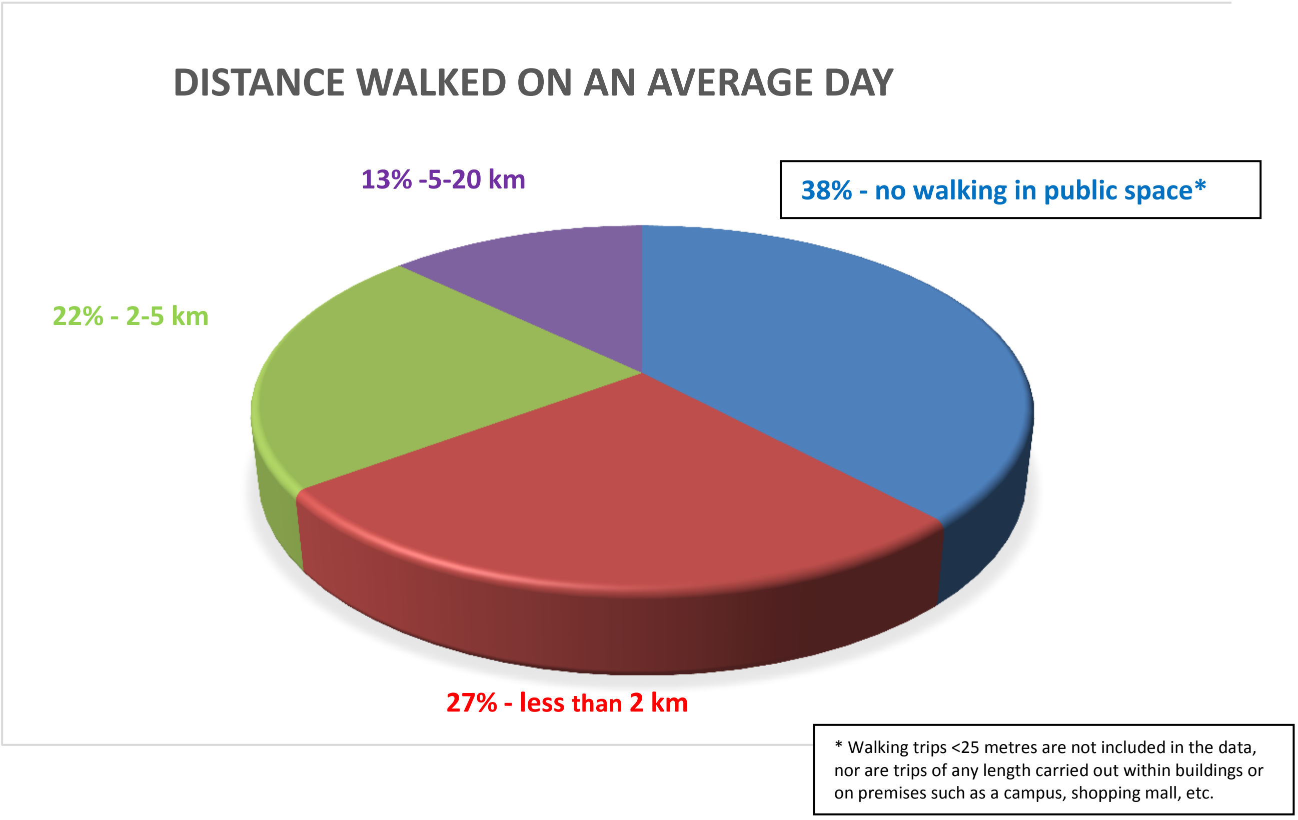


Analysing the distribution of walking in the Swiss population

Derek Christie, Laboratory of urban sociology, EPFL
Emmanuel Ravalet, Laboratory of urban sociology, EPFL
Vincent Kaufmann, Laboratory of urban sociology, EPFL

Conference paper STRC 2015

STRC | **15th Swiss Transport Research Conference**
Monte Verità / Ascona, 15-17 April 2015

