PRIORITISING HEALTH IN MOBILITY PLANNING

ASSESSING HEALTH AND CO-BENEFITS IN EUROPEAN SUSTAINABLE URBAN MOBILITY PLANS

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Contents

Transport policies that promote health can have major environmental and economic co-benefits and are critical for achieving the United Nations Sustainable Development Goals

1. Introduction

Health has implications for physical, mental and social wellbeing (World Health Organisation, 1946) and is a state where not only the needs of vulnerable individuals are met, but where the current and future good health is protected and promoted and health inequalities are reduced (Davis et al., 2019). Transport can influence health both positively and negatively through its impact on various detrimental and beneficial pathways such as road traffic injuries, air and noise pollution, and access to opportunities including public and green space for various users. Transport policies that promote health can have major environmental and economic co-benefits and are critical for achieving the United Nations Sustainable Development Goals (SDG) presented in the 2030 Agenda for Sustainable Development (UN, 2015).

The links between transport and health and wider co-benefits are increasingly recognised in European partnerships such as THE PEP (the Transport, Health and Environment Pan-European Programme) and European policies. For example, the European Member States of the WHO adopted a declaration[1] in 2023 which included a commitment to promote healthy, safe, climate-friendly and inclusive mobility and transport for all. This is to be achieved by developing and implementing policies and strategies to promote health, safety, climate-friendliness and active mobility and by creating favourable conditions and planning safe infrastructures for walking and cycling suitable for all populations.

The concept of Sustainable Urban Mobility Plans (SUMPs) and their associated guidelines were introduced in the European Commission's 2013 Urban Mobility Package (UMP) (European Commission, 2013). Sustainable Urban Mobility Planning is an integrated and strategic approach with the aim of supporting the transition towards sustainable mobility and enhancing the quality of life. It is a vision-led, fact-based and resilient approach designed to address the urban mobility challenges of the people and businesses in the entire functional urban area. It advocates a thorough assessment of the status quo and future trends, a shared vision that is operationalised into strategic objectives, and an integrated set of measures whose implementation should be systematically monitored (Rupprecht Consult, 2019). The European Commission has been advocating the widespread uptake of SUMPs as a cornerstone of European urban mobility policy. Furthermore, it proposes urban nodes on the trans-European transport (TEN-T) network to adopt a SUMP in order to meet SUMP-related requirements at the EU level (European Commission, 2023a). However, it is argued that higher-level strategies and guidance including the TEN-T network guidelines (European Commission, 2021b) miss a clear link between transport and health (Davis et al., 2022).

The relationship between SUMPs and health is recognised in a dedicated topic guide "Linking transport and health in SUMPs: how health supports SUMPs" (Davis et al., 2019) within a revised edition of SUMP guidelines (Rupprecht Consult, 2019). In this guide, a call is made for SUMPs to explicitly outline transport's pathways to health and include health promotion as an objective (Davis et al., 2019). Recent studies also emphasise that the link to health should be included as a standard in mobility frameworks and that appropriate indicators and methods of assessment should be used to assess the progress of SUMPs towards health targets (Lozzi and Monachino, 2021; Okraszewska et al., 2022).

To increase the attention to health in SUMPs, we first need to analyse their status quo in terms of health inclusion. However, few studies to date have tried to empirically investigate the degree to which health goals and methodologies have been incorporated into transport planning (Lozzi and Monachino, 2021). To address the above gap, we investigate the extent to which: i) health and its various aspects like health equity are included in current SUMPs, ii) transport pathways to health

[1] https://www.who.int/europe/publications/i/item/WHO-EURO-2023-3198-42956-69520

and their associated health outcomes in terms of increases or decrease in physical / social / mental wellbeing are made explicit, and iii) health is operationalised into targets and KPIs and the health-rationale of various actions and measures are elaborated.

To do so, we apply a mixed methods approach that combines quantitative text analysis of 230 SUMPs in the Eltis City database and a qualitative evidence synthesis of a purposive sample of 13 SUMPs across Europe. This report is arranged in six sections. Section 2 outlines the theoretical framework used to identify pathways from transport to health. Section 3 elaborates on our methodology. Sections 4 and 5 present the results of the quantitative text analysis and the qualitative evidence synthesis with good practice examples, respectively. Finally, Section 6 provides our conclusion and recommendations for including health in SUMPs.

2. Theoretical framework for pathways to health

Transport impacts health through various interlinked pathways. Several transport-Health frameworks have been suggested (Hannah et al., 1991; Khreis et al., 2017; van Wee and Ettema, 2016; Widener and Hatzopoulou, 2016). A recent and comprehensive framework is the work of Glazener et al. (2021) in which "transport" is the synergistic outcome of the interplay between four factors: i) land use and the built environment, ii) transport infrastructure, iii) transport mode choice, and iv) transport technologies and disruptors. Transport influences environmental exposures and lifestyles, or pathways to health by influencing factors which are beneficial and detrimental to health. Figure 1 shows a conceptual model of transport-health relationship, and Table 1 outlines the pathways and their link to transport and consequences for health (for more detail see Glazener et al., (2021)). These pathways were used in the subsequent work to identify the extent to which SUMPs included explicit references to how health could be promoted through transport strategies. (*See Section 5, sub-section "Transport pathways to health".*)

Figure 1. Transport-health relationship based on Glazener et al. (2021)

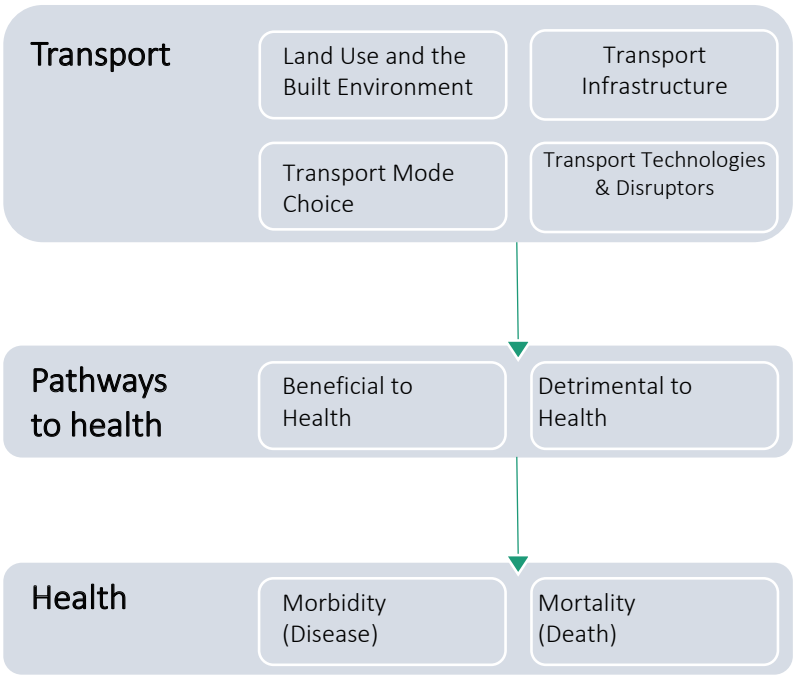


Table 1. Transport pathways to health and their health outcomes based on Glazener et al. (2021)

Pathway to health	Link to transport and consequences for health
Green and blue spaces and aesthetics	Transport can lead to the loss of areas covered with vegetation or water and unpleasant aesthetics in terms of the visual integration of transport facilities in the surrounding environment. Green or blue spaces can mitigate transport-related environmental exposures and can positively influence physical activity and mental health. Pleasant aesthetics can contribute to a sense of safety and comfort.
Physical activity	Physical activity involves body movement and is crucial for maintaining good physical and mental wellbeing, while physical inactivity can lead to obesity and various diseases. Policies promoting active travel and modal diversity can decrease physical inactivity and obesity and the various mental health problems associated with them.
Access	Access refers to the ability of individuals, including those with disabilities, to reach various opportunities and services such as jobs, education, leisure facilities, green / blue space, healthcare and healthy food. Interventions to increase access like complete streets and transit oriented development can reduce morbidity and mortality while accessibility poverty can lead to adverse (mental) health outcomes.
Mobility independence	Mobility independence is the ability to autonomously use various transport modes to access different facilities and activities. Availability of safe, affordable and independent transport modes can influence mental wellbeing, healthy ageing and in general the quality of life of individuals, especially vulnerable groups like older adults and children.
Contamination	Chemicals and pollutants like oils, gasoline, heavy metals, and lead from road traffic can contaminate the environment, leading to serious adverse health outcomes including renal dysfunction, arthritis and cognitive impairments. Impermeable road infrastructure increases the volume of polluted runoff, causing illness due to water and food source contamination. Alternative transport modes and eco-friendly road materials can help mitigate the health risks.
Social exclusion	Transport-related barriers regarding affordability, accessibility, appropriateness, location, time, and fear can hinder community participation and lead to social isolation, disproportionately affecting vulnerable groups. Social exclusion can reduce overall wellbeing through negative health outcomes like poor mental health, cardiovascular disease and stress.
Noise	Transport-related noise pollution, resulting from motorised vehicle sounds at detrimental levels has significant adverse physical and mental health effects including cardiovascular diseases, sleep disturbance, cognitive impairment and stress. Urban planning strategies that encourage active travel and alternative transportation modes can act as effective noise reduction measures.
Heat	Urban Heat Islands (UHIs) are urban areas that experience higher surface and air temperatures compared to their surroundings. Heat-absorbing transport infrastructure continue to expand and replace cooling elements like trees, influencing UHI intensity. The resulting increase in ambient temperatures and heat wave (intensity) cause significant morbidity and mortality.

Road traffic injuries	Road traffic injuries, often caused by motor vehicle collisions cause significant morbidity and mortality and are a major global health issue. Crash rates are higher for vulnerable road users like pedestrians and (motor)cyclists. Land use and transport strategies that reduce car dominance are associated with fewer road crashes.
Air pollution	Traffic-related air pollution disproportionately affects vulnerable communities and causes a wide range of adverse health outcomes from respiratory and cardiovascular diseases, neurodegenerative conditions, and mental health issues to reproductive problems, resulting in hundreds of thousands of deaths annually.
Community severance	Community severance refers to the division of communities and limitation of access to opportunities due to obstructive transport infrastructure and/or motorised traffic. It is highly correlated with reduced physical activity, stress, poor mental health, and overall reduced mobility independence and access, leading to morbidity and premature mortality.
Electromagnetic fields	Electromagnetic fields (EMFs) are produced by electrically charged particles and can be created near infrastructure for transport technologies and disrupters (autonomous, connected, electric and shared vehicles). EMF can potentially impact the reproductive system, cognitive development and nervous tissue. However, comprehensive research on the health consequences of transport-related EMF exposure is needed.
Stress	Transport can influence stress levels through commute mode choice, waiting / travel time, traffic noise and lack of green space availability, with health implications ranging from increased risks of acute illness and obesity to mental health issues and cardiovascular conditions.
Greenhouse gases	Transport sector is a major GHG producer and contributor to climate change. Climate change can exacerbate the detrimental health effects of air pollution, urban heat islands and physical inactivity. It can also increase extreme weather events and rates of infectious disease transmission and displacements, resulting in adverse mental and physical health.

3. Research methods

A three-step mixed methods approach (Figure 2) was used to review existing European SUMPs from the health perspective:

1. A *health dictionary (Annex 1)* and a *policy analysis checklist (Table 4)* were developed to assess the extent to which SUMPs address health. For this, we extracted health themes, keywords and pathways from two sources: i) the theoretical framework (Section 2), and ii) a review of existing literature on SUMPs and health.

   - We opted to build a custom dictionary due to there not being an already existing health dictionary that fit our purposes. The dictionary was compiled starting with the key terms in English identified in the previous step and then further refining the list of terms, including different variations of words to be sure to capture variations in other languages when translating, and then allocating the words into three separate *custom sub-dictionaries* for more precise analysis of different topics: i) health, ii) equity, and iii) health pathways (Table 3). The keywords were first translated using Google Translate then validated by native speakers of all 22 languages except for five (Croatian, Danish, Estonian, Lithuanian, and Norwegian).

   - For the policy analysis checklist, we identified four papers through an exemplary review of the literature that analysed multiple SUMPs from a health perspective, including 3 multi-country studies, one with multiple cities in Portugal and another with major cities in Italy (Table 2).

   - The health dictionary and the policy analysis checklist were then extended in an iterative process of initial SUMP analysis looking at sample SUMPs from the countries of the paper's authors and in collaboration with the European Public Health Alliance (EPHA).

2. A *quantitative text analysis* was carried out on 230 SUMPs (blue dots in Figure 3) extracted from the Eltis City database of urban mobility plans using the health dictionary from step 1. (*See the "Quantitative text data snapshot" in the next section for more details on the dataset used.*) Using R, we subset the text by language, pre-processed the text, then applied the three sub-dictionaries to determine i) the frequency of words from the dictionary to generate "top words", and ii) "scores" for each of the overarching concepts (health, equity, and health pathways) – the ratio of number of times the key words are included to the total number of words in the SUMP text. This analysis aimed to provide an overall understanding of the extent to which health is mentioned in SUMPs, without necessarily determining which SUMPs are superior in terms of health aspects. (*See Annex 5 for quantitative analysis methodology notes.*)

3. The findings from the previous step were validated with an in-depth analysis of a purposive sample of 13 SUMPs (red dots in Figure 3). This involved a *qualitative evidence synthesis* (Grant and Booth, 2009) – a method which uses purposive sampling to link and compare the results of qualitative studies– using our policy analysis checklist.

   To choose the purposive sample, we first performed a quantitative scan of all SUMPS based on a simplified "health score" (i.e., ratio of the number of times "health" was mentioned to the total word count). We used this indicator as a proxy for determining how much health is emphasised in each SUMP. We then removed the documents with no mention of health and organised the remaining SUMPs into quintiles, representing a range from documents with minimal references to health to those with extensive mentions of it.

We chose the final sample (Table 8) based on the following considerations:

- covering the spectrum from low to high health scores,
- maximising the diversity of the countries based on the language expertise in the team (UK, Ireland, France, Germany, Austria, Finland, Netherlands, Belgium) and EPHA and its partners (Italy and Bulgaria),
- ensuring a representative spread of European countries with different stages of socioeconomic development and planning regimes,
- including a range of cities and regions from small (Delft, the Netherlands, with 100K inhabitants) to large (Île-de-France region, France, with 6,715K inhabitants), and
- including publication dates ranging from late 2000s to early 2020s.

