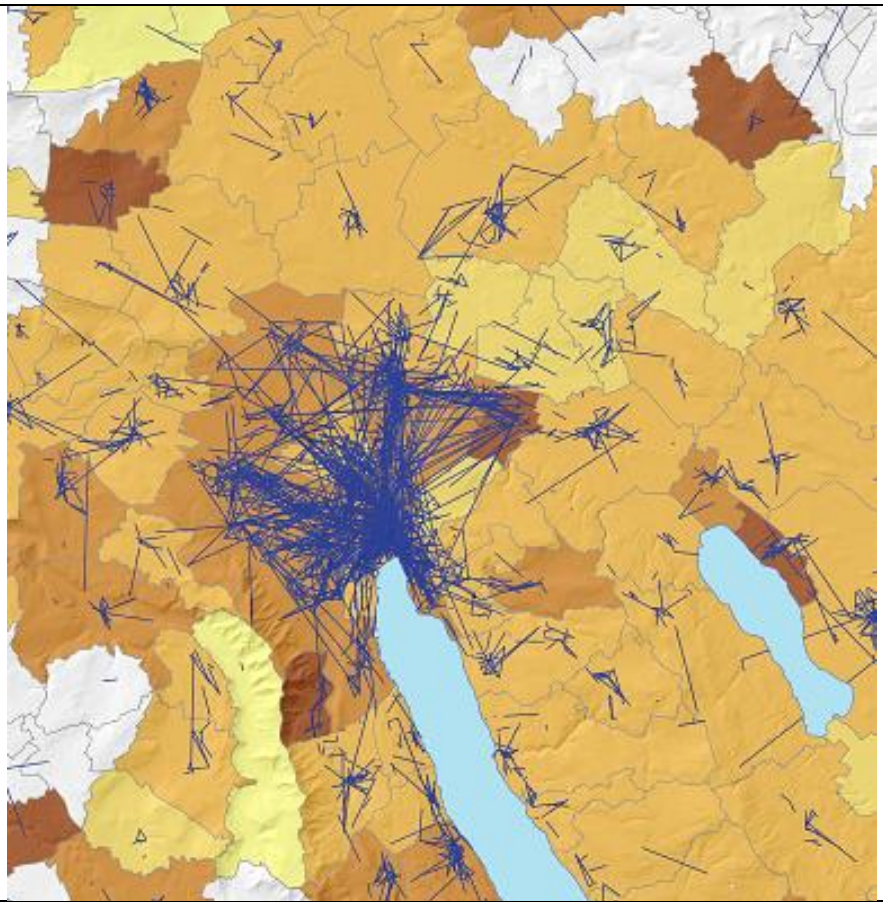

Analysis of walking in five Swiss cities: a quantitative and spatial approach

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1. Abstract

Many European cities are experiencing an apparent shift in mobility patterns. Walking and cycling are becoming increasingly popular, while many households are deciding not to have a car. These trends feed into a new concept of urban proximity, within which walking is to be considered as a transport mode in its own right. However, little is known about the social and spatial determinants of urban walking, which is why the present study seeks to ask the two following questions: What is the profile of urban walkers in the five largest conurbations in Switzerland: Basel, Bern, Geneva, Lausanne and Zurich? And to what extent can the level of walking in a given area be explained by urban density or urban function (mainly residential; mainly employment; mixed residential and employment)? To answer these questions, we analysed data from the 2010 Swiss transport micro-census using a quantitative and spatial approach, introducing sub-sectors which we characterised according to jobs/residents ratios and measures of urban density. Results show that urban density and urban function do play a role in stimulating or impeding walking behaviours, but this effect is weak compared to the effect of individual characteristics. Intriguing differences were found between the French-speaking cities, Geneva and Lausanne, which display significantly more walking, and the three German-speaking cities, which have less walking but better public transportation systems. The article concludes with a contribution to the research agenda: that the link between walking and public transport use in medium-sized cities should be investigated at the European level.

Keywords

Walking – urban – spatial – density – Swiss – motility – mobility

1. Introduction

Transport planning has traditionally used cost-benefit analysis and related methods in order to determine how much investment is required for each transport mode (Bristow and Nellthorp, 2000). The relative speed of each transport mode plays an important role in these policy processes. As a consequence, private road transport – and in more recent years mass public transport – have been systematically privileged across Europe and beyond. Whether explicit or not, the choice to encourage fast transport modes has had a detrimental effect on slower modes such as walking. Because of fast transport becoming a social norm, urban sprawl has ensued and many locations within urban areas have become extremely difficult to reach on foot.