Mapping the distribution of walking in the Swiss population

Derek Christie
Laboratory of urban sociology, EPFL
1015 Lausanne
Switzerland

Phone: +4121 693 8069
derek.christie@epfl.ch

Emmanuel Ravalet
Laboratory of urban sociology, EPFL
1015 Lausanne
Switzerland

Phone: +4121 693 3296
emmanuel.ravalet@epfl.ch

Vincent Kaufmann
Laboratory of urban sociology, EPFL
1015 Lausanne
Switzerland

Phone: +4121 693 6229
vincent.kaufmann@epfl.ch

Revised version, May 2015

Abstract

In many countries including Switzerland, public policy encourages people to walk for reasons linked to health, the environment, and transport. However, the distribution of walking in the population is not known. People who walk great distances have not been investigated, nor have people who do no walking in public spaces although they drive a motorised vehicle (and who, arguably, may be seen as not conforming to certain public policy objectives). Nothing is known about the proportions or their distribution in space of these groups. In order to answer these questions, this project uses the Swiss transport micro-survey (MRMT2010), a complex database whose 13 inter-related sub-files include information on transport behaviour on a randomly selected reference day for 62'686 individuals. Each person was interviewed by telephone, in a representative stratified sample covering the whole of Switzerland.

Rather than investigating mode shares, this study concentrates on the people involved in the survey. Preliminary analyses allowed the selection of walking bouts in one data file, which were then aggregated and linked to the characteristics of the people which were in another file. Detailed investigations on the distribution of walking in the population were carried out.

The results show that walking in Switzerland is not normally distributed. The curve representing kilometres walked on the reference day is strongly skewed towards the left because a substantial proportion of the population walked very little or not at all. This finding is illustrated using histograms, and its implications are discussed. We then sub-divided the population into several groups, with different levels of walking and other transport behaviours. Altogether, 12% of the sample stayed at home on the reference day. A further surprise was that 23% of the sample succeeded in driving a mechanised vehicle, without any walking in public space (transport within buildings or facilities is not covered in MRMT2010, nor are any bouts < 25 metres).

Other groups of interest identified were small walkers (who walked less than 2 km on the reference day) representing 27% of the sample), average walkers (2-5 km, 22%) and big walkers (>5km, 13%), as well as non-walking cyclists (4%) and outliers (>20 km of walking, 0.6% of the total sample). The implications of such a wildly unequal distribution of walking in Switzerland are discussed, and preliminary maps are shown, suggesting that people with widely different transport behaviours on a given day may well live next to each other. A suggestion is made to start tailoring public policy information in order to target the aforementioned groups. This has been done with success in sectors such as tobacco control, so in our view there is potential for such an approach if it is suitably adapted and applied to the promotion of walking.

Keywords

Walking – Mobility – Motility – Switzerland – Urban sociology

1. Introduction

1.1 Renewal of research and public policy interest in walking

Walking is the focus of increasing interest for reasons linked to public health, environmental protection, climate change and transport policy. The European COST Action 358, Pedestrian Quality Needs (Methorst R. 2010), came to the following conclusion:

> *People need to walk. The quality of their experience however can vary greatly and this in turn is known to directly impact on their decisions to choose to walk instead of choosing other modes and the frequency, length, scope and enjoyment of their trips. Walking is such a basic way of travelling that it is easy to forget its importance. Walking however should be considered as the essential lubricant of the transport system. Although almost everyone agrees that it is important to have pedestrian facilities, few politicians give it priority (…). For pedestrian policy to be further developed and implemented a new impulse is clearly needed.*

Walking is the most fundamental form of human transportation and the one that leaves the smallest environmental footprint. It is also the least-understood major mode of transportation in many countries, although knowledge about pedestrian behaviour has critical policy applications (Agrawal and Schimek 2007). Many researchers, advocates and experts have argued that walking should be placed at the centre of transport policy, however this is clearly not yet the case (Von der Mühll 2004).

1.2 Distribution of walking in the population

Despite considerable research interest for walking, little is known about the distribution of this activity in the general population. In Switzerland, an average (mean) walking distance of 1.9 km per person and per day has been published by the Swiss Federal Office of Statistics (OFS and ARE 2012). But little is known about the distribution of walking distances within the population, and even less about associated demographic, socio-economic or geographic characteristics.