Figure 2. The three-step approach

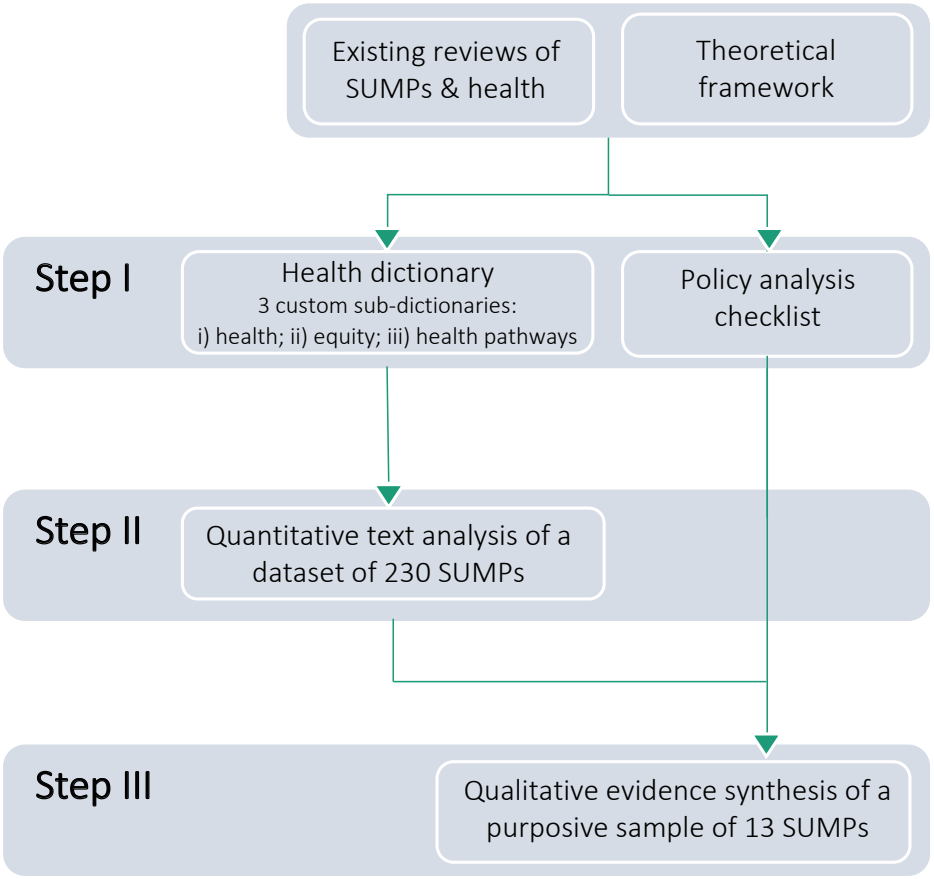


Figure 3. SUMPs analysed by the quantitative text analysis (blue dots) and those also included in the purposive sample (red)

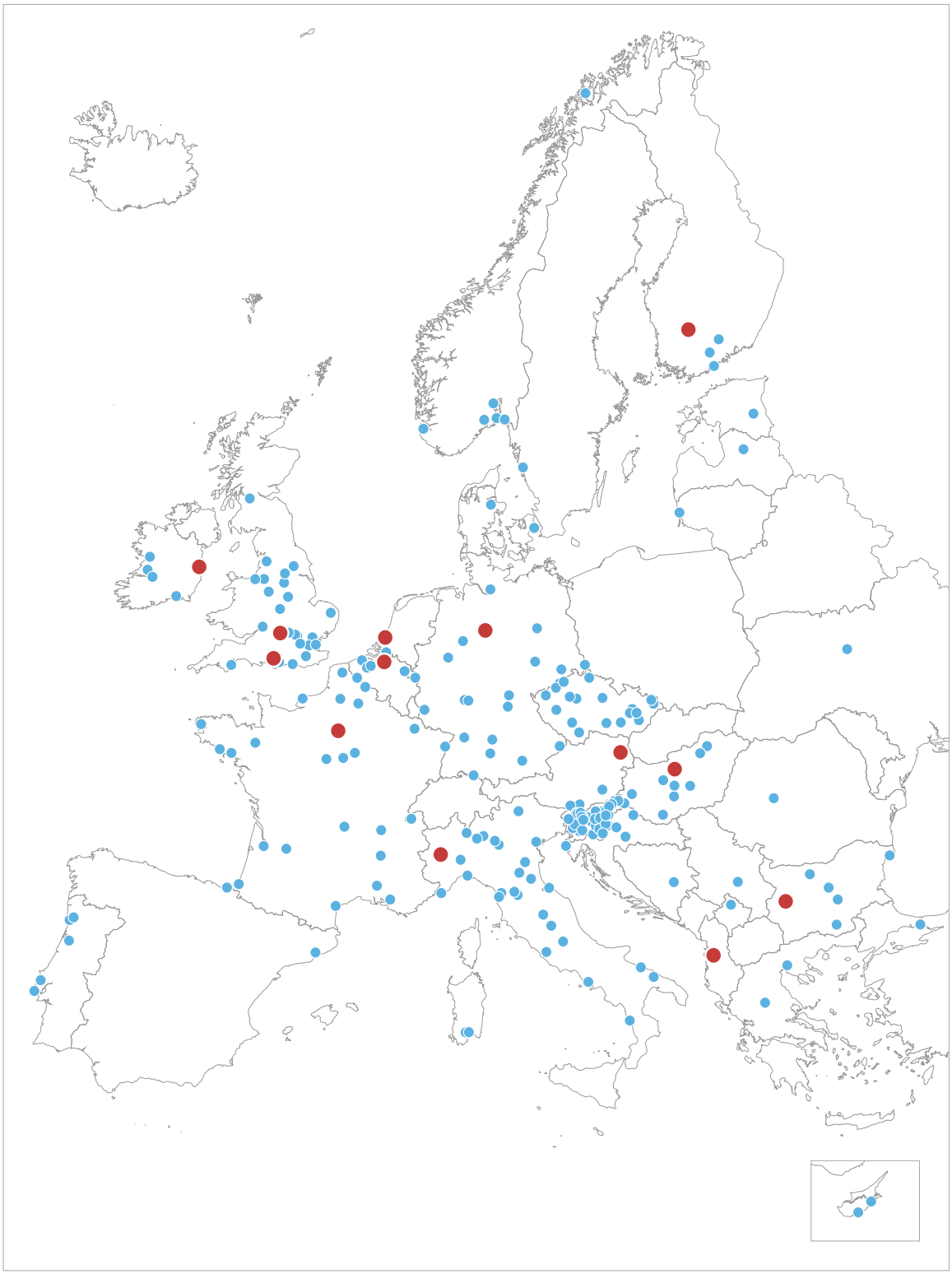


Table 2. Existing reviews of SUMPs and health

Author (year)	Arsenio et al. (2016)	Cirianni et al. (2018)	Maltese et al. (2021)	Lozzi and Monachino (2021)	Okraszewska et al. (2022)
Focus	Social equity and climate change	Objectives & actions to promote cycling & pedestrian mobility	Active travel (AT)	Health considerations (health objectives and assessment methods)	SUMPs implementation process and indicators to evaluate effects on physical activity
Cases, locations	40 pilot cities for SUMPs, Portugal	6 cities in 6 countries: Aberdeen (UK) Bremen (Spain) Rivas-Vaciamadrid (Spain) Malmo (Sweden) Vienna (Austria) Marseille (France)	Major Italian cities	European, national and local; 4 cities and their respective countries: Lisbon (Portugal) Paris (France) London (UK) Rome (Italy)	5 cities in 3 countries: Copenhagen (Denmark) Gdynia (Poland) Wroclaw (Poland) Stuttgart (Germany) Ulm (Germany)

Table 3. English search keywords for 3 custom sub-dictionaries for: i) health, ii) equity, and iii) health pathways (non-exhaustive – See Annex 1 for full dictionary)

Sub-dictionary	Keywords
Health	General: (public/mental/physical) health; healthy; healthcare; wellbeing; quality of life; liveability
	Detrimental to health: obesity; morbidity; mortality; (chronic) cardiovascular/ respiratory/pulmonary disease; diabetes; cancer
	Methods and indicators: Health impact assessment (HIA); Disability-adjusted life-year (DALY); years of life lost (YLL)
	Entities: Centre for disease control (CDC); European Centre for disease control (ECDC); World Health organisation (WHO); National Health service (NHS)
Equity	equity; inclusivity; justice; disability; social life; social cohesion; community; jobs/ employment; affordability; costs; independence; vulnerability
Health Pathways	motor vehicle crashes; road travel injury; air pollution; noise; green space; aesthetics; physical activity; community severance; social exclusion; electromagnetic field; greenhouse gases; urban heat island; accessibility; contamination; independence; stress

Table 4. Policy analysis checklist

Category	Question
Frequency and position	‣ How many times is health* mentioned?
	‣ What other terms is health mentioned in combination with? How often?
	‣ Is a health entity or health agreement mentioned?
	‣ Is a health indicator or a health assessment method mentioned? Which?
	‣ Is there a dedicated (sub)section on health?
	‣ What is the ratio of health-related words to all words in the document?
Urgency	‣ Is the urgency of addressing health issues established?
Definition & nature of reference	‣ Is health enhancement / a healthy city mentioned as a desired future in the vision?
	‣ Is a “healthy” future defined (or just name dropped)?
	‣ Is health enhancement mentioned specifically as an objective?
	‣ Is there a specific health-related target/indicator?
Health-transport relation	‣ Is any transport-health pathway explained? Is the health-based rationale for a measure explained?

* Includes the variants of health (e.g., healthy, unhealthy, healthier)

4. Quantitative text analysis

Quantitative text data snapshot

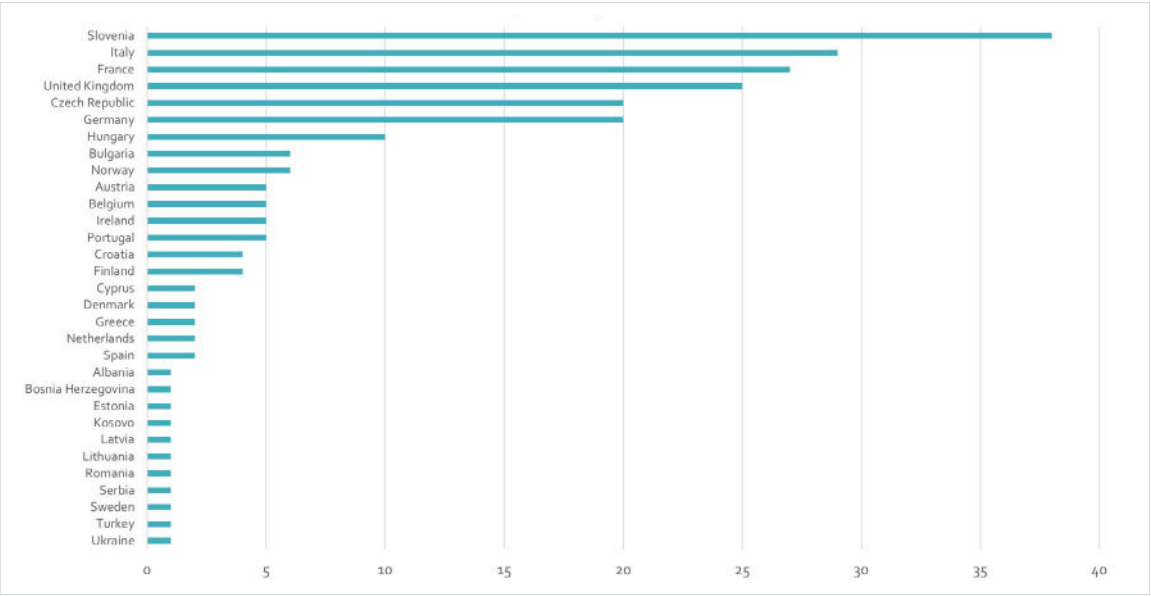
The Eltis database of cities that have made their SUMPs available online contained 631 entries when the dataset was downloaded on 28 June 2023. Following initial data cleaning, there were 596 unique cities in the dataset. In the end, SUMP texts were possible to collate for 230 of these cities, located in 31 different countries and in 22 different languages.

Many SUMP texts were not accessible for analysis for a variety of reasons: i) the principal reason being that the referenced websites were unresponsive or no longer existing; ii) to a lesser extent because it was not possible to locate the SUMP on the websites (and so possibly did no longer exist); and iii) for some, because the SUMP did not actually exist yet (i.e., the cities only had a page about SUMP development but no actual SUMP). There were also several duplicates in the original list, including some with different spellings, while other cities in the same agglomeration were using the same agglomeration's plan.

There was a large variety in length and detail in the sample, with SUMPs ranging from a couple dozen pages to over 600 pages based on the ones encountered during the data collection. The total number of words[2] was an average of 20,268 and median of 13,040. There also was much variation in the number of SUMPs per country, ranging from 1 to 38, with an average of 7.4 plans per country and median of 2 plans per country. Slovenia had the highest number of SUMPs, with 38, followed relatively closely by Italy (29), France (27), the UK (25), and the Czech Republic and Germany (20 each) (Figure 4).

One main reason for the large variation in number of SUMPs per country seems to be what is required by the national governments and how much support is provided by national and regional governments – for example, some of the countries with higher numbers require certain cities to have a SUMP (e.g., with populations above 100,000, such as in France (Eltis, 2019) and Italy (Eltis, 2022)), while some require cities to have a SUMP to be able to access funding and/or provide for the development of SUMPs (such as in Belgium (Durlin et al., 2018) and Slovenia (Tinga, 2018)).

Figure 4. Number of SUMPs per country in dataset

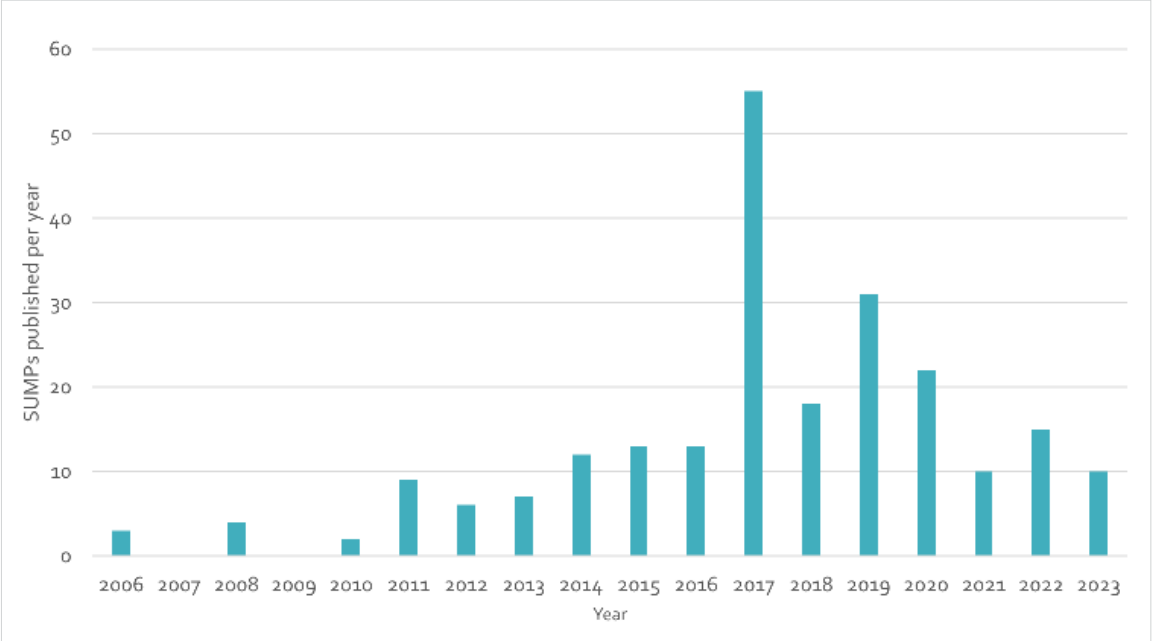


[2] Here this refers to individual words after text cleaning (e.g., removing numbers, stop words, etc.) - referred to as "tokens" in quantitative text analysis.