Walking is an essential ingredient of the mobility cocktail. It readily combines with other modes, often forming the initial and final sections of a transport chain. This is why walking has often been considered an ancillary mode rather than a transport mode in its own right. However, walking also allows walkers to access a wide range of locations and services directly, a fact which has often been discounted in policy processes. As for transportation research, it has for a long time concentrated on aligning supply with demand, a process which is very rarely done for walking. In line with this tradition, many household travel surveys have neglected the importance of walking and of short trips as a whole (Berge and Peddie, 2010; Morency et al., 2011). Nowadays, despite the availability of origin-destination matrices in many countries, datasets focusing on walking remain rare (Millward et al, 2013).

With environmental and climate-change issues becoming increasingly influential on the global agenda, walking is mentioned more often than before in transport planning documents. However, much of the scientific literature on walking focuses on public health, the intensity of the urban experience afforded by walking (Amar, 1993; Morris, 2006), or environmental considerations. Few publications describe the profiles of everyday walkers or investigate why some people walk amid urban conditions which do not always encourage walking.

Several studies have shown that marginalised populations walk more than more affluent populations in most settings. However, since the beginning of the 2000s, a new trend seems to be emerging across Europe, linked to the proximity of urban lifestyles and to the use of sustainable transport modes. This trend makes it all the more timely to investigate urban walking, which we suggest to do in Switzerland, using a two-pronged approach, both social and spatial.

Human-powered transport modes such as walking and cycling are more heavily dependent on the quality of the urban environment than other modes. Urban fragmentation, density and urban form are among several factors which may encourage or discourage people from walking. Amar (1993) suggests that interventions aiming at improving the quality of urban space have the potential to influence mode choices, because such choices depend on the characteristics of the areas through which people walk. More recently, researchers such as Lavadinho and Abram (2005) and Kelly et al. (2011) have investigated the walkability of urban territories. This approach underlines the importance of the built environment in encouraging or discouraging people to walk (Cervero and Duncan, 2003). So-called walkability indices now integrate built environment factors such as pavements (sidewalks), roads and buildings, as well as territorial factors such as urban density, safety, the weather, etc.[1]

While such indicators are useful for town planners, they can also inform micro-social decision processes. To our knowledge, very few studies have sought to associate urban form and mode choice

[1] See Lavadinho and Abram (2005) for a full list of spatial factors likely to influence walking.

and when they have, it has usually been with a public health perspective (Humpel et al., 2004; Frank et al., 2008).

As far as walking behaviour is concerned, few studies have investigated how individuals resort to walking in European contexts. The coming together of spatial and individual characteristics can be documented in only a handful of studies in the international literature: Giles-Corti and Donovan (2003) and Frank et al (2008) conducted such investigations respectively in urban Australia and North America, while Diaz Olvera and Kane (2002) and Kane et al. (2008) used a similar approach in urban settings in West Africa. Our investigation of the factors likely to influence walking behaviour may be compared to the approach used by Agrawal and Schimek (2007) in the United States, except that we apply it to Switzerland.

Mobility is usually a means to an end, in the sense that its purpose is to access goods, services or other venues situated outside the home. Traditionally, trips are subdivided into groups with labels such as: work, study, shopping, leisure, visits, etc. Income inequality is known to have a strong effect on access to mobility (Mignot, 2001), however this is far less the case for walking which does not require as much money or network knowledge than public or private motorised transport. The main barriers to walking – which may however prove significant among aged and/or handicapped populations – are physical. However, safety is an issue for all walkers, who are far more exposed than other road users, notably because they spend longer on the road to cover the same distance.

Given that walking is for practical purposes free of charge, and that compared to other modes it exposes people to high short-term risks (accidents) while bringing long-term health benefits (mainly cardiovascular), why would people choose such a mode? The negative image often associated to not being mobile is one element which should be taken into account. Kaufmann (2005) associates mode choice with specific motilities, i.e. mobility potentials. This implies that the use of any mode, including walking, requires skills which can be developed – or not – over time. These skills are related to the characteristics of the geographical areas within which people live their lives, and ultimately contribute to the formation of their lifestyles as a whole. Financial, social or cultural weaknesses can play a role in limiting motility, and therefore mobility. This is true not only for access to motorised vehicles, but also for other transport modes. The complex link between motility and mode choice was recently reviewed by De Witte et al. (2013), who defined mode choice as "the decision process to choose between different transport alternatives, which is determined by a combination of individual socio-demographic factors and spatial characteristics, and influenced by socio-psychological factors".