A Canadian research team recently provided detailed geographical information on walking behaviour in two cities, including travel episodes, origins and destinations, routes, durations and distances (Spinney, Millward, and Scott 2012; Millward, Spinney, and Scott 2013). Otherwise, detailed descriptions of walking at an aggregate level have rarely been carried out (Hallal et al. 2005).

A study in the USA found that only 16% of respondents (in a general population-based sample) had at least one daily walking trip; here, the mean walking distance was 0.7 miles (~1.1 km), and the activity took around 15 minutes. In that study, the distances and durations of walking for recreation were longer than those for other purposes; and people with lower household income walked longer distances for work but shorter distances for recreation. The authors concluded that there was variability in the distance and duration of walking trips by purpose and population subgroups and that these differences have implications for developing strategies to increase physical activity through walking (Yang and Diez-Roux 2012). The consensus in the literature is that walking is highly relevant as a source of daily physical activity, all the more so that active commuting was recently linked to general physical activity levels, according to a study carried out in Cambridge, UK (Yang et al. 2012).

A recent study on 706 participants in Seattle (USA) gave an average walking time of 26 minutes per day, although the sample was not considered representative of the general population. In fact, the primary interest of that study is methodological: the authors came to the conclusion that the integration of GPS and travel diary data with accelerometer data allows reliable identification of walking behaviour in almost all investigated individuals (Kang et al. 2013).

Another quantitative aspect relevant to our research is the so-called Zahavi conjecture, which holds that the total time spent in travelling remains more or less constant, at around one hour per day (Zahavi and Talvitie 1980). This suggested stability of the travel-time budget has been called into question, because the same person may display very different transport behaviours on different days of the same week (Pas and Koppelman 1986). Recently, the phenomenon of highly mobile people has given rise to publications which also cast doubt on the Zahavi conjecture, because total time budgets for mobility do seem to be rising, at least for some categories of the population (Viry, Kaufmann, and Ravalet 2015). However, so far this research has concentrated on transport by road, rail and aeroplane (Viry and Kaufmann 2015, in Press) and therefore it is not known whether people who habitually walk great distances conform or not to the Zahavi conjecture.

It should be added that the idea of a more or less constant travel time for home-to-work commutes – despite ever greater transport distances – still has its supporters, who sometimes refer to commuter time tolerance. This concept implies that there is a maximum tolerated value for travel time, but no minimum (Vale 2013; Van Ommeren and Rietveld 2005).

A separate analysis of walking for exercise (Hovell et al. 1989), transport or leisure (Cleland, Timperio, and Crawford 2008) is often found in the literature. However, key experts on walking have advised us not to operate an ex ante separation between these categories, because motivations for walking or not walking are often complex (von der Mühll, personal communication) (Sauter, personal communication). Indeed, a Swiss study found evidence of a correlation between walking for leisure and for transport, suggesting that it is common for a single walking bout to have several motivations (Spissu et al. 2009). It would therefore be advisable for future projects to aim at capturing all walking bouts, which may later be subdivided into episodes with various motivations or goals.

1.3 Walkability and urban form

The prevalence of walking in a population is influenced by the type of territory in which walking might take place. There is abundant literature showing that urban quality stimulates walking (Turrell et al. 2013; Alfonzo et al. 2014; Lin and Moudon 2010), although it is clear that urban quality is a partly subjective concept (Lin and

Moudon 2010) and that it does not influence every individual in the same way (Forsyth et al. 2009). A recent study on Swiss cities showed that walking tends to concentrate in city centres and other areas with high densities of inhabitants and economic activities (Ravalet et al. 2013). Several studies have shown that land use mix, street and pedestrian connectivity, population density and neighbourhood design are important determinants of urban walking. However, a recent review found that street connectivity, land use mix and traffic-related factors were associated only with walking for transport and not with recreational walking. The same study found that population density was associated with walking but not with cycling (McCormack and Shiell 2011).