The publication year of the extracted SUMPs ranged from 2006 to 2023, with the average year being 2017. Countries with at least 20 SUMPs in the dataset appear to have regularly published SUMPs over this timeframe, spread out relatively evenly, with the exception of Slovenia and Italy, both of which saw a large number of SUMPs published during a single year – 2017 and 2019, respectively (Figure 5 and Annex 2).

The peak in 2017 was mainly due to the large number of Slovenian cities in the dataset publishing SUMPs that year (33). This corresponds with EUR 20 million from the Operational Programme of European Cohesion Policy being made available to Slovenian cities through a tender in October 2015 for SUMP development and other SUMP-related activities, leading to a total of 62 SUMPs being published in the country by mid-2017 (Tinga, 2018). The second smaller peak in 2019 was due in large part to 11 Italian cities in the dataset publishing SUMPs that year. This corresponds with supportive laws being approved in Italy, including mandating the adoption of a SUMP for all cities with populations over 100,000 starting in 2019 (Eltis, 2022).

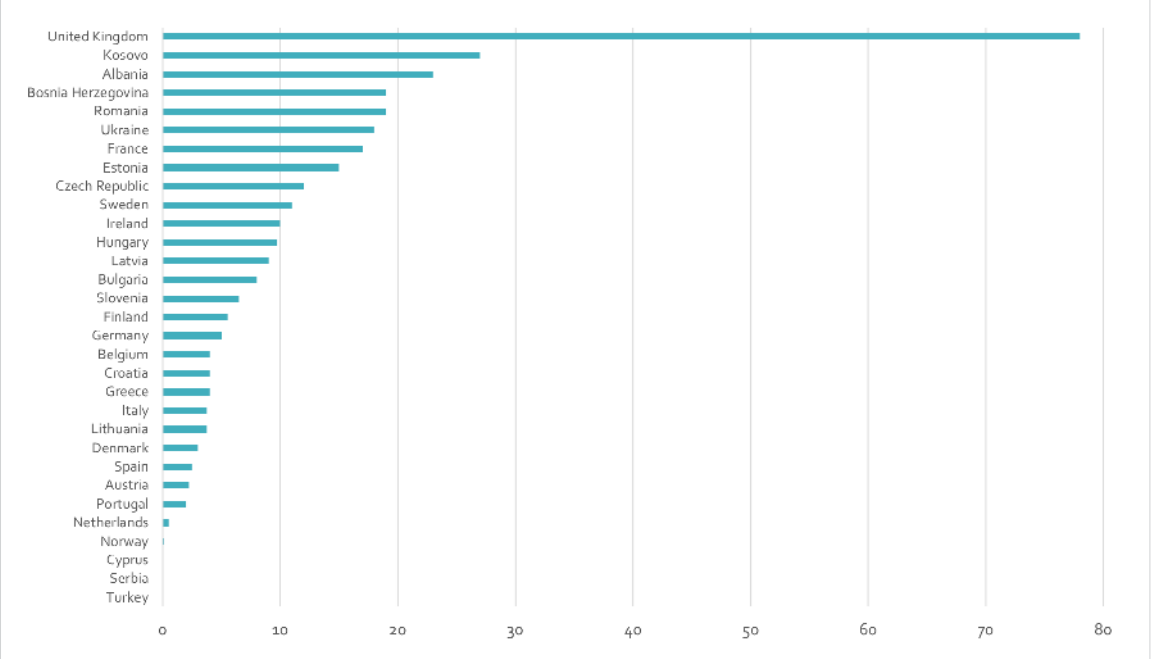
Figure 5. Number of SUMPs in dataset published per year



Quantitative text analysis results

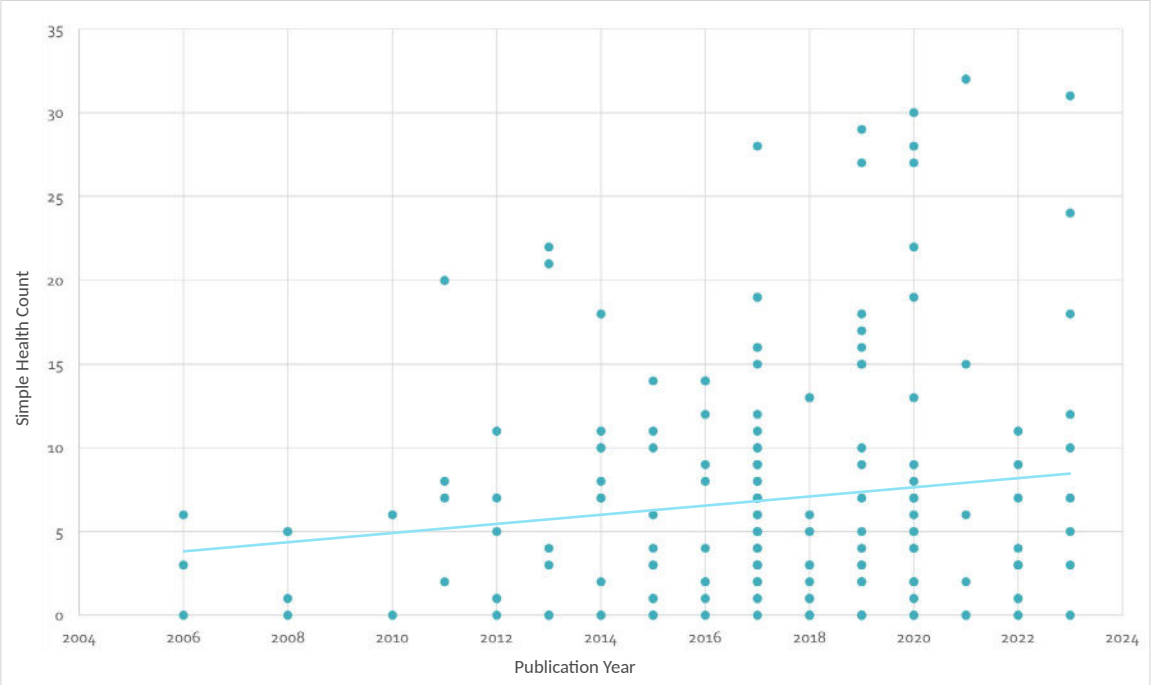
To get a general picture of the coverage of the word "health" in the 230 SUMPs in the dataset, we first looked at simple "health" count by country. This includes the total *count of "health" and its variants (e.g., healthy, unhealthy, healthier). Here, the United Kingdom came in first with an average of 78.6 mentions of "health" and its variants, followed distantly by other countries (Figure 6*). For comparison, the overall average mention of "health" and its variants across the entire dataset was 15.6. The top 5 cities for this count were also from the United Kingdom: Nuneaton and Bedworth, Oxford, London, Southampton, and Gloucestershire. On the other hand, some cities (34 out of 230) did not mention "health" or its variants a single time.

Figure 6. Simple health count (the mentions of "health" and its variants) in SUMPs in dataset, by country



We had observed anecdotally outside of this analysis that it seemed that health was increasingly important in mobility planning. When looking at this graphically using our dataset and the total count of "health" and its variants per SUMP, an upward trend is indeed apparent of the inclusion of health increasing over time (Figure 7).

Figure 7. Timeline of simple health count (the mentions of "health" and its variants), in SUMPs in dataset, outliers removed

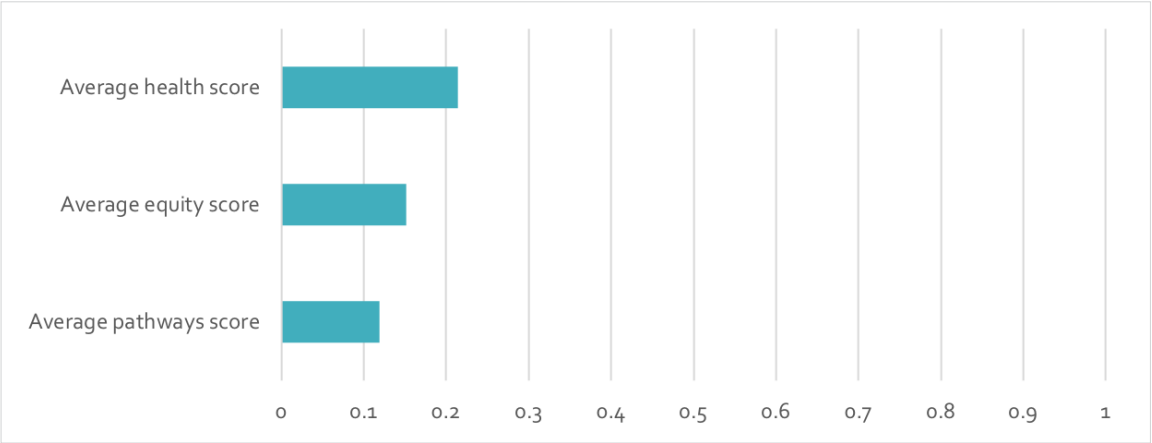


Following this, the three custom sub-dictionaries – health, equity, and health pathways – were applied to the SUMPs to obtain a more nuanced picture of their coverage of health and related concepts. While the first analysis above captured the *word* "health" and its variants, this second analysis sought to capture the broader *concept* of health. This was done by measuring the inclusion of the many different health-related terms that were selected for our custom sub-dictionaries as a more comprehensive measure of the overall inclusion of health concepts in the SUMPs (see Annex 1 for the list of terms in the sub-dictionaries).

The application of the sub-dictionaries revealed that overall, the 230 SUMPs included the highest number of key words from the health pathways sub-dictionary, followed by equity and then health. In terms of overall average score, however, the health pathways sub-dictionary's normalised average score[3] was 0.12/1. In comparison, the SUMPs' overall average health score using the custom health sub-dictionary was highest, at 0.21/1. The focus on equity concepts as measured by the equity sub-dictionary came in second among the three sub-dictionaries, with an overall average score of 0.15/1 (Figure 8). Per sub-dictionary, some top scorers emerged:

- The top score for the health sub-dictionary among countries was Spain (0.59/1), followed by Latvia (0.56/1) and the United Kingdom (0.53/1). The top cities were Granollers (Spain), Wirral (UK), and Norwich (UK).
- For the equity sub-dictionary, Turkey and the United Kingdom tied for the top score with 0.46/1, followed by Latvia (0.37/1). Top cities included Glasgow, Wirral, and Thurrock (UK).
- For the pathways sub-dictionary, Denmark was by far the leader with 0.72/1, followed by Ukraine (0.48/1) and Cyprus (0.41/1). The top cities for this category were Copenhagen (Denmark), Torres Vedras (Portugal), and Delft (the Netherlands).

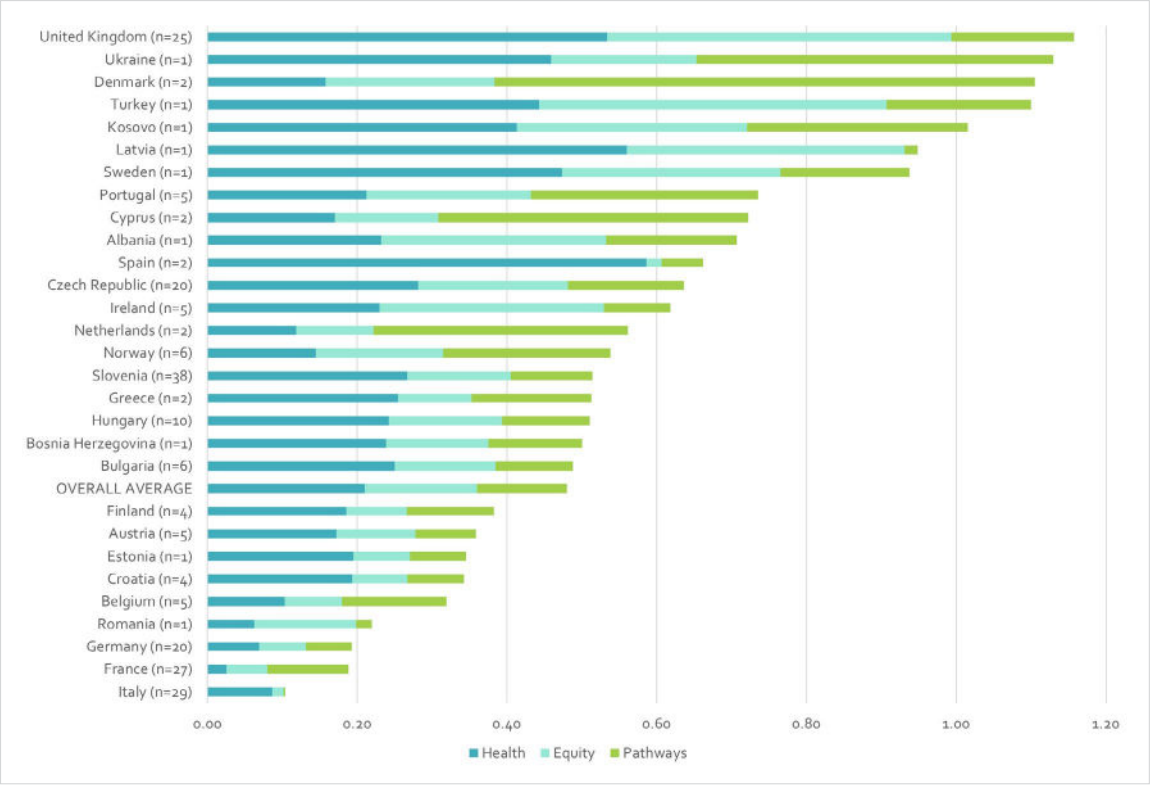
Figure 8. Overall average score per sub-dictionary for all SUMPs across all countries in dataset, normalised



[3] The "score" is the ratio of the sub-dictionary's key words in a SUMP to the total number of words in that SUMP, normalised to scale the value to a range between 0 and 1 (using min-max normalisation).