2. Methods

Data from the 2010 Swiss transport micro-census (MRMT) were used for the analysis. This complex database covers the whole of Switzerland. It enables the analysis of all transport bouts in excess of 25 metres and which are not entirely within a closed space such as a train station or shopping mall. During the course of the year 2010, over 62,000 people were interviewed by telephone and asked to describe in detail what transport activities they had carried out on a reference day (see Table 1). The MRMT database therefore allows the detailed analysis of all walking bouts, whether they were carried out in the same area as the area of residence or not.

Table 1. Total number of people investigated in each conurbation

Conurbation	Number of people investigated	Total number of trips (all modes)
Zurich	7662	25 539
Geneva	5094	17 004
Basel	3240	10 663
Berne	3082	10 153
Lausanne	2296	7588
Switzerland	**62 868**	**211 302**

Our analysis concentrated on the five largest conurbations in Switzerland, according to the official definitions of the Swiss Statistical Office. In order to carry out more detailed analyses, the cities were sub-divided into sectors. The details and geographical coordinates of these sectors were supplied by the Swiss Statistical Office and correspond to official definitions. This allowed our team to distinguish between the dense central areas within the cities and other areas within city limits which are residential, industrial or unbuilt. Each conurbation was analysed sector by sector within the city centre, and commune by commune in the outskirts.

We added the following variables to the MRMT dataset:[2]

- Variable A: jobs/residents ratio = full-time job equivalents/number of inhabitants;
- Variable B: human activity density = (inhabitants + jobs)/hectare of built surface.

Thanks to the presence of XY coordinates in the MRMT dataset, we were able to attribute values for Variable A and Variable B to all the walking trips. In order to allow comparisons between zones, we decided to qualify Variable A and Variable B in the following manner:

- Weak: 1st quartile
- Medium: 2nd and 3rd quartiles

[2] Other more traditional measures of density were used in the analysis but are not presented here.

- High: 4th quartile

For each zone, we defined the mode share of walking for trips which had this zone as a destination.

3. Results – individual characteristics

The average mode share of walking across all five conurbations is slightly less than one third. As can be seen in Table 2, women walk significantly more than men. People aged 21-60 walk less (mode share in the range of 28-29%) than people who are either younger (40%) or older (37% between 61 and 80 years old, 47% over the age of 81). These differences are similar across the five cities. People in employment walk less than those either in education or retired (mode shares respectively 27 %, 32 % and 40 %). Among people in employment, those with a management role (23%) or who run their own business with the help of employees (24%) walk less than the unemployed (41%). Regarding family structure, people living alone (36%) walk more than people living as a couple, with or without children (30-31%). Single parents living with one or more children are in an intermediate position (34%). These data may be interpreted in terms of time constraints leading to less walking among people who do not live alone.

Table 2. Mode share for walking

Conurbation	Mode share for walking (men)	Mode share for walking (women)	Mode share for walking (average)
Zurich	28%	33%	30%
Geneva	34%	40 %	37%
Basel	29%	35%	32%
Berne	29%	34%	32%
Lausanne	28%	34%	31%
Average	**30%**	**35%**	**32%**

As far as level of education is concerned, people who have only had compulsory education walk more than those who have a qualification, whatever that qualification may be: apprenticeship, vocational education, University, etc. (respectively 36% vs. 29% mode share for walking). In a similar vein, people at the lowest salary level walk a great deal more (41%) than those at the highest salary level (28%). Despite recent changes in urban lifestyles, basic economic power still appears to exert a "traditional" effect on mode choice.

Walking is linked to the availability of a car (see Table 3), which is particularly interesting in the case of Geneva where 55% of city residents do not have a car. So the economic factor mentioned in the previous paragraph appears to be compounded by an environmental factor (linked to density) and a contextual factor (parking is strongly constrained in Geneva).

