	75	37.5	Based on published risk coefficients from multi-centre studies and meta-analyses (about 1.2% increase in short-term mortality over the AQG value).
Air quality guideline (AQG)	50	25	Based on relationship between 24-hour and annual PM levels.

[a] 99th percentile (3 days/year).
[b] For management purposes. Based on annual average guideline values; precise number to be determined on basis of local frequency distribution of daily means. The frequency distribution of daily $PM_{2.5}$ or PM_{10} values usually approximates to a log-normal distribution.

WHO air quality guidelines for PM2.5s [25]

concern about episodic excursions. Meeting the guideline values for the 24-hour mean will however protect against peaks of pollution that would otherwise lead to substantial excess morbidity or mortality. It is recommended that countries with areas not meeting the 24-hour guideline values undertake immediate action to achieve these levels in the shortest possible time.

Multi-city studies conducted in Europe (29 cities) and in the United States (20 cities) reported short-term mortality effects for PM_{10} of 0.62% and 0.46% per 10 $\mu g/m^3$ (24-hour mean), respectively (Katsouyanni et al., 2001; Samet et al., 2000). A meta-analysis of data from 29 cities located

These threshold values are based on adults. What can we do to protect children?

Should cars come in standard green packaging with health warnings?

Real-time air pollution alerts e.g. Stuttgart, Germany [26]. Stuttgart is similar in Bristol in that is sits in a river basin. The Baden-Württemberg Department of Transport estimates that 50% of PM_{10} in Stuttgart are due to road traffic and 77% of $N0_2$ due to road traffic emissions. In order to reduce the number of days when PM_{10} exceed the EU threshold of 50 $\mu g/m^3$ daily mean (equivalent to 25 $\mu g/m^3$ for $PM_{2.5}$) when the German Meteorological Service issues a forecast for 2 days of still weather between October and April, a real-time air pollution alert is triggered:

- Residents are asked to not use their cars.
- Regional and city bus and public transport tickets are available at half-price.
- Use of "comfort" wood stoves and fireplaces is forbidden.
- Use of diesels which do not meet the EURO6 emissions standards is forbidden.

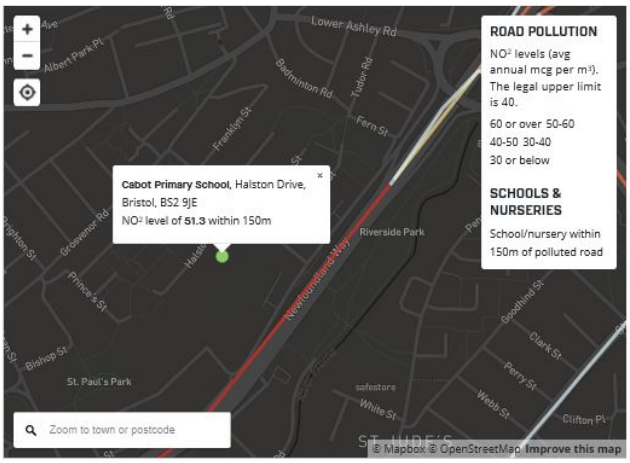
Paris, January 2017 – real time transport response to air pollution peaks [29]. Cars with even licences plate are banned from the city [29].

Tableau des seuils (niveau horaire)

	NO2	O3	SO2	PM10
niveau d'information	200 µg/m³	180 µg/m³	300 µg/m³	50 µg/m³ (en moyenne calculé sur la période entre 0 et 24 heures)
niveau d'alerte et de recommandation	400 µg/m³ 200 µg/m³ (si la procédure d'information et de recommandation a été déclenchée la veille et le jour même et si les prévisions font craindre un nouveau risque de déclenchement pour le lendemain)	1er seuil : 240 µg/m³ 2e seuil : 300 µg/m³ (dépassé pendant 3 heures consécutives) 3e seuil : 360 µg/m³	500 µg/m³ (dépassé pendant 3 heures consécutives)	80 µg/m³ (en moyenne calculé sur la période entre 0 et 24 heures)

Paris thresholds are triggered when >10% of the population is affected, or 100km2 area [28]. Individual pollutant threshold levels which trigger responses [28]

But is this enough to protect children? What is the threshold relevant for children?



Data sources: Modelled roadside NO² data for 2015 downloaded from Defra. School data from Edubase, early years data from Ofsted. Data reproduced under the Open Government Licence. Underlying datasets and base maps include information from Ordnance Survey data © Crown copyright and database, Royal Mail data © Royal Mail copyright and database, National Statistics data © Crown copyright and database.

Some schools in Bristol are at highly vulnerable locations near to roads with high or unmonitored pollution levels [30].

Key aspects of a child-relevant response to air pollution could include:

- Real-time health information.
- Real-time transport responses.
- Real-time measurement at the most vulnerable locations e.g. schools, hospitals, older adult homes, highly frequented public spaces.
- Pollutant thresholds relevant to children and older adults.

- Real-time health warnings for lock-down days:
  - Children should not play outside.
  - Older adults, people with pre-existing conditions including respiratory disease, asthma and cardiovascular disease should avoid going outside.
  - People with symptoms should avoid going outside.
  - Real-time transport responses lock-down days:
  - No cars/vehicles in the city without prior exception (e.g. Disabled people, emissions free taxis etc.)
  - Public transport free

- Real-time measurement at high risk locations:
  - At schools
  - At hospitals
  - At older adults centres.

Temporary changes to the road environment can make them a viable environment for children [32].

Healthy Transport Corridors Roads can be re-designed to create a child-enabling environment. Full vehicular circulation is maintained with added blue-green infrastructure functions [33].