In summing the scores from the three sub-dictionaries for each country, the result could be considered an overall health score – encompassing not only explicit health-related terms but also equity-related terms and those related to health pathways. The top countries in this regard were the United Kingdom (1.16/3), Ukraine (1.13/3), Denmark and Turkey (each 1.10/3), and Kosovo (1.02/3) (Figure 9). (*See Annex 3 for full list of scores by country.*)

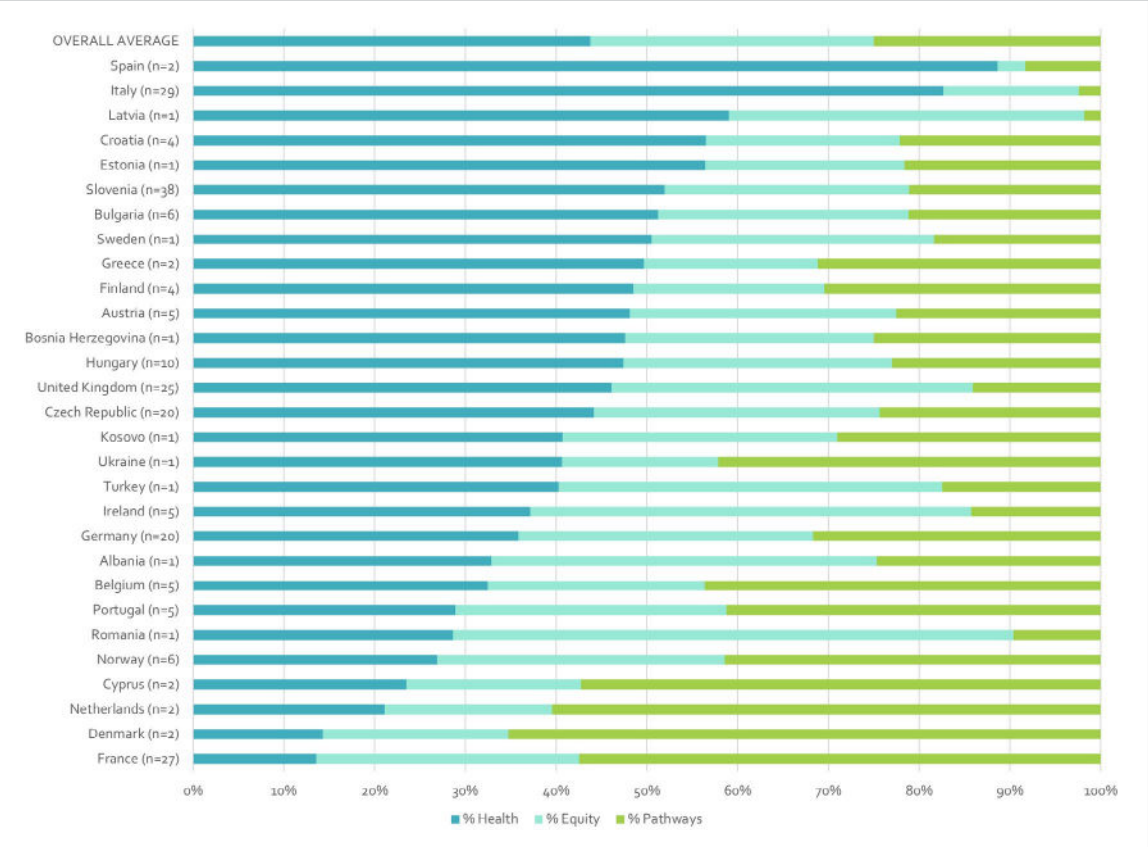
Figure 9. Cumulative scores from each sub-dictionary, by country



The relative focus on the three sub-dictionaries varied across the different countries in the dataset (Figure 10).[4] SUMPs in nine countries placed more than 50% emphasis on health on average compared to equity or pathways, with two countries (Spain and Italy) placing significantly more relative emphasis on health (greater than 80%). Only one country (Romania) saw more than 50% relative emphasis on equity in its SUMPs, while four countries saw more than 50% relative emphasis on pathways in their SUMPs (Denmark, the Netherlands, Cyprus, and France).

4 The number of SUMPs in each country should be taken into consideration, as those with fewer SUMPs should not necessarily be considered representative of the language overall, while those with higher numbers might be considered more representative.

Figure 10. Share of relative focus on health vs equity vs health pathways words in SUMPs, by country (Note: Lithuania and Serbia not shown in figure due to scores of 0 for each dictionary. See Annex 3.)



In looking more in detail at the words most mentioned in SUMPs from the three sub-dictionaries, we can see a further nuanced picture of which aspects within the sub-dictionaries are emphasised more than others. This can further provide an idea of the relative importance of the different concepts based on the number of times policymakers have included a mention of them in the SUMPs. To that end, the top 20 most mentioned unique words from the sub-dictionaries were compiled from each language subset of SUMPs, and they were then combined into a single list with similar concepts grouped (Annex 4).

Across all the key terms in the three sub-dictionaries, terms related to *cycling* (from the pathways sub-dictionary) and *access/accessibility* (from the equity sub-dictionary) appeared to be the most important – nearly tied for the top number of mentions across all SUMPs with 4556 and 4371 mentions, respectively. Following these, were terms related to *safety/security* (2933), *walking/ pedestrians* (2628), and *health* (2422) (Figure 11).

Figure 11. Word cloud of most frequently mentioned key words in SUMPs from the three sub-dictionaries, combined across all languages

Specifically for the health sub-dictionary, words relating to security and safety topped the list with 2933 mentions across the 230 SUMPs, while "health" and its variants were a close second with 2419 mentions (Table 5). On a lower level were words related to activity (889) and risk (841), followed more distantly by words related to sports/fitness (456), and accidents (365). Others above 100 mentions included words related to death (238), care (211), and injury (128).

Table 5. Top words in SUMPs from health sub-dictionary application, combined from all languages

Top words from health sub-dictionary	Frequency
secur*/safe*	2933
health*	2419
activ*	889
risk*	841
fit*/sport*/exercise	456
accident*/crash*/collision*	365
dead*/death/kill*/mortality/fatal/casualt*	238
care	211
injur*	128
quality of life/liveability	98
disease*/ill*/sick*	66
NHS (or equivalent)	60
medical	36

anxiety/stress	32
welfare	31
cardio	19
dangerous	14
relax*	12
WHO	10
CDC	8
lifespan	7
sanitary	3
lung	1

For the equity sub-dictionary, words relating to access and accessibility were by far the most mentioned, at 4371 times – surpassing the top words from the health sub-dictionary (Table 6). The next most important words related to cost (1504), inclusivity (1393), and social aspects (1190), followed more distantly by words relating to jobs (633), affordability (300), equality/equity (269), community (147), and disability (125).

Table 6. Top words in SUMPs from equity sub-dictionary application, combined from all languages

Top words from equity sub-dictionary	Frequency
access*	4371
cost*/expens*	1504
inclusiv*	1393
social*	1190
employ*/job*/work*	633
afford*	300
equal*/equit*	269
community	147
disabilit*/disable*/handicap*	125
fair*/justice	57
society	34
vulnerable	5

Among key terms for health pathways, biking/cycling topped the list not only in this sub-dictionary but across all sub-dictionaries, at 4556 mentions, surpassing the number of mentions of access/accessibility as the top word in the equity sub-dictionary (Table 7). This was followed by words relating to walking/pedestrians (2628), speed (1148), noise (975), green (855), emissions (829), and more distantly by words relating to clean (286), pollution (206), and congestion (126). This overwhelming focus on cycling over walking may be due to many cities already having basic pedestrian infrastructure but not necessarily the basic infrastructure for cycling, and/or due to walking already being more common than cycling in many places (Partnership on Sustainable Low Carbon Transport, 2023).

Table 7. Top words in SUMPs from health pathways sub-dictionary application, combined from all languages

Top words from pathways sub-dictionary	Frequency
bicycl*/bik*/cycl*	4556
walk*/pedestrian*	2628
speed	1148
noise/loud	975
green	855
greenhouse gas*/emission*	829
clean	286
pollut*/air quality/smog	206
congestion/traffic jam*	126
renewable	41
traffic calm*	25
aesthetics	5
independen*	4

5. Qualitative evidence synthesis

This section presents the qualitative evidence synthesis findings under four subsections on SUMPs' health characteristics, health as an objective in SUMPs, specified transport pathways to health and operationalisation of health. State-of-the-art and best practices for each subsection are demonstrated in the tables using examples from the purposive sample. Quotes from the SUMPs not written in English are translated by the authors familiar with the SUMP's language. Table 8 shows the overview of the purposive sample resulting from step 3 described in the research methods section.

Table 8. Purposive sample overview

#	Location	Inhabitants urban centre*	Name	Year	Simple count of "health"**	Normalised health score***
1	Antwerp (Belgium)	490K	Active and accessible Antwerp; Mobility plan 2020, 2025, 2030	2015	8	0.19
2	Budapest (Hungary)	1,736K	Budapest Mobility Plan 2030	2019	13	0.59
3	Delft (the Netherlands)	100K	Mobility program Delft 2040; Our Delft, sustainably accessible	2020	1	0.19
4	Dublin (Ireland)	1,260K	Transport Strategy for the Greater Dublin Area 2016-2035	2016	12	0.19
5	Hannover (Germany)	520K	Mobility Master Plan 2025	2011	7	0.09
6	Île-de-France (France)	6,715K	Urban travel plan	2014	49	0.02
7	Oxfordshire (UK)	152k	Local Transport and Connectivity Plan 2022 - 2050	2022	234	0.63
8	Sofia (Bulgaria)	1,170K	Mobile Sofia 2035; Sustainable mobility for everyone	2019	15	0.13
9	Southampton (UK)	250K	Connected Southampton Transport Strategy 2040	2019	113	0.52
10	Tampere (Finland)	200K	Sustainable Urban Mobility Plan	2021	15	0.65
11	Tirana (Albania)	418K	Sustainable Urban Mobility Plan for the City of TIRANA	2020	22	0.23
12	Turin (Italy)	872K	Urban plan of sustainable mobility	2008	5	0.03
13	Vienna (Austria)	1,867K	STEP 2025 Thematic concept; Urban Mobility Plan Vienna; Together on the move	2015	4	0.34

* From Eltis City database; ** Including its variants (e.g., healthy, unhealthy, healthier); ** The ratio of the number of times "health" was mentioned to the total word count, normalised to a range between 0 and 1 (using min-max normalisation).

SUMPs' health characteristics

Health, well-being and quality of life are mentioned to various degrees in the reviewed SUMPs, especially in more recent documents. All documents have some analysis of the mobility situation and mobility trends are usually discussed, while health-related status-quo and trends are often not described. Most documents mention the adjective healthy, which is usually combined with "city" (and its different forms such as healthy urban/living environment). Healthy streets (or place), healthy mobility, and healthy lifestyles (or living, behaviour) are also mentioned, but to a lesser extent. When health is discussed, the focus is on physical health while social and mental wellbeing receive much less attention.

Many SUMPs touch on equity or inclusivity in terms of ease of access to opportunities and/or ease of movement for vulnerable groups, but very few elaborate on the fact that transport and its related policies could have unequally distributed health impacts across space and society. Examples are Oxfordshire and Southampton, where the transport's role in health inequality and the importance of addressing it is highlighted. For instance, Southampton explains that: "Residents in areas of high levels of deprivation have fewer opportunities to access jobs, health care and leisure opportunities. Residents in these areas can encounter higher levels of air pollution, and live closer to major roads which sever their communities."

Many SUMPs argue the urgency of addressing health pathways, often underscoring their commitment to reduce traffic injuries and air pollution. However, a direct emphasis on the urgency of prioritising health protection and promotion and the aim to protect and promote it is hardly articulated, except in select recent SUMPs. Being healthy is often mentioned in the vision (e.g., healthy city, healthy mobility, a better urban environment for a healthy lifestyle), especially in the more recent documents. Yet, there is not always a clear-cut definition presented for what constitutes a healthy city (see next subsection, *Health as objective*). Few documents have (sub)sections specifically dedicated to health. Of these, some focus on environment and health and well-known pathways such as road traffic injury, air pollution and noise (e.g., Antwerp and Île-de-France), while few touch on other pathways such as physical activity and green spaces (e.g., Delft, Oxfordshire and Vienna) (Table 9).

Table 9. Examples of SUMPs with a dedicated section on health

City	Explanation
Antwerp	Has a subsection on Environment and health, almost exclusively focusing on strategies for reducing noise exposure.
Delft	Has a section on "social aspects of mobility", including the subsection "mobility and health" where the link between active travel and green spaces and health is explained. There is also a subsection on "transport poverty", but the health consequences of the issue are not discussed.
Île-de-France	Has a section dedicated jointly to health and the environment, focusing only on protection from detrimental impacts of transport (air pollution, noise and road traffic injury) and does not mention opportunities for health enhancements (e.g., physical activity, green spaces).
Oxfordshire	Has 'health' as one of the six themes of its vision. Most of the policies defined have a subsection dedicated to health, including a policy focus area on "Healthy place shaping".
Vienna	Has a section on a specific objective of being healthy, explaining the effects of active mobility on noncommunicable diseases, the opportunities for encounters and communication as well as the goal to further reduce accidents, pursuing a Vision 0 approach.

Health as an objective in SUMPs

Health on its own is scarcely mentioned as an objective. While many of the objectives have health implications, their link to health is not explicitly underlined. Few SUMPs specifically emphasise health promotion as their objective (e.g., Oxfordshire, Southampton, Vienna), some, like Île-de-France only mention health protection and safeguarding the quality of life (Table 10).

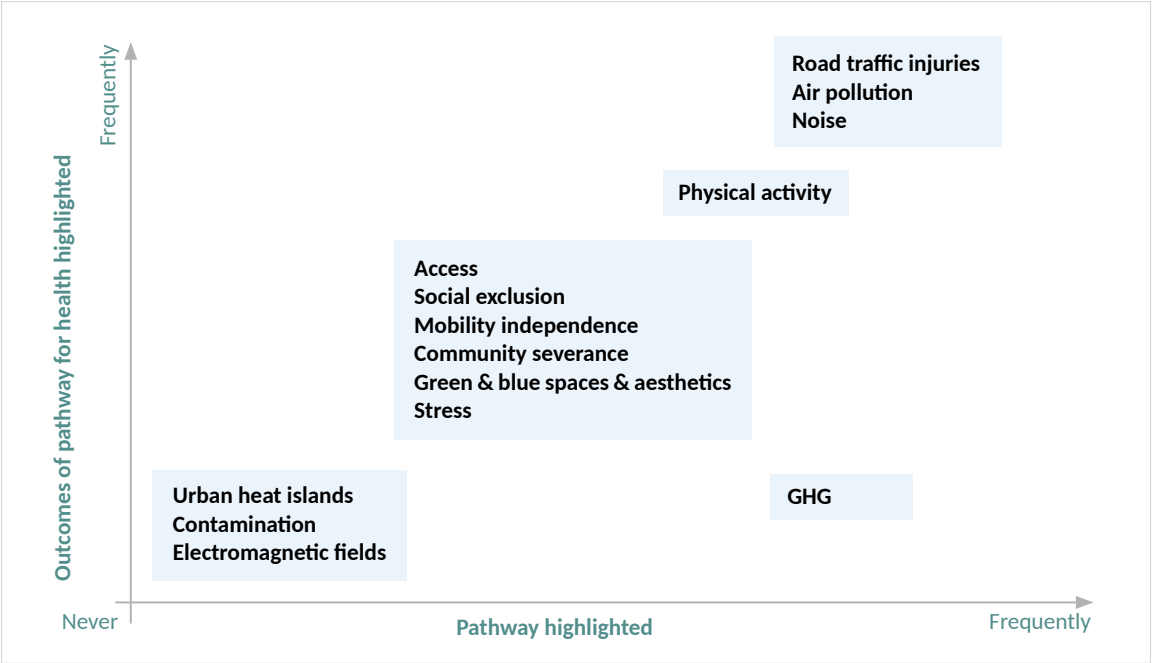
Table 10. Sample SUMPs with health as an objective

City	Sample quote
Île-de-France	"The challenge of the PDUIF is to ensure a sustainable balance between mobility needs and environmental and health protection. This balance must promote the attractiveness of Île-de-France and guarantee the region's social cohesion."
Oxfordshire	"Our Local Transport and Connectivity Plan vision is for an inclusive and safe net-zero Oxfordshire transport system that enables all parts of the county to thrive. It will tackle inequality, be better for health, wellbeing and social inclusivity and have zero road fatalities or life-changing injuries."
Southampton	"Improving people's health and quality of life" is one of the main four objectives of the plan. This is also highlighted as a goal to achieve "an Active and Healthy City that is easy to get around with joined up networks for active travel to promote healthy lifestyles and has vibrant people friendly liveable neighbourhoods"
Vienna	Being fair and healthy are two of the plan's six main objectives: Health goal: "The share of people in the Viennese population who are actively in motion for 30 minutes daily as they run their daily errands is to rise from 23% in 2013 to 30% in 2025. The number of traffic casualties and persons injured in traffic accidents declines further."