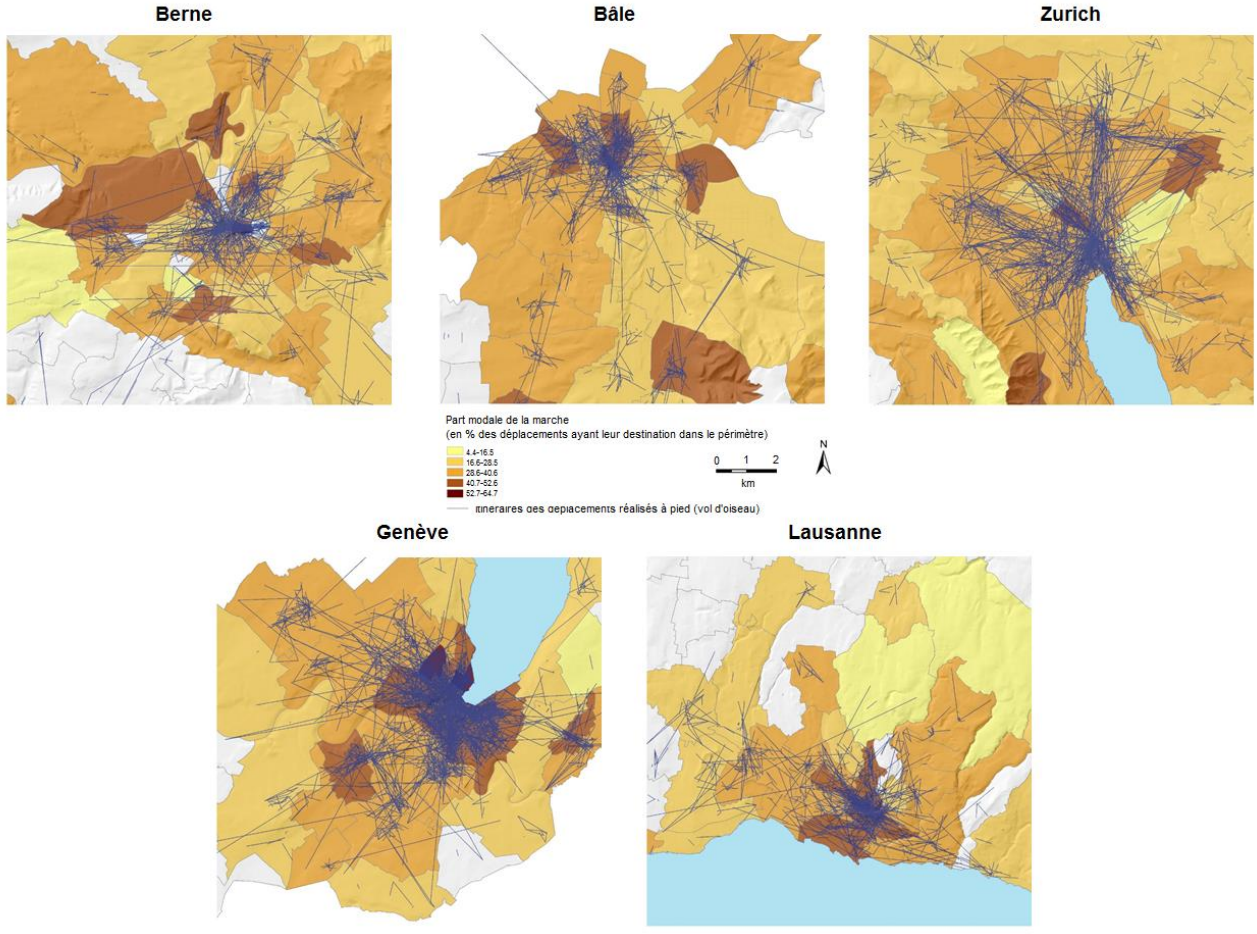
Table 3. Mode share for walking, compared to the availability of an automobile

Conurbation	Car always available	Car available on demand	Car not available	Average
Zurich	23%	29%	37%	25%
Geneva	29%	39%	55%	32%
Basel	25%	32%	44%	28%
Berne	26%	31%	37%	28%
Lausanne	23%	33%	49%	26%
Average	**25%**	**31%**	**44%**	**27%**

4. Results – spatial analysis

Spatial analysis of walking bouts whose destinations are the sectors and sub-sectors of the five conurbations is shown in Figure 1. Mode split is coded in colour from dark brown = lots of walking, to yellow = very little walking. Walking trips are represented as straight lines (as the crow flies).

Figure 1. Mode share of walking and OD paths[3] in the 5 largest conurbations in Switzerland.



From Figure 1 it can be seen that the mode share of walking does not vary systematically in a circular manner, with more walkable central areas surrounded by areas with less walking. However, the actual walking trips (straight lines) do congregate in the city centres. This is partly because these

[3] Origin-destination (OD) paths are shown as straight lines. The darker areas correspond to higher shares of walking compared to other modes.

areas have far more trips altogether, i.e. the colour code corresponds to the proportion of walking trips while the straight lines point to the number of walking trips.