Paris "Breathes" [34]. Areas of the city are closed through traffic on Sundays and holidays.

Barcelona "Superblocks" [35]. New road types

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Chapter eight
Amend the Highway Code to protect people walking

The UK Highway Code shows a bias towards motorised traffic, and places the burden of self-preservation on individuals walking. This interpretation requires further legal scrutiny, but is supported by national traffic risk data which shows that current traffic standards to do not provide equal levels of safety for people walking and car users [1] [2] [6].

Great Britain	**KSI/bn miles**
All Ages – 2013 [1]	
Pedestrians	**463**
Cyclists	**1036**
Car occupants	**24**

Absolute traffic risk as killed or seriously injured per billion miles - car travel is 19 times safer than walking per mile and 43 times safer than cycling per mile

In Bristol, as nationally, most collisions take place at junctions [3]. Traffic is leading cause of death for children aged 0-19 in UK [4] [5].

EXISTING
170
Take extra care at junctions. You should
- watch out for cyclists, motorcyclists, powered wheelchairs/mobility scooters and pedestrians as they are not always easy to see. Be aware that they may not have seen or heard you if you are approaching from behind
- watch out for pedestrians crossing a road into which you are turning. If they have started to cross they have priority, so give way.
- watch out for long vehicles which may be turning at a junction ahead; they may have to use the whole width of the road to make the turn (see Rule 221)
- watch out for horse riders who may take a different line on the road from that which you would expect.
- not assume, when waiting at a junction, that a vehicle coming from the right and signalling left will actually turn. Wait and make sure.
- look all around before emerging. Do not cross or join a road until there is a gap large enough for you to do so safely.

PROPOSED
170
Take extra care at junctions. You **MUST**
- watch out for cyclists, motorcyclists, powered wheelchairs/mobility scooters and pedestrians as they are not always easy to see. Be aware that they may not have seen or heard you if you are approaching from behind
- watch out for pedestrians crossing a road into which you are turning. If they have started to cross they have priority, you **MUST** so give way
- watch out for long vehicles which may be turning at a junction ahead; they may have to use the whole width of the road to make the turn (see Rule 221)
- watch out for horse riders who may take a different line on the road from that which you would expect
- not assume, when waiting at a junction, that a vehicle coming from the right and signalling left will actually turn. Wait and make sure
- look all around before emerging. Do not cross or join a road until there is a gap large enough for you to do so safely.

EXISTING
171
You **MUST** stop behind the line at a junction with a 'Stop' sign and a solid white line across the road. Wait for a safe gap in the traffic before you move off.
Laws RTA 1988 sect 36 & TSRGD regs 10 & 16

PROPOSED
171
You **MUST** stop behind the line at a junction with a 'Stop' sign and a solid white line across the road. **You MUST give way to pedestrians and cycle lanes crossing your direction of travel whether they are marked with a solid white line or not.** Wait for a safe gap in the traffic before you move off.
Laws RTA 1988 sect 36 & TSRGD regs 10 & 16

EXISTING

172

The approach to a junction may have a 'Give Way' sign or a triangle marked on the road.

You **MUST** give way to traffic on the main road when emerging from a junction with broken white lines across the road.

Laws RTA 1988 sect 36 & TSRGD regs 10(1),16(1) & 25

PROPOSED

172

The approach to a junction may have a 'Give Way' sign or a triangle marked on the road.

You **MUST** give way to traffic on the main road **including walking and cycling lanes which cross your trajectory whether they are marked or not** when emerging from a junction with broken white lines across the road.

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Chapter nine
Add near-misses and harassment to Fix-my-Street

Currently, near-misses experienced by people walking are not recorded in Bristol. Community consultation suggests that Disabled people and older adults may be put off from walking due to near-miss experiences [1] [2]. Tracking this would provided data on the prevalence of near-misses and potentially reveal if this related to geographic locations.

Equally, feeling safe while walking is important. National data shows large gender differences in feeling safe while walking home at night, with 38% of women not feeling safe walking home at night compared to 14% of men [3]. Local community groups confirm that street harassment is a serious issue restricting women's free movement in Bristol [4] [5].

Fix-my-Street is a national website and app which allows users to log problems in their street [6]. This data is sent directly to local authorities. Near-misses and street harassment could be added to this national database, to allow local authorities to identify and target key hotspots.

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Chapter ten
Raise the status of walking

Offer tax breaks per mile walked to work[1][2]:
- 41p/mile
- 1.5 miles commute one way (30 mins)
- 1.5 x 2 x 220 (work days) *0.41 p = £270
- Basic rate tax 20% = £54 savings per year.
- This doesn't seem enough, £270 would be meaningful [3].

Expenses claims:
- £1/mile

Walking to work reward schemes [4] [5]:
- Vouchers for shoes, backpacks, waterproofs.
- Umbrellas.
- Local city walking maps.
- Recreational & cultural walking maps.
- Air pollution face mask.
- A sports physiotherapy session.

Last thought:
Increasing population levels of walking for transport is not a "campaign" issue, but related to legal duties placed on local authorities through the Health and Social Care Act 2012 to promote public health through transport.
This needs further legal clarification to operationalise public health targets through transport practices.

REFERENCES – 10. Raise the status of walking.

The "Pendlerpauschale" is currently a tax break used in Germany and Austria, although this is offered for all modes of transport as a social support to employment rather than to promote healthy transport. An additional financial incentive is used by German national health insurance companies which offer up to 225 Euro annual reimbursement for physical activity courses each year. As for cycling, business engagement can be relevant for walking, not only as a behaviour change support to increase the number of people walking but to develop communication channels to capture business relevant needs related to walking for transport.

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