Transport pathways to health

As discussed in Section 2, *Theoretical framework*, transport can influence health through different interrelated pathways. We discuss the (un)specified pathways in the purposive sample based on the extent to which the following are highlighted: i) the health-pathway, and ii) its associated health outcomes, i.e., how it increases or decreases physical / social / mental wellbeing (Figure 12). Furthermore, we discuss whether the pathway's link to transport is specified.

Figure 12. Grouping transport's pathways to health based on the extent to which i) a health-pathway is highlighted, and ii) its outcomes for health, i.e., how it increases or decreases physical / social / mental wellbeing, are highlighted in the purposive sample of SUMPs



Frequently highlighted health pathways: road traffic injuries, air pollution and noise

Road traffic injuries is the most mentioned detrimental pathway to health, followed by **air pollution** and **noise**. Some documents have highlighted the impact of transport-related air pollution on health, especially cardiovascular/respiratory diseases, and the effect of transport-related noise on sleep and behaviour. The role of transport in all three pathways is well-known and implied (Table 11).

Table 11. Sample SUMPs highlighting the road traffic injuries, air pollution and noise pathways

City	Sample quote
Île-de-France	"Transport has a major impact on people's health. Road safety is a direct cause of injury, disability and premature death. The health of the population is also very closely linked to the quality of the environment, particularly through air, soil and water pollution, as well as noise pollution. [...] There is no threshold below which atmospheric pollution has no effect on health, and there is a correlation between exposure to air pollution and mortality. Noise is responsible for health impacts of various kinds: direct impacts on hearing, but also on general state of health (sleep disturbance, behavioural effects, etc.) directly linked to the discomfort experienced."
Southampton	"Exposure to particulate matter (both PM2.5 and PM10), which are fine particles including soot and dust from road traffic, can cause the most serious health problems among those susceptible groups with pre-existing lung or heart disease, the elderly and children. There is evidence that short and long-term exposure to particulate matter causes respiratory and cardiovascular illness and even death. Particulate matter is predicted to contribute to an estimated 110 early deaths in Southampton each year. Source apportionment work has identified that road transport is one of the largest contributors to air pollution in Southampton."

Pathway highlighted without mentioning health consequences: Greenhouse gases (GHG)

The role of transport in producing CO2 and other **greenhouse gases** and their contribution to climate change is discussed at some level in most SUMPs. However, the potential health consequences of the resulting climate change are not explained. Climate change, caused by GHG emissions, impacts health by leading to increased fatalities and illnesses through more frequent extreme weather events like heatwaves, wildfires, storms and floods, disrupted food supply chains, higher pollen and zoonotic disease rates. The detrimental health effects of air pollution, urban heat islands and physical inactivity can be worsened by climate change, and the displacements engendered by it can result in adverse mental and physical health (Glazener et al., 2021).

Some plans conflate GHG emissions and air pollution impacts. Not all air pollutants are GHGs. GHGs contribute to climate change and have long-term environmental impacts, while many air pollutants, such as particulate matter, have immediate and local environmental impacts. The reviewed SUMPs focus on strategies to mitigate air pollution, which often address GHG emissions as well. However, it is important to note that the health impacts and pathways of air pollutions and GHG emissions differ.

Occasionally highlighted pathway: physical activity

While walking and cycling are referred to frequently, **physical activity** (PA) as a pathway to health and the health outcomes of physical (in)activity are relatively less emphasised. Table 12 shows three good exceptions. The link to transport is implied as physical activity is almost always mentioned in combination with active travel modes, i.e., walking and cycling.

Table 12. Sample SUMPs highlighting the physical activity pathway

City	Sample quote
Oxfordshire	"In children, regular physical activity is associated with improved learning and attainment, better mental health and cardiovascular fitness. It also reduces sickness absence and can reduce crime and anti-social behaviour. In adults, there is strong evidence to demonstrate that physical activity can help to protect from a range of chronic conditions including coronary heart disease, obesity, type 2 diabetes, Alzheimer's and social isolation. Physical activity has also been shown to improve mental health. Those who walk for more than 8.6 minutes per day are 33% more likely to report better mental health."
Tampere	"A municipality resident who exercises regularly creates less costs for society. Increasing incidental exercise can affect the risk of many national diseases, functional ability and sick leave. […] Everyday physical activity promotes well-being and health and decreases the costs caused by physical inactivity. […] Cycling is excellent health-enhancing physical activity. Cycling five kilometres in both directions meets the recommended daily amount of physical activity."
Vienna	"Active mobility, i.e. walking and cycling, demonstrably improves people's health. A lack of exercise is a main risk factor in many diseases and disorders, such as back and joint aches, cardiovascular diseases and type II diabetes. People who frequently cover above average distances not only reduce their disease risk, they also help avoid health care costs."

Less elaborated health pathways: access, social exclusion, mobility independence, community severance, green spaces and aesthetics, stress

SUMPs often conflate accessibility-related issues such as **access** to opportunities, social exclusion, and mobility independence. Most SUMPs do touch on at least one health pathway and its link to transport when explaining the need for planning for inclusivity and equity, however the health outcomes of these pathways are usually not made explicit.

Some SUMPs discuss **access** in terms of number of opportunities reachable to people (Table 13). However, access to healthcare or healthy food which have important implications for wellbeing are scarcely mentioned.

Table 13. Sample SUMPs highlighting access to opportunities.

City	Sample quote
Oxfordshire	"Developing accessible 'Local Community hubs' where a range of services, activities, and opportunities are focussed, will lead to greater social cohesion, reduce the need to travel, and support the 20-minute neighbourhood initiative."
Sofia	"A key condition for further growth and development of Sofia is the accessibility and connectivity of the city. People need easy and safe access to workplaces, schools, public spaces, parks, services and entertainment, regardless of age, sex, health status and income."
Southampton	"It is important that people of different backgrounds and abilities do not encounter barriers that cause them difficulties or restrict their options for travelling around. We need to ensure that people from all backgrounds can access the same employment, health, leisure and education opportunities."

The concept of **social exclusion** is discussed in several SUMPs, however its implications for health are not (Table 14).

Table 14. Sample SUMPs highlighting social exclusion.

City	Sample quote
Île-de-France	"Social disparities are great in Île-de-France, and the share of the population in difficulty is far from negligible. […] Adapting transport systems so that they respond as a priority to these populations is essential" "So that people with reduced mobility can participate in social life, it is the entire chain of travel, roads and public transport, which must be made accessible."
Oxfordshire	"In this way 20-minute neighbourhoods address some of the drivers of health inequality, with residents who may have felt socially excluded able to access the services that they need in a sustainable way and in a welcoming environment." "Buses help tackle loneliness and social isolation, keeping people in touch with their friends and families."

Similarly, the need to provide access for people with disabilities, vulnerable transport and/or public space users is also established in many documents without an explicit discussion on its health implications (Table 15).

Table 15. Sample SUMPs highlighting access for vulnerable groups

City	Sample quote
Antwerp	Focus on "those victims [sic] who are overrepresented in accident statistics: the elderly, people in their twenties, and children", and promoting "obstacle-free pedestrian and cycle paths, especially during road constructions and in bad weather conditions."
Hannover	Specific goals on "Opportunities for mobility for all: 1) special attention to the needs of women, children, elderly, migrants, people with a handicap or socially disadvantaged people in transport planning 2) promotion of alternatives to driving on all travels 3) barrier-free participation in public life for all transport modes"
Vienna	"Many steps were taken in making the transport system barrier-free. Kerbstones at nearly all intersections were lowered, barrier-free public transport was stepped up, acoustic traffic lights and tactile guidance systems were set up and experts from organisations representing the interests of people with restricted mobility are involved in building projects."

Moreover, the focus is almost exclusively on reducing barriers, primarily for vulnerable people, by changes in the built environment, and the social environment is overlooked. For example, the purposive sample lacks any mention of the deterrent role of perceived fear of crime and harassment during active travel or public transport use for vulnerable groups which can lead to social exclusion. An exception is the Delft plan, which briefly mentions the aspect of social safety (Table 16).

Table 16. Sample SUMP highlighting the issue of social safety

City	Sample quote
Delft	"Making the city inclusive is an integral task. This does not only concern the physical environment, but also the social environment of people with mobility limitations." "To get home safely as a cyclist, social safety is also important. Users can make known in which places they do not feel (socially) safe."

Some SUMPs discuss access in the form of (vulnerable) population's ability to travel independently with their mode of choice, however few (e.g., Tampere) make the link between **mobility independence** and health (Table 17).

Table 17. Sample SUMPs highlighting mobility independence

City	Sample quote
Tampere	"Safe school routes support children's opportunities for independent mobility." "In an accessible environment, all people can operate equally and independently regardless of their mobility or functional ability." "An accessible environment makes independent mobility easier and enables living at home for longer, which increases quality of life and creates service cost savings for the city." "Every child should have the right to a safe and independent journey to school on foot, by bike or using public transport."
Turin	"The urban mobility system should allow everyone to exercise their right to move, without burdening, as far as possible, the community in terms of air pollution, noise, congestion and accidents." "The theme of urban accessibility - set of spatial, distributional, organisational and management characteristics capable of allowing mobility and easy use, in conditions of safety and autonomy, of the spaces and infrastructures of the city by any person - is central today in the planning of the mobility system." "The application of the principle of urban accessibility makes it possible to contain and reduce to the point of eliminating obstacles, sources of danger and situations of fatigue and discomfort not only for disabled people, but for everyone, especially for those who due to advanced age and therefore physical or sensory limitations, their ability to circulate autonomously is compromised."

Community severance, which refers to the division of communities and limitation of access to opportunities due to obstructive infrastructure is hardly mentioned. However, reduced social interactions, or social exclusion –which is highly correlated with community severance (Boniface et al., 2015)– are touched upon.

The link between transport and **green and blue spaces and aesthetics** and eventually health is not often highlighted, though there are some mentions of how green spaces can improve quality of life. Most plans mention creating an attractive and liveable urban environment in their vision. However, there is rarely a discussion on how to do that or what the health implications would be. **Blue spaces** are almost completely overlooked.

Oxfordshire discusses the importance of green spaces for attractive and healthier places, and Vienna includes a section titled "Public space: sharing streets in a fair way". However, very few documents, like Delft discuss the role of the reduction of transport space in providing opportunities for street restructuring, greenspace and better public space (Table 18).

Table 18. Sample SUMPs highlighting green spaces and aesthetics pathway

City	Sample quote
Delft	"We want to encourage movement also more space for greenery and resting. This stimulates outdoor sports and (recreational) walking and cycling. It also offers a good living environment and sufficient green space for relaxation and space to meet each other. This has a positive effect on well-being." "With the freed up space, we can increase the quality of the public space. This can then benefit the liveability of the (inner) city."
Oxfordshire	"The protection, maintenance and enhancement of Green Infrastructure is required in Oxfordshire if we are to deliver our vision for air and environmental quality, healthy places and increased walking and cycling. The GI network is multifunctional and a core part of Oxfordshire's 'living landscape' of attractive and healthier places."
Tirana	Mentioned in relation to "quality of public spaces" … expected to have an increase in "The average reported satisfaction of green (parks, gardens) and non-green (markets, squares, pedestrian areas) public spaces."
Southampton	"Develop and promote networks of green infrastructure (open spaces, parks, wooded areas, nature reserves, waterfront areas and country parks) to support quality of life and wellbeing."

Transport, including its infrastructure and operational performance (such as congestion and delays), is shown to impact mental well-being, resulting in psychological and physiological health outcomes (Conceição et al., 2023). However, the link between transport and mental health in general, and **stress** in specific, is rarely discussed in the SUMPs. Examples are Delft, which mentions stress in relation to active mobility, and Oxfordshire, which touches on mental health (Table 19). While relaxation is mentioned few times, it is mostly in the sense of places for resting as opposed to movement (e.g., Delft and Antwerp).

Table 19. Sample SUMPs highlighting stress pathway (Delft) and the mental health outcome of transport mode (Oxfordshire)

City	Sample quote
Delft	"The way we move affects our health. Research shows that people who take public transport to work, have fewer health problems than have people who travel by car. The cause is twofold. On the one hand, public transport travellers experience less stress, on the other hand, public transport travellers often spend part of their journey on foot or by bicycle, which gives them more exercise than normal average motorist."
Oxfordshire	"Those who walk for more than 8.6 minutes per day are 33% more likely to report better mental health."

Missing health pathways: urban heat islands, contamination, electromagnetic fields

Urban heat islands are not mentioned in the reviewed SUMPs. This shows that even though this issue has been known for some time, it has not made it through the political processes leading to formulation of SUMPs. References to the contamination and electromagnetic field pathways are also missing, probably due to them being acknowledged more recently.

Operationalising health: Targets and KPIs

Targets and their concreteness

In the purposive sample, we find that the degree to which a health pathway is highlighted is often accompanied with a specific target set for that pathway: as we proceed along the X axis in Figure 12, i.e., the frequency of mentions of the pathway increases, targets become increasingly emphasised and concrete. Table 20 and

Table 21 outline sample targets and key performance indicators (KPIs) for identified pathways in the purposive sample.

Almost all documents have concrete targets for increasing road safety and reducing road injuries and mortality and strive for zero road fatalities in the long term. Similarly, most SUMPs have targets for reducing air pollutants (e.g., PM10, NO2) based on national limits or EU limits, and specify target levels for noise reduction. Many SUMPs have GHG reduction targets and some strive to become carbon neutral (Tampere) or have a net-zero transport network (Oxfordshire by 2040) in the long term.

Some SUMPs have active mobility targets which can relate to increasing physical activity (e.g., targets on the share/amount of active travel). However, very few SUMPs attempt to specify a preferred level for physical activity *per se* (Table 20). Targets to improve accessibility (access to opportunities, social exclusion, mobility independence) are often described in general terms (e.g., increase access, decrease social exclusion) and detailed target levels are harder to come by here. Targets for enhancing green spaces and aesthetics are even more abstract (e.g., enhance attractiveness) and hardly operationalised. No targets or KPIs were found for the missing pathways.

Regarding the timeline of the health-related targets, the majority has long term goals without mentioning how they will exactly be achieved. However, there are few plans that have targets and KPIs to meet and measure along the way (e.g., Oxfordshire has a long-term plan set to 2050 with targets for 2030, 2040 and 2050).