In Berne, our results show that the Old Town has mode shares for walking in excess of 40%. This is interesting because most of this area is banned to all motorised traffic except delivery vehicles and public transport. In the outer parts of the Bernese conurbation, the highest levels of walking are observed in Neufeld and Bethlehem to the north-west and in Köniz to the south. In the rest of Berne, the mode share of public transport is higher than the mode share of walking. As for the OD walking trips, they congregate around the historic centre of the city and extend to the west towards Hollingen and Bümpliz. High numbers of walking trips can be observed in the direction of the Wankdorf complex to the north-east, an area where substantial development has occurred in recent years including a new football stadium combined with a shopping mall, offices and concert halls.

In Basel, walking has a high mode share in the old town and in adjacent areas to the north of the Rhine (Claraplatz, Matthäus). A handful of residential areas have walking shares in excess of 40%, such as Gotthelf and Iselin within city limits and Birsfelden and Arlesheim on the outskirts. The high concentration of walking trips emphasises the geography of the city, with a partially pedestrianized centre with many shops extending from the main train station north towards the old town and covering both banks of the Rhine.

In central Zurich, the mode share of walking lies between 30% and 40%. The only district of the city where its share exceeds 40% is around the Gewerbeschule. Nevertheless, some areas outside city limits exceed the 40% mark, such as Hirzenbach or Leimbach. Public transport has a higher mode share than walking in many sectors inside and outside city limits. The concentration of walking trips in the centre of the city co-exists with substantial secondary concentrations in areas such as Kloten to the north and Altstetten to the west.

In Geneva, the mode share of walking is high in almost every borough within city limits, exceeding 40% in 13 out of 16 of them. Walking even reaches 58% in the extremely dense Pâquis area (between the central train station and the lake) and in more residential Grand Pré/Vermont (between the central train station and the United Nations area). Suburban Onex to the west and Chêne-Bourg to the east also have walking levels in excess of 40%. In contrast to Zurich, in Geneva walking has a comparable market share to public transport in the city centre. On the map, walking trips can be observed leading towards the west (Charmilles/Châtelaine and Saint-Jean/Aïre) as well as south (Carouge) and to the north-west (Meyrin).

In Lausanne, a clear north-south axis (from Bellevaux down to Ouchy by the lakeside) has walking levels in excess of 40%. This area includes the city centre and more residential boroughs such as Maupas-Valency, Montriond-Cour and Sous-Gare. In the rest of the city, walking levels are under the 30% mark. Contrary to the Swiss-German cities, walking is less in competition with public transport, but more with private motorised vehicles. Lausanne is a notoriously hilly city, and the

east-west walking routes more or less follow contour lines (level curves). The suburban towns of Renens and Prilly to the west and Pully to the east are identifiable as secondary walking hotspots on the map.

The five maps in Figure 1 show that the dense urban centres are the focus of many walking trips, which may be expected in a country such as Switzerland where, in contrast to some other countries, urban sprawl has been partly contained through land-use legislation. Nevertheless, secondary centres are emerging in each of the five settings. An interesting common element is the effect of large infrastructure such as motorways or airports, or physical barriers such as lakes or mountains (especially in Zurich) which discourage walking far more than other modes. This is apparent to the west of Geneva (airport, motorway) and to the west of Lausanne (motorway, railway, former industrial area).

Another interesting point is that the association between the number and proportion of walking trips is strong in Geneva and Lausanne, but relatively weak in the three Swiss-German cities. The mode share of public transportation is higher there than in Geneva or Lausanne, which might explain this phenomenon. Finally, the concentration of walking is very different across the five settings, ranging from high density in Geneva to a more diffuse pattern in Zurich.

5. Results – density and urban function

We explored the effects of two structural parameters on the mode share of walking: density of jobs and inhabitants, and the ratio between jobs and inhabitants. These variables reflect density and urban function, respectively. For both of these variables, the effect of the zone of origin and of the zone of destination was analysed.

At a general level, the mode share of walking is higher when the zone of origin and the zone of destination are similar in nature (Table 4). No more than 5% of trips between areas with different densities are captured by walking, although part of this effect is probably due to the increased distances involved. Walking is more often used to link up two high density areas (47%) than between two medium-density areas (40%). But the mode share increases somewhat surprisingly for trips where both the origin and destination are low-density areas. This is particularly apparent in Basel, Bern and Zurich. In Geneva and Lausanne, walking is strongly associated with high-density areas, whereas the pattern is more diffuse in the Swiss-German cities.