Table 20. Sample SUMPs' health-related targets

Health pathway	Targets
Reducing road traffic injuries	
Hannover	Halving of cycling crashes with severely injured or killed.
Oxfordshire	Reduce road fatalities or life changing injuries by 50% by 2030, and have a zero, or as close as possible, road fatalities or life-changing injuries by 2050.
Southampton	A safe City that reduces the number of people killed or injured on the transport system towards zero.
Reducing air pollution	
Oxfordshire	Continue to implement the Zero Emission Zone in Oxford. Investigate Clean Air Zone and Zero Emission Zone schemes for other parts of Oxfordshire where traffic emissions are contributing significantly to air pollution problems.
Southampton	Ensure compliance with EU limit levels for NO2 in the shortest possible time. Consider evolving its Clean Air Zone into a Zero Emission Zone by 2030.
Tampere	Investigating access regulations, for instance, a studded tyre ban and low-emission vehicle zone in Tampere.
Vienna	To safeguard the extensive quality of life Vienna is offering, particulate matter and nitrogen oxide (NOx) pollution in Vienna must be reduced further.
Tirana	Reducing air polluting and CO2 emissions attributable to the transport sector by 2030
Reducing noise	
Antwerp	Reduce the number of residents exposed to an average noise exposure of more than 70 dB(A) to 0.
Tampere	Implementing noise prevention of noise protection destination according to the action plan and promoting the implementation of protected destinations from railway noise in cooperation with the Finnish Transport Infrastructure Agency.
Tirana	Reducing the exposure of the population to noise by giving priority to the protection of the most sensitive areas near schools, health facilities and residential areas by 2030.
Increasing physical activity	
Hannover	Doubling of cycling modal split to 25%.
Budapest	Target mode share of 5% for bike and 15% for walk, along with a reduction to 30% for car by 2030.
Oxfordshire	Increase the number of cycle trips in Oxfordshire from 600,000 to 1 million cycle trips per week by 2030.

Southampton	A connected cycle network by 2027 and a 10% increase annually in the number of cycle journeys. This means that initially by 2030 15% of all the people coming into the City Centre each morning will be doing so by bike.
Vienna	Modal split change from 72:28 in 2013 to 80% of eco-mobility and 20% of car traffic by 2025. The share of people in the Viennese population who are actively in motion for 30 minutes daily as they run their daily errands is to rise from 23% in 2013 to 30% in 2025.
Dublin	To expand the urban cycle network to over 1,485 kilometres in length, and provide over 1,300 kilometres of new connections between towns in the rural areas.
Tampere	Increased mode share of walking from 31% to 33% and cycling from 10% to 15% by 2030.
Reducing GHG	
Southampton	A Zero Emission City that is moving towards having zero emissions from transport delivering cleaner air and reduced emissions by 2040.
Oxfordshire	Reduce per capita carbon emissions from transport in Oxfordshire in line with UK Government targets. Deliver a net-zero transport network by 2040.
Vienna	The CO2 emissions caused by transport in the Vienna road network will decline by about 20%, from roughly 2.1 million tonnes/year in 2010 to about 1.7 million tonnes/year in 2025.
Tampere	In a carbon-neutral city, greenhouse gas emissions to the atmosphere do not exceed the amount of carbon dioxide it can sequester from the atmosphere. The climate target set by Tampere means that greenhouse gas emissions from traffic must be cut down by more than half (55%) from 1990 to 2030.
Improving accessibility (access to opportunities, social exclusion, mobility independence)	
Southampton	Increase in access to jobs, skills and markets and increase in access to services.
Île-de-France	Removal of 80% of areas with problematic accessibility for people with disabilities. Reduce the discontinuity of pedestrian/cycle paths, e.g., reduction of 100 identified cases, with a priority of 35.
Improving green space and aesthetics	
Delft	Create more resting spaces and spaces for pedestrians and cyclists, improve public space
Tampere	Granting more space for walking and urban green areas in connection with street renovations.

KPIs

Direct health indicators like disability-adjusted life-year (DALY) or years of life lost (YLL) are missing throughout the analysed SUMPs but there are health-related KPIs for various pathways (Table 21).

Table 21. Sample SUMPs' health-related KPIs

Health pathway	KPIs
Reducing road traffic injuries	
Oxfordshire	Total number of Killed or Seriously Injured (KSI), number of KSI per mode
Vienna	Accidents: ‣ Number of traffic casualties per year ‣ Number of persons injured in traffic accidents per year
Tampere	Accidents in the street network
Reducing air pollution	
Oxfordshire	Transport emissions, years of healthy life lost due to air pollution
Vienna	PM10 concentration: ‣ PM10 limit values exceeded: Number of days when limit value was exceeded (daily mean value >50 g/m^3) p.a. (mean value from 13 measuring stations) ‣ PM10 annual mean value mean value NO2 concentration: ‣ NO2 limit values exceeded: Number of half hours when limit value was exceeded (>200 g/m^3) p.a. (measuring station at Hietzinger Kai) ‣ NO2 annual mean value mean value (measuring station at Hietzinger Kai)
Tampere	Air quality: nitrogen oxides and MP10 level
Tirana	Number of air pollution monitoring stations implemented and maintained
Reducing noise	
Antwerp	Number of residents exposed to an average noise exposure of more than 70 dB(A)
Vienna	Traffic noise nuisance in close surroundings of home (cumulative, marks 3-5)
Tampere	Number of residents exposed to traffic noise exceeding the daily guideline limit of 55 dB
Increasing physical activity	
Oxfordshire	Percentage of residents walking / cycling, number of walking / cycling trips Percentage of adults / children meeting physical activity recommendations

Vienna	Share of persons in the Viennese population who are in motion for at least 30 minutes a day in the course Modal split share of bike and walking to cover the distances for “getting supplies”, “spending leisure time”, “taking someone to a destination or collecting someone from a place” Share of walking and cycling in modal split: ‣ Modal split walking summer half-year (April-October) ‣ Modal split walking winter half-year (November-March) ‣ Modal split cycling summer half-year (April-October) ‣ Modal split cycling winter half-year (November-March) Modes of transport on way to school: Tendency among 6-10 year olds who walk, cycle or travel on public transport Percentages of 6-14 year olds who walk, cycle or travel on public transport Bicycle availability: Percentage of households with at least one bicycle Satisfaction with transport in Vienna: Satisfaction with pavements and footways for pedestrians (school marks 1-5) Satisfaction with cycling path network (school marks 1-5)
Reducing GHG	
Vienna	Traffic-related CO2 emissions in Vienna, according to EMIKAT
Tampere	Number of low-emission vehicles in relation to population and number of vehicles
Improving accessibility (access to opportunities, social exclusion, mobility independence)	
Oxfordshire	Healthy Streets score improvements, 20 minute neighbourhood index improvements
Vienna	Reachability of primary schools Percentage of primary school pupils able to find a place in school located 1,500 m or less from their home
Southampton	Sustainable transport catchment; Perceptions around affordability of transport
Improving green spaces and aesthetics	
Delft	“10 healthy street indicators” are mentioned but are not explained
Southampton	Perceptions around the attractiveness of the public realm

Health-related actions and measures

Similar to health-related targets and KPIs, health-related actions and measures are more emphasised and frequent as we progress on the X axis of Figure 12. There are many measures to increase road safety and reduce injuries (e.g., speed limits, traffic calming elements, pedestrianisation of some centres). Most SUMPs have measures for reducing air pollution. Solutions include a shift towards less polluting modes of transport, clean air zones and zero emissions zones, improvements in vehicle technology and phasing out diesel and petrol vehicles. Noise measures aim to reduce the number of residents exposed detrimental noise exposure, e.g., noise barriers along major roads and investigating the potential of quiet road surfaces on 50 km/hr roads.

The focus of the measures related to PA is mainly on increasing active travel share / amount and providing a network of safe and continuous pedestrian / bike infrastructure. Furthermore, some documents recommend campaigns and educational programmes to promote active travel. Measures to encourage modal shift to active travel also contribute to GHG reduction. The relation between these measures and health is occasionally explained but not consistently.

The measures to increase access range from integrated land-use transport interventions (e.g., 'local community hubs', '20-minute neighbourhood' suggested in Oxfordshire) to reducing barriers (for the vulnerable people) by changes in the built environment (e.g., barrier-free pedestrian / cycle paths and public transport, lowered kerbstones at intersections, acoustic traffic lights and tactile guidance systems in Vienna). We did not come across concrete measures on how to improve green and blue spaces and aesthetics and to decrease stress. However, some suggested measures for enhancing slow traffic routes can potentially help achieve this (e.g., network of green routes with resting opportunities along the way in Delft).

In general, the health-rationale of many measures and their implications for wellbeing are not made explicit (see two exceptions in Table 22). Furthermore, the direct contribution of measures to objectives is mostly implied rather than explicit. An exception is Vienna, which outlines the expected contribution of fields of actions and measures to each of its objectives (including "healthy" and "fair"). The expected contributions are categorised into: i) small or no contribution, ii) mid-sized or indirect contribution to the objective, and iii) major contribution to the objective.

Table 22. Sample SUMPs providing a health rationale for their targets and measures

City	Sample quote
Delft	"With the freed up space, we can increase the quality of the public space. This can then benefit the liveability of the (inner) city."
Oxfordshire	"Improve public health and wellbeing by increasing levels of walking and cycling, reducing transport emissions, reducing casualties and enabling inclusive access to jobs, education, training and services."

Health impact assessment and monitoring

Health Impact Assessment (HIA) is a crucial tool for incorporating health considerations into decision-making processes and promoting a "health in all policies" approach. The inclusion of HIA within mobility plans improves the commonly used cost-benefit analyses in transport planning which often overlook health impacts.

Our analysis shows that HIA only received attention in some recent plans, specifically the Oxfordshire plan (Table 23). This plan has HIA as part of an Integrated Sustainability Appraisal (ISA) which also includes Environmental and Equalities assessments. The aim is to ensure that, while assessing the health impact of schemes, decision-makers maintain a focus on addressing health inequalities in Oxfordshire. Consequently, the plan mandates a rapid or full HIA for all major infrastructure proposals and major transport schemes or plans.

Table 23 Sample SUMP addressing health impact assessment (HIA)

City	Sample quote
Oxfordshire	"HIAs provide a systematic framework to identify the potential impacts of an infrastructure proposal on the health and well-being of the population and highlight any health inequalities that may arise. HIAs can highlight mitigation measures that may be appropriate to enable new infrastructure to maximise the health of communities. …. Requiring the use of HIAs and embedding their use into the design process will ensure that future development and improvements to the transport network across Oxfordshire positively impacts on existing health inequalities and creates healthy, more resilient and sustainable communities. The use of HIAs will also provide a mechanism for putting the healthy place making principles into practice and delivering improvements to health and well-being"

Evaluation of SUMPs and their impact on health

The presence of health concepts in SUMPs, while indicative of awareness of impacts of mobility strategies, does not, however, necessarily indicate the plans have or can effectively improve health. Evaluating SUMPs' impacts on public health is complex and requires first an assessment of their implementation.

There is a limited but steadily growing number of studies that have attempted to evaluate SUMP implementation. These studies identified that SUMPs that exhibit attributes such as adherence to national guidance, active public participation, financial linkages, and political support were more effectively implemented (May et al., 2017). Primary barriers to effective SUMP implementation encompass funding constraints, lack of comprehensive national framework, lengthy legislative and planning processes, societal attitudes, the dominance of motorised traffic, legislation, political consensus, human resource shortages, communication challenges, dysfunctional institutions, and technology limitations (Jordová and Brůhová-Foltýnová, 2021). Lack of comprehensive national frameworks is considered a less challenging barrier to address compared to issues such as funding shortages and public resistance to contentious transport measures (Mladenovič et al., 2022). Overall, these studies have shown that cities with legally defined well-established SUMPs tend to implement sustainable transport measures more frequently, include transport mode hierarchisation, employ transport models in strategic decisions, engage in more participation activities, and possess better capabilities for data monitoring and analysis (Jordová and Brůhová-Foltýnová, 2021; May et al., 2017; Mozos-Blanco et al., 2018). Interestingly, a review of SUMPs in 39 cities in the Czech Republic shows there are no significant differences in the barriers faced by cities to implement sustainable transport measures with and without SUMPs, suggesting that the presence of a SUMP is not strongly associated with unique implementation challenges (Jordová and Brůhová-Foltýnová, 2021).

Two studies have attempted to examine the role of health in SUMPs. Lozzi and Monachino (2021) investigated SUMPs in Lisbon (Portugal), Paris (France), London (UK), and Rome (Italy), while Okraszewska et al. (2022) focused on Copenhagen (Denmark), Gdynia and Wroclaw (Poland), Stuttgart and Ulm (Germany). Both studies, based on semi-structured interviews with transport researchers and practitioners, underscore the need for standardising the inclusion of health considerations and frameworks into mobility planning, as well as the incorporation of health impact assessments (HIAs) and appropriate indicators for assessing the achievement of SUMP objectives and monitoring those indicators over time (Lozzi and Monachino, 2021; Okraszewska et al., 2022).

Nevertheless, further research is needed to first scrutinise the implementation of SUMPs. It is only through a comprehensive evaluation of the actual execution of these plans that we can fully grasp their potential impact on health. Once we have a comprehensive understanding of the extent to which SUMPs have been effectively implemented, we can proceed to assess the health implications of these policies. This assessment will not only help us determine the tangible effects of SUMPs on public health but also guide the development of strategies for enhancing their effectiveness in promoting healthier urban environments.

Health-centred SUMPs can in turn significantly co-benefit a host of European strategies and policies that target public health, such as EU Global Health Strategy

6. Conclusions and recommendations

This work assesses how much health is addressed in current SUMPs, including the extent to which: i) health and its various aspects like health equity are highlighted, ii) transport pathways to health and their associated health outcomes in terms of increases or decrease in physical / social / mental wellbeing are made explicit, and iii) health is operationalised into targets and KPIs and the health-rationale of various actions and measures is elaborated. For this, we used a three-step method: i) developing a health dictionary and a policy analysis checklist based on existing reviews of SUMPs and health and a theoretical framework, ii) conducting a quantitative text analysis on a dataset of 230 SUMPs, and iii) performing a qualitative evidence synthesis on a purposive sample of 13 SUMPs across Europe.

The analysis has shown that health is quite commonly present in SUMPs across Europe, and its prominence seems to be increasing (Figure 7). From the quantitative text analysis counting words related to health, equity, and health pathways identified in our dictionary we show that:

- Cities in some countries emphasise health explicitly in their mobility planning, while some cities do not factor it in at all (34 out of the 230 cities in the database did not mention “health” or its variants a single time).

- Based on overall average scores from the respective sub-dictionaries, cities emphasise health most, followed by equity and then health pathways (Figure 8). However, based on top words, cycling (from the pathways sub-dictionary - Table 7) and accessibility (from the equity sub-dictionary - Table 6) are the top two most frequent health-related concepts mentioned across SUMPs.

- In the health sub-dictionary, security and safety are slightly more important to cities than explicitly emphasising “health” itself. All other health-related concerns appear far less important in mobility planning (Table 5).

- Accessibility is the most prominent equity-related construct mentioned, cost being a distant second (Table 6).

- Cities view cycling as the most important among health pathways by far, mentioned nearly twice as much as walking / pedestrians (Table 7).

- SUMP development could be strongly influenced by national / regional government requirements and support, as demonstrated by the peaks in SUMP publication in 2017 and 2019 following supportive measures taken by Slovenia and Italy, respectively (Figure 5 and Annex 2).

The qualitative evidence synthesis of the purposive sample of SUMPs indicates the following:

- Many SUMPs argue the urgency of addressing health pathways, often underscoring their commitment to reduce traffic injuries and air pollution. However, a direct emphasis on the urgency of prioritising health protection and promotion is hardly articulated, and sub-sections dedicated to health are scarce, except in select recent SUMPs.
  Good practice:
  Southampton has “improving people’s health and quality of life” as one of the main four objectives of the plan, and Vienna has being “fair” and “healthy” as two of the plan’s six main objectives.

- The link between transport and social and mental wellbeing is not frequently discussed (see good practices below under the social exclusion and stress pathways).

- While many SUMPs touch on equity, the fact that transport and its related policies could have unequally distributed health impacts across space and society is seldomly made clear.
  Good practice:
  Southampton: "Residents in areas of high levels of deprivation have fewer opportunities to access jobs, health care and leisure opportunities. Residents in these areas can encounter higher levels of air pollution, and live closer to major roads which sever their communities."

- While being healthy is often mentioned in the vision, there is not a clear-cut definition presented for what constitutes a healthy city.
  Good practice:
  Southampton strives to be "an active and healthy city that is easy to get around with joined up networks for active travel to promote healthy lifestyles and has vibrant people friendly liveable neighbourhoods."

- Most SUMPs recognise the need to protect against harmful effects of transport, but few recognise explicitly the opportunity for health enhancement through transport policy.
  Good practice:
  Delft has a section on "social aspects of mobility", including the subsection "mobility and health" where the link between active travel and green spaces and health is explained.
  Oxfordshire: "Those who walk for more than 8.6 minutes per day are 33% more likely to report better mental health. […] 20-minute neighbourhoods address some of the drivers of health inequality, with residents who may have felt socially excluded able to access the services that they need in a sustainable way and in a welcoming environment."

- Most SUMPs elaborate **road traffic injuries**, **air pollution** and **noise** health pathways.
  Good practice:
  Île-de-France: "Transport has a major impact on people's health. Road safety is a direct cause of injury, disability and premature death. The health of the population is also very closely linked to the quality of the environment, particularly through air, soil and water pollution, as well as noise pollution. […] There is no threshold below which atmospheric pollution has no effect on health, and there is a correlation between exposure to air pollution and mortality. Noise is responsible for health impacts of various kinds: direct impacts on hearing, but also on general state of health (sleep disturbance, behavioural effects, etc.) directly linked to the discomfort experienced."

- The role of transport in producing CO2 and other **Greenhouse gases** and their contribution to climate change is recognised at some level in most SUMPs. However, the health implications of climate change are missing. Climate change, driven by GHG emissions, leads to more frequent extreme weather events, disrupted food supply chains, and increased zoonotic disease rates, all of which can have adverse health effects.

- While walking and cycling are referred to frequently, **physical activity** (PA) as a pathway to health and its health outcomes are rarely explicitly expressed.
  Good practice:
  Tampere: "A municipality resident who exercises regularly creates less costs for society. Increasing incidental exercise can affect the risk of many national diseases, functional ability and sick leave. […] Everyday physical activity promotes well-being and health and decreases the costs caused by physical inactivity. […] Cycling is excellent health-enhancing physical activity. Cycling five kilometres in both directions meets the recommended daily amount of physical activity."

- The pathways of **access**, **social exclusio**n, **mobility independence**, **green spaces** and **aesthetics** are touched upon, but their health outcomes are not made explicit. **Blue spaces** and their health implications are almost completely overlooked.
  Good practice:
  Oxfordshire: "Buses help tackle loneliness and social isolation, keeping people in touch with their friends and families."
  Tampere: "An accessible environment makes independent mobility easier and enables living at home for longer, which increases quality of life and creates service cost savings for the city."
  Delft: "We want to encourage movement also more space for greenery and resting. This stimulates outdoor sports and (recreational) walking and cycling. It also offers a good living environment and sufficient green space for relaxation and space to meet each other. This has a positive effect on well-being."

- When discussing access, the focus is almost exclusively on reducing barriers, primarily for vulnerable people, by changes in the built environment (e.g., obstacle-free pedestrian and cycle paths), and the social environment is not addressed.
  Good practice:
  Delft: "To get home safely as a cyclist, social safety is also important. Users can make known in which places they do not feel (socially) safe."

- The link between transport and **stress** and its health consequences are rarely discussed.
  Good practice:
  Delft: "The way we move affects our health. Research shows that people who take public transport to work, have fewer health problems than have people who travel by car. The cause is twofold. On the one hand, public transport travellers experience less stress, on the other hand, public transport travellers often spend part of their journey on foot or by bicycle, which gives them more exercise than normal average motorist."

- The role of transport in **urban heat islands**, **contamination** and **electromagnetic fields** and their health outcomes are missing.

- Direct health targets and KPIs like disability-adjusted life-year (DALY) or years of life lost (YLL) are missing but there are health-related targets and KPIs for various pathways and corresponding measures to achieve them:

  - Most SUMPs have targets and KPIs to reduce road traffic injuries and mortalities and strive for zero road fatalities in the long term. Many measures are suggested to increase road safety and reduce injuries (e.g., speed limits, traffic calming elements, pedestrianisation of some centres).

  - Most SUMPs have targets for reducing air pollutants (e.g., PM10, NO2) based on national limits or EU limits. For example, Southampton aims to ensure compliance with EU limit levels for NO2 in the shortest possible time and considers evolving its Clean Air Zone into a Zero Emission Zone by 2030. Suggested measures in SUMPs to reduce air pollution include a shift towards less polluting modes of transport, clean air zones and zero emissions zones, improvements in vehicle technology and phasing out diesel and petrol vehicles.

  - Noise level targets and KPIs are also frequent. For example, Antwerp aims to reduce the number of residents exposed to an average noise exposure of more than 70 dB(A) to zero and suggests noise barriers along major roads and investigating the potential of quiet road surfaces on 50 km/hr roads for reducing noise exposure.

- Many SUMPs have GHG reduction targets and some strive to become carbon neutral (Tampere) or have a net-zero transport network (Oxfordshire by 2040) in the long term. Among others, various measures to increase active mobility contribute to this goal (see below).

- Some SUMPs have active mobility targets which can relate to increasing physical activity (e.g., targets on the share / amount of active travel). However, very few SUMPs attempt to specify a preferred level for physical activity per se. The focus of the measures related to PA is mainly on providing and enhancing a network of safe and continuous pedestrian / bike infrastructure. Furthermore, some documents recommend campaigns and educational programmes to promote active travel.
  Good practice:
  Vienna: "The share of people in the Viennese population who are actively in motion for 30 minutes daily as they run their daily errands is to rise from 23% in 2013 to 30% in 2025."

- Targets to improve access are discussed in general terms (e.g., increase opportunities, decrease social exclusion, enhance attractiveness) and are hardly operationalised. Measures to increase access range from integrated land-use transport interventions (e.g., 'local community hubs', '20-minute neighbourhood' suggested in Oxfordshire) to reducing barriers, primarily for the vulnerable people, by changes in the built environment (e.g., barrier-free pedestrian / cycle paths / public transport, lowered kerbstones at intersections, acoustic traffic lights and tactile guidance systems in Vienna)

- We found no concrete targets or KPIs related to improving green and blue spaces and aesthetics and to decreasing stress. However, some suggested measures could potentially help achieve this (e.g., creating a network of green routes with resting opportunities along the way in Delft).

- The health-rationale of the suggested actions and measures and their health outcomes in terms of increase or decrease in physical / social /mental wellbeing are often not made explicit.
  Good practice:
  Delft: "With the freed up space, we can increase the quality of the public space. This can then benefit the liveability of the (inner) city."

- Regarding the timeline of the health-related targets, the majority has long term goals without mentioning how they will exactly be achieved. However, there are few plans that have targets and KPIs to meet and measure along the way (e.g., Oxfordshire has a long-term plan set to 2050 with targets for 2030, 2040 and 2050).

- Few SUMPs mention health impact assessment methods and monitoring mechanisms. The presence of HIA within a SUMP can serve as a valuable indicator of the plan's acknowledgement of the health implications associated with transport. Its presence on its own, however, does not necessarily mean that concrete targets related to health are defined in SUMPs.

Recommendations

In all, SUMPs miss out on the opportunity to embrace mobility as a driver of health promotion. Overwhelmingly SUMPs' health aspirations are concerned with minimising detrimental impacts of transport on health, primarily from traffic injuries and to a lesser extent from air pollution. Health related concepts such as accessibility and active travel feature prominently but are never seen as an opportunity to enhance health. The mere mention of health and prominence of health and equity concepts in some SUMPs is an encouraging sign of recognising impacts of transport, but continuing to conceive of health and health pathways as separate entities runs the risk of perpetrating a siloed approach to decision making. The opportunity for a holistic or systemic approach to tackle health through mobility plans is thus missed.

On a technical level, we suggest the following recommendations to foster the inclusion of health in SUMPs, grouped into four main phases in a SUMP's planning cycle based on the revised SUMP guideline (Rupprecht Consult, 2019): i) preparation and analysis, ii) strategy development, iii) measure planning, and iv) implementation and monitoring (Figure 13).

Figure 13. Sustainable Urban Mobility Planning cycle (Rupprecht Consult, 2019).

In the *preparation and analysis* phase SUMPs should:

- Formulate the existing urban health challenges and establish the urgency of addressing transport-induced health issues, including negative impacts of transport on social and mental wellbeing. As transport planners may not always be familiar with the breadths and depths of these topics, foster the inclusion of these topics into international and national SUMP guidance materials. This may include advocacy and training opportunities for professionals developing or implementing SUMPs.
- Ensure that health is addressed specifically, ideally in a dedicated sub-section in addition to throughout other sections. Outline the current and (potential) future health situation using health-related indicators for the status quo and health trends such as the amount of physical activity.
- Ensure that next to the justified recognition of cycling as a healthy mode of transport, the usually more prevalent mode of walking receives the necessary focus and attention, also with regard to being equally available across all population groups.
- Highlight the issue of health equity, making it explicit that transport (policy) could have unequally distributed health impacts across space and society.
- Aspects such as access, social exclusion, mobility independence and community severance should feature more specifically.
- The role of the reduction of transport space in providing opportunities for street restructuring, greenspace and better public space can also be promoted more strongly.
- Emphasise on healthy placemaking to design a built environment to support healthy lifestyles, foster a sense of belonging and community, enhance green spaces and promote active travel. This approach can make effective use of the newly available spaces resulting from car reduction strategies, offering associated health benefits.
- Quantify and monetise health(care) costs and benefits of transport across as many pathways as possible. This holistic assessment should establish the urgency by showing the severity of health loss imposed on population through transport and the potential health gains by taking the transport pathways into account. The assessment should include when possible multiple health pathways and both mortality and morbidity impacts derived from local data using established methods (Barban et al., 2022; Mueller et al., 2020; Rojas-Rueda et al., 2013; Schröder et al., 2023) sedentary lifestyles and increased vulnerability to the effects of climate change. The Barcelona Superblock model is an innovative urban and transport planning strategy that aims to reclaim public space for people, reduce motorized transport, promote sustainable mobility and active lifestyles, provide urban greening and mitigate effects of climate change. We estimated the health impacts of implementing this urban model across Barcelona. Methods: We carried out a quantitative health impact assessment (HIA. Even when specific attributions to transport are not possible, the extent of health burden associated with transport could be qualitatively discussed, such as emergency admissions, sick days, asthma rates, etc.
- Determine how the SUMP is embedded in the health goals of European, national / regional / city development frameworks.
- Foster collaborations across government departments to receive input or potentially co-design SUMPs.

In the *strategy development* phase SUMPs should:

- Highlight health protection and enhancement as a justification for the vision and promotion of policies with health implications. It is established that sustainable mobility has clear health co-benefits (De Nazelle et al., 2011; Glazener et al., 2021)limit chronic disease, and reduce air pollution emissions, including greenhouse gasses, have been recommended. Transportation and planning policies that promote active travel by walking and cycling can contribute to these goals, potentially yielding further co-benefits. Little is known, however, about the interconnections among effects of policies considered, including potential unintended consequences. Objectives and methods: We review available literature regarding health impacts from policies that encourage active travel in the context of developing health impact assessment (HIA. Highlighting such benefits would make the adoption of these plans easier.
- Operationalise (health-related) objectives into concrete targets and ensure the target levels are as detailed as possible and that the suggested KPIs can measure progress towards targets.
- Ensure environmental targets such as air and noise pollutions are aligned with national and EU policies.
- Clearly demonstrate which impact targets and KPIs serve which objective. It is useful to have KPIs also grouped by transport modes.
- Strengthen the role of HIA and make it a standardised routine planning and development tool.
- Specify the needed data sources and the actors to evaluate the progress towards the implementation of health-related measures.

In the *measure planning* phase SUMPs should:

- Consider actions and measures that can influence different potential pathways of health.
- Elaborate how the suggested measures contribute to health-related objectives through their respective pathways.
- Ensure including measures for important but less emphasised pathways such as social exclusion, mobility independence, community severance, green and blue spaces, aesthetics, and stress. Make it explicit how such measures can improve health.

In the *implementation and monitoring* phase SUMPs should:

- Carry out continuous monitoring of progress towards targets, considering shifts in the relevant national and EU policies (e.g., target / limit values to be met in terms of air pollution, noise, and GHG levels).
- When possible, monitor a range of pathways such as traffic injuries, air quality, noise, carbon footprint, walking and cycling levels, green spaces, heat.
- Report across all areas of the SUMP including the health and equity related goals and KPIs.
- Support open data initiatives to enable independent evaluation of plan effectiveness, implementation progress, and target achievement.

On a European level, the interlinkages between transport, health and environment are increasingly being recognised by policies and partnerships such as THE PEP (the Transport, Health and Environment Pan-European Programme). However, higher-level strategies and guidance, such as the Sustainable and Smart Mobility Strategy (European Commission, 2020) and the revision of the trans-European transport network guidelines (European Commission, 2021b) miss a clear link between transport

and health (Davis et al., 2022). The lack of health-considerations at the higher-level mobility policy, planning and implementation has significant implications beyond urban settings and impacts the overall adoption of healthy and sustainable transport at a national level. Thus, it is critical that relevant higher-level environmental and health strategies, guidelines, and policy documents are updated to emphasise the urgency of health protection and promotion and the transport-health link. Importantly, the role of transport policy should be highlighted not only in reducing adverse health effects, but also as an opportunity for health enhancement. This is also true for EU-funded research projects such as EIT Urban Mobility, EIT Health and the Driving Urban Transitions (DUT) partnership. Furthermore, the development and implementation of health-centred SUMPs can be used as a condition for funding urban mobility projects, e.g., through funding schemes such as European Structural and Investment Funds, Horizon 2020, or Connecting Europe Facility (CEF).

Health-centred SUMPs can in turn significantly co-benefit a host of European strategies and policies that target public health, such as EU Global Health Strategy (European Commission, 2022), European Disability Strategy 2021-2030 (European Commission, 2021c) and the EU Digital Health and Care Strategy (European Commission, 2018). They can accomplish this by supporting the direct and indirect pathways that are beneficial to health (physical activity, access, mobility independence, green spaces, and aesthetics) and by discouraging those that are detrimental to health (road traffic injuries, air pollution, noise, GHG, social exclusion, stress, community severance, UHIs, contamination and electromagnetic fields). For example, SUMPs can directly contribute to cancer prevention and treatment targeted in the Beating Cancer Plan (European Commission, 2021a) by measures to: i) decrease sedentary behaviour by promoting active travel, ii) reduce exposures to environmental risk factors associated with cancer like air pollution, and iii) provide equitable access to healthy food and quality health care facilities. Similarly, they can contribute to the European Framework for Action on Mental Health and Wellbeing (EU Joint Action on Mental Health and Wellbeing, 2016) and EU mental Health in All Policies (EU Joint Action on Mental Health and Wellbeing, 2018), and the Comprehensive Approach to Mental Health Plan (European Commission, 2023b) through transport-related measures that could improve mental health by reducing air pollution, noise, social exclusion, and stress, and improving access, mobility independence, green and blue spaces and aesthetics.