Table 4. Effect on mode share of walking, linking areas with low, medium or high density

Conurbation	From low to low	From medium to medium	From high to high	From low to medium	From low to high	Average
Zurich	52%	36%	41%	1%	2%	30%
Geneva	37%	50%	50%	4%	7%	38%
Basel	49%	40%	46%	2%	5%	33%
Berne	43%	41%	47%	3%	6%	32%
Lausanne	34%	35%	5%	1%	9%	31%
Average	**43%**	**40%**	**47%**	**2%**	**6%**	**33%**

The jobs/inhabitants ratio is low when the area is residential and high in areas which concentrate offices and other employment facilities; the ratio qualifies as medium or mixed when there are a comparable number of jobs and residents. The effect of this metric on the mode share of walking is surprising. As can be seen in Table 5, it is not in the mixed areas that the most walking is observed but in areas with more jobs than inhabitants. There also is more walking in residential areas than in mixed areas, which could qualify as a further surprise.

In order to attempt to explain the results obtained regarding density (jobs + inhabitants) and functional specialisation (jobs/inhabitants ratio), we investigated the given motives for the walking trips. Indeed, if walking is present in various types of areas, it is not the same sort of walking. Across the five conurbations, leisure explains 40-43% of walking trips, followed by shopping (20-25%) and working or studying (9-14% for each). In our view, if walking is to become the dominant mode in a given area, it is not sufficient for it to capture only one motive. In Basel, Berne and Zurich, strong secondary poles have appeared on the outskirts of the city centre. In these areas, there are far more jobs than inhabitants (hence the high jobs/inhabitants ratio). However, these areas bring together jobs with other attractions such as schools, shops and leisure centres, which are each able to capture some walking trips. More work is clearly needed in this area, in order to define what mix of activities and urban functions is most conducive to walking. In contrast, in Geneva and Lausanne, most of the walking taking place in the outskirts is recreational.

Table 5. Effect of the jobs/inhabitants ratio on the mode share of walking

Conurbation	From residential to residential	From mixed to mixed	From job-oriented to job-oriented	From residential to mixed	From residential to job-oriented	Average
Zurich	48%	37%	51%	8%	11%	30%
Geneva	45%	49%	62%	13%	26%	37%
Basel	52%	39%	57%	9%	21%	32%
Berne	53%	41%	58%	5%	13%	32%
Lausanne	45%	40%	67%	7%	13%	31%
AVERAGE	49%	41%	59%	8%	17%	32%

6. Conclusion

Our results show similarities between the 5 largest urban areas in Switzerland. In particular, the role of individual socio-demographic and economic factors is confirmed as being very important in determining the propensity to walk. Regarding the role of spatial factors, the situation is less clear-cut. Contrary to what might have been expected, dense areas and areas which are functionally mixed, i.e. combining both jobs and residents, do not concentrate walking or walkers in significant amounts. It appears that a high proportion of urban walking takes place in areas which are not particularly dense, nor particularly mixed from the functional point of view. Many of these pedestrian trips lead towards schools or other educational institutions, or are leisure-inspired. These findings are in keeping with a recent study conducted on 13 sustainable neighbourhoods in the United Kingdom, which also failed to find higher incidences of walking in denser, more highly mixed and more permeable developments (Susilo et al, 2012).

Regarding the link between spatial factors and walking, a further unexpected result of our study is the difference between French-speaking and German-speaking cities. Indeed, Geneva and Lausanne have significantly higher rates of walking than Basel, Berne and Zurich. This result should be analysed with caution, however, because public transport use is higher in the German-speaking cities than in Geneva and Lausanne. There may therefore be an element of competition between walking and public transport, with the former winning in French-speaking areas where public transport is traditionally weak (despite recent improvements) and the latter capturing higher market shares in the German-speaking cities, all three of which never dismantled their extensive tramway networks inherited from over one century ago (contrary to Geneva and Lausanne).

It is not possible to establish causality based on this study, but it is tempting to hypothesise whether an excellent public transport system may in some cases lead to less walking within a city. As a contribution to the research agenda, we suggest investigating such a hypothesis by analysing the link between walking and public transport use in a large number of medium-sized cities across Europe.

More work is also needed in order to define the mix of activities and urban functions most conducive to walking, taking into account the multiple interactions with individual characteristics. Therefore, we suggest that the choice of walking as a transport mode should be investigated specifically, using a wide range of individual, social and spatial parameters. This work at the quantitative level would need to be guided and reinforced using qualitative methods such as individual interviews, walk-along interviews and GPS-assisted travel diaries.

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