This work provides insights into the degree to which current SUMPs address health. There are several avenues for future research that deserve more in-depth investigation. First there is a need to further identify the enablers and barriers to the effective implementation of SUMPs and their implications for health co-benefits. Second, it is urgent to empirically evaluate the state of implementation of SUMPs and the extent to which their KPIs and targets are met and assess the realisation of health co-benefits of SUMPs after their implementation. Third, it is important to examine how arguments for health co-benefits can help with the engagement and involvement of various stakeholders, including marginalised communities, in the development and implementation of SUMPs. Finally, special attention should be given to the challenges to HIA implementation and how to overcome them.

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Annex 1. Health, Equity, and Pathways sub-dictionaries

Note: Only the English version is included below.

Health		
health	cancer	risk
e-health	diabetes	risks
healthy	diabetic	accident
unhealth	pre-diabetic	physical activity
healthful	cardio	activity
healthier	cardiovascular	active
healthily	mortality	inactive
illhealth	morbid	inactivity
unhealthy	pathology	insufficient (physical) activity
healthcare	morbidity	anxiety
healthfull	co-morbidity	stress
healthiest	morbidly	stressful
healthspan	Center for Disease Control	obese
healthwise	CDC	obesity
nonhealthy	European Centre for disease control	fit
telehealth	ECDC	fitness
telehealthcare	World Health organization	sport
cyberhealth	WHO	sports
healthfully	National Health service	exercise
healthiness	NHS	relax
healthscape	medical	relaxation
unhealthful	lifespan	handicap
unhealthier	fatal	kill
unhealthily	fatality	kills
healthcentre	injure	killed
healthworker	injured	psychology
hearthealthy	injures	psychological
superhealthy	injury	Disability-adjusted life-year
unhealthiest	injuries	DALY
unhealthsome	casualty	years of life lost
healthfulness	casualties	YLL
unhealthfully	death	liveability
unhealthiness	deaths	care
unhealthyness	dead	sanitary
healthsomeness	deadly	accidents
nonhealthiness	pulmonary	crash
healthconscious	malady	crashes
public health	maladies	collision
physical health	sick	collisions
mental health	sickness	safety
health impact assessment	ailment	safe
illness	ailments	unsafe
illnesses	quality of life	secure
disease	wellbeing	security
chronic respiratory disease	well-being	insecurity
respiratory		

Equity		Health pathways
equity	congestion	clean water
equal	walk	green space
equality	walking	aesthetics
equitable	bike	community severance
inequity	biking	barrier effect
inequitable	bicycle	social exclusion
inclusive	cycle	social interaction
inclusivity	cycling	electromagnetic field
uninclusive	clean mobility	greenhouse gas
justice	green mobility	greenhouse gases
injustice	clean energy	urban heat island
access	renewable	contamination
accessible	renewable energy	emission
accessibility	green energy	emissions
disability	clean transport	speed
disabled	green transport	pollution
social	clean	air pollution
social life	green	air quality
social distancing	active travel	noise pollution
community	pedestrian	independence
social safety	pedestrianise	
social cohesion	pedestrianize	
jobs	pedestrian zone	
safety net	traffic calming	
employment	loud	
affordability	noise	
costs	smog	
vulnerable	clean air	

Annex 2. SUMPs in dataset published per year, by country, 2006-2023

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Albania															1				**1**
Austria							1	1				1		1	1				**5**
Belgium			1						2		1		1						**5**
Bosnia Herzegovina															1				**1**
Bulgaria										2		1		1	2				**6**
Croatia								1				3							**4**
Cyprus														2					**2**
Czech Republic									1		1	2	2	3	2	2	3	4	**20**
Denmark								1									1		**2**
Estonia														1					**1**
Finland					1					1		1				1			**4**
France	1		1			1	1	1	4	2		1		4	5	1	2	3	**27**
Germany	2					2	3	1	1	1	1	1	2		3		1	2	**20**
Greece												1	1						**2**
Hungary										2	2	2	1	1	1			1	**10**
Ireland								1			2			1	1				**5**
Italy			1		1				1	2		4	4	11	1	2	2		**29**
Kosovo															1				**1**
Latvia											1								**1**
Lithuania												1							**1**
Netherlands									1								1		**2**
Norway							1			1		1	1	1			1		**6**
Portugal										1	1		1		1		1		**5**
Romania												1							**1**
Serbia													1						**1**
Slovenia											2	33	1	1	1				**38**
Spain			1										1						**2**
Sweden									1										**1**
Turkey																	1		**1**
Ukraine														1					**1**
United Kingdom						6		1	1	1	2	2	2	3	1	4	2		**25**
Total	**3**	**0**	**4**	**0**	**2**	**9**	**6**	**7**	**12**	**13**	**13**	**55**	**18**	**31**	**22**	**10**	**15**	**10**	**230**

Annex 3. Average normalised scores by sub-dictionary, by country

Country	Health	Equity	Pathways
Albania (n=1)	0.23	0.30	0.17
Austria (n=5)	0.17	0.11	0.08
Belgium (n=5)	0.10	0.08	0.14
Bosnia Herzegovina (n=1)	0.24	0.14	0.13
Bulgaria (n=6)	0.25	0.13	0.10
Croatia (n=4)	0.19	0.07	0.08
Cyprus (n=2)	0.17	0.14	0.41
Czech Republic (n=20)	0.28	0.20	0.16
Denmark (n=2)	0.16	0.23	0.72
Estonia (n=1)	0.19	0.08	0.07
Finland (n=4)	0.19	0.08	0.12
France (n=27)	0.03	0.05	0.11
Germany (n=20)	0.07	0.06	0.06
Greece (n=2)	0.25	0.10	0.16
Hungary (n=10)	0.24	0.15	0.12
Ireland (n=5)	0.23	0.30	0.09
Italy (n=29)	0.09	0.02	0.00
Kosovo (n=1)	0.41	0.31	0.30
Latvia (n=1)	0.56	0.37	0.02
Lithuania (n=1)	0.00	0.00	0.00
Netherlands (n=2)	0.12	0.10	0.34
Norway (n=6)	0.14	0.17	0.22
Portugal (n=5)	0.21	0.22	0.30
Romania (n=1)	0.06	0.14	0.02
Serbia (n=1)	0.00	0.00	0.00
Slovenia (n=38)	0.27	0.14	0.11
Spain (n=2)	0.59	0.02	0.06
Sweden (n=1)	0.47	0.29	0.17
Turkey (n=1)	0.44	0.46	0.19
Ukraine (n=1)	0.46	0.19	0.48
United Kingdom (n=25)	0.53	0.46	0.16
OVERALL AVERAGE	**0.21**	**0.15**	**0.12**

Annex 4. Top words in SUMPs from each sub-dictionary, combined across all languages

Top words	Frequency	Sub-dictionary
bicycl*/bik*/cycl*	4556	Pathways
access*	4371	Equity
secur*/safe*	2933	Health
walk*/pedestrian*	2628	Pathways
health*	2419	Health
cost*/expens*	1504	Equity
inclusiv*	1393	Equity
social*	1190	Equity
speed	1148	Pathways
noise/loud	975	Pathways
activ*	889	Health
green	855	Pathways
risk*	841	Health
greenhouse gas*/emission*	829	Pathways
employ*/job*/work*	633	Equity
fit*/sport*/exercise	456	Health
accident*/crash*/collision*	365	Health
afford*	300	Equity
clean	286	Pathways
equal*/equit*	269	Equity
dead*/death/kill*/mortality/fatal/casualt*	238	Health
care	211	Health
pollut*/air quality/smog	206	Pathways
community	147	Equity
injur*	128	Health
congestion/traffic jam*	126	Pathways
disabilit*/disable*/handicap*	125	Equity
quality of life/liveability	98	Health
disease*/ill*/sick*	66	Health
NHS (or equivalent)	60	Health
fair*/justice	57	Equity
renewable	41	Pathways
medical	36	Health
society	34	Equity
anxiety/stress	32	Health
welfare	31	Health
traffic calm*	25	Pathways
cardio	19	Health
dangerous	14	Health
relax*	12	Health
WHO	10	Health
CDC	8	Health
lifespan	7	Health
vulnerable	5	Equity
aesthetics	5	Pathways
independen*	4	Pathways
sanitary	3	Health
lung	1	Health

Annex 5. Quantitative analysis methodology notes

Methods selection

A dictionary application approach was selected for this study for a few reasons: i) dictionaries are a relatively mature and straightforward method for quantitative text analysis and were well suited to our objectives of assessing health content in SUMPs; ii) building a novel dictionary using expert human validation to customise it to the SUMP context and our objectives favours improved accuracy of the analysis; iii) the approach allows for increased transparency; and iv) the dataset had fewer than 2000 observations and thus was relatively small, so a dictionary approach was preferable to other methods, such as supervised learning.

Limitations and further research

The dictionary used for this study is an imperfect measure, and working with multiple languages brings inherent challenges in many respects. This analysis allows for general observations to be drawn about the inclusion of health in European SUMPs (or lack thereof) and some differences across countries and languages; however, further research could build on the work done for this study to refine the methods and conduct additional analyses.

The relatively limited timeframe and resources of this study meant that analyses beyond the three sub-dictionaries were not able to be conducted. Additional research could further explore the data for other elements, such as the position/proximity of terms, as well as other themes/concepts. The dictionary could be further refined and expanded, while additional sub-dictionaries could be developed to assess different concepts. (For example, we have put “access” in the equity sub-dictionary, but access is not solely an equity construct, nor discussed only from that perspective.) The dictionary translations could be validated for the languages that were not able to be validated during this study. Also, the dataset could further be expanded to include the observations that had to be left out due to their texts not being easily available for extraction.

Stop words and stemming were not available for all languages in our dataset, so these two functions were employed only for the languages where they were available. Further research could explore creating stop words lists for the languages where they were not available, as well as employing lemmatisation instead of stemming for the languages where it is an option. Conversely, stop words could be kept across all languages considering they might be present in parts of some dictionary terms. Stemming is important for capturing the root part of a word where conjugation or gender would alter the word ending; where it was not available for certain languages, the dictionary for that language could be expanded to include all possible word endings.

The methods used allowed for capturing multi-word expressions from the dictionary for scores, but further research could employ n-grams to explore if more meaningful combinations of words could be captured for top dictionary term frequencies for example. This study only captured unique words for the top frequencies. This is one area where working with multiple languages poses a particular challenge, as some non-English languages may use a single word for a concept that requires multiple words in English, and vice versa. The top words tables may include some multi-word expressions due to the reverse translation of results to English for consolidated analysis. Some words that were returned among the top words for some languages were not included in creating the top words tables in cases where the dictionary term to which they corresponded could not be determined (e.g., due to stemming), though this was very rare (less than 2% of all words returned).

Dictionary application and word frequency code

Note: Code below shows English version only and for the health sub-dictionary only. The process was repeated for other sub-dictionaries and languages (excluding stop words removal and stemming for Bosnian, Bulgarian, Croatian, Czech, Estonian, and Slovenian; and excluding stop words removal but including stemming for Greek, Lithuanian, and Turkish).

```
# Load required libraries
library(tm)
library(dplyr)
library(slam)
library(quanteda)
library(textstem)

### TEXT PRE-PROCESSING

# Define text field
clean_text <- english_subset$plan_text

# Preprocess text data to remove special characters
clean_text <- gsub("[^[:alpha:][:space:]]*", "", clean_text)

# Convert text to lowercase
clean_text <- tolower(clean_text)

# Remove punctuation
clean_text <- gsub("[[:punct:]]", "", clean_text)

# Remove numbers
clean_text <- gsub("[[:digit:]]", "", clean_text)

# Remove stop words
clean_text <- removeWords(clean_text, stopwords("english"))

# Remove extra whitespace
clean_text <- gsub("\\s+", " ", clean_text)

# Stem words
clean_text <- stem_words(clean_text, language = "english")

### GETTING TOKEN COUNT FOR EACH OBSERVATION

# Create a corpus for each observation's text
corpus_list <- Corpus(VectorSource(clean_text))
```

```
# Calculate the number of tokens for each observation's corpus
num_tokens <- sapply(corpus_list, function(x) {
  tokens <- quanteda::tokens(x)
  return(ntoken(tokens))
})

# Add the number of tokens as a new column in the dataset
english_subset$tokens <- num_tokens

### HEALTH DICTIONARY

# Extract words from the applicable language column of filtered dataset
clean_words_health <- unique(health_dictionary_full$english)

# Remove stop words
clean_words_health <- removeWords(clean_words_health, stopwords("english"))

# Stem the words in the dictionary using textstem
clean_words_health <- stem_words(clean_words_health, language = "english")

# Preprocess text to remove special characters
clean_words_health <- gsub("[^[:alpha:][:space:]]*", "", clean_words_health)

# Convert text to lowercase
clean_words_health <- tolower(clean_words_health)

# Remove extra whitespace
clean_words_health <- gsub("\\s+", " ", clean_words_health)

# Remove duplicates from the stemmed words
unique_stemmed_words_health <- unique(clean_words_health)

# Convert unique stemmed words to character vector
unique_stemmed_words_health <- as.character(unique_stemmed_words_health)

# Remove blanks from unique stemmed words
unique_stemmed_words_health <- unique_stemmed_words_health[nzchar(unique_
stemmed_words_health)]

# Create a dictionary with the unique stemmed words - so "health" is now a mea-
sure of all of the unique stemmed words in the custom health dictionary
dictionary_stemmed_health <- dictionary(list(health = unique_stemmed_words_
health))

### APPLY DICTIONARY
```

```
# Create a corpus from the text
corpus <- corpus(clean_text)

# Tokenise
tokens <- quanteda::tokens(corpus, verbose = quanteda_options("verbose"))

# Create a document-feature matrix (DFM) for health-related tokens
health_dfm <- tokens_lookup(tokens, dictionary = dictionary_stemmed_health) %>%
                  dfm()

### INDIVIDUAL HEALTH SCORES

# Add the dictionary results (sums) from dfm to subset
english_subset$health_dict_sum <- row_sums(health_dfm)

# Calculate score for each observation and add to subset
english_subset$health_score <- english_subset$health_dict_sum / english_sub-
set$tokens

### TOP WORD FREQUENCIES

# Create a dictionary list with unique stemmed health words
dictionary_list <- list(dictionary_words = unique_stemmed_words_health)

# Tokenise
corpus_tokens <- quanteda::tokens(clean_text)

# Count word frequencies
word_frequencies <- table(unlist(corpus_tokens))

# Filter word frequencies based on the dictionary
dictionary_word_frequencies <- word_frequencies[names(word_frequencies) %in%
dictionary]

# Get the top 20 words from the filtered frequencies
top_words <- head(sort(dictionary_word_frequencies, decreasing = TRUE), 20)
```

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