Another study, on pedestrian attitudes, perceptions and behaviour in 19 European countries (not including Switzerland), found that 30% of respondents expressed anger and/or frustration regarding the quality of infrastructure for pedestrians (Papadimitriou, Theofilatos, and Yannis 2013). Another aspect on which there is substantial literature, especially from Asia, is the positive effect of walking in a natural environment versus walking in a built environment (Li et al. 2008; Li et al. 2009; Li et al. 2011). There is an apparent trade-off between walking a longer distance through a park and enduring a shorter but less pleasant trudge along a major road; indeed, there is evidence that people walk faster in a green environment in order to offset the longer travel time (Sellers et al. 2012).

The appropriateness of a given territory or area for walking has sometimes been framed as walkability. We conducted a preliminary overview of one of the leading walkability metrics: the "Neighbourhood Environment Walking Scale" (NEWS), put forward by James F. Sallis and his team at the University of California, San Diego (Saelens et al. 2003). NEWS assesses “residents' perception of neighbourhood design features related to physical activity, including residential density, land use mix (including both indices of proximity and accessibility), street connectivity, infrastructure for walking/cycling, neighbourhood aesthetics, traffic and crime safety, and neighbourhood satisfaction”.

1.4 Motility, determinants and routines

At EPFL, the Laboratory of urban sociology (LaSUR) has developed an approach towards urban science based on the observation of mobility. This follows in the footsteps of the Chicago School which stated, in the 1930s, that people endowed with locomotion were a key object of sociological study. The present research proposal builds on three research threads developed at the LaSUR: motility, the determinants of modal practices, and daily routines.

The concept of “motility” describes the ability of individuals to be mobile (Kaufmann 2002; Kaufmann 2006). It includes access (social gateways), core competencies and mobility projects (Kaufmann 2011). Although several studies have sought to measure motility (Kaufmann, Viry, and Widmer 2010; Canzler W. 2008; Kesselring 2005), this research area is still in an exploratory phase, in the sense that it has not yet produced a standard method for measuring motility. Motility forms a practical framework for the analysis of the motivations, decision-making processes, and constraints that dominate the use of space. Research conducted at LaSUR indicates that motility is not a personal trait based on innate skills, nor a simple consequence of the geographic position of a workplace or place of residence. Rather, it is a construct based upon multiple interactions (Kaufmann 2006). To draw a parallel with physics, the difference between mobility and motility is akin to the difference between kinetic and potential energy.

1.5 Health effects of walking

Walking is the most easily accessible form of physical activity. Regular physical activity has significant health benefits and can help prevent numerous chronic diseases as well as improving well-being and quality of life. Physical inactivity is a modifiable causal factor contributing to the current global epidemic of overweight and obesity (Spinney, Millward, and Scott 2011).

According to the World Health Organization (WHO), during the 2000s and 2010s non-communicable diseases became the leading cause of death in the world. A high proportion of the surplus mortality and morbidity could be prevented by acting on only 4 parameters: tobacco, alcohol, diet and physical activity (WHO, 2011). Physical activity levels for adults in 122 countries were recently reviewed by the Lancet Physical Activity Series Working Group, which concluded that, globally, around 31% of adults are physically inactive. As shown in Figure 1, Europe is close to the global average. According to WHO statistics, one-third of the global adult population is overweight, defined as having a body-mass index (BMI) over 25 kg/m2, and around one-third of these are obese, with a BMI ≥30 kg/m2 (www.who.int). Between 1980 and 2008, the age-standardised mean BMI for men increased in every sub-region in the world except central Africa and south Asia, at a rate of 0.4 kg/m2 per decade (Finucane et al. 2011).

Obesity comorbidities include coronary heart disease, hypertension and stroke, certain types of cancer, non-insulin-dependent diabetes mellitus, gallbladder disease, dyslipidaemia, osteoarthritis and gout, and pulmonary diseases (WHO 2000). Lack of physical activity has been identified as the fourth leading risk factor for global mortality (6% of deaths globally) and as the main cause for 21–25% of breast and colon cancers, 27% of diabetes and approximately 30% of the ischaemic heart disease burden (WHO World Health Report, 2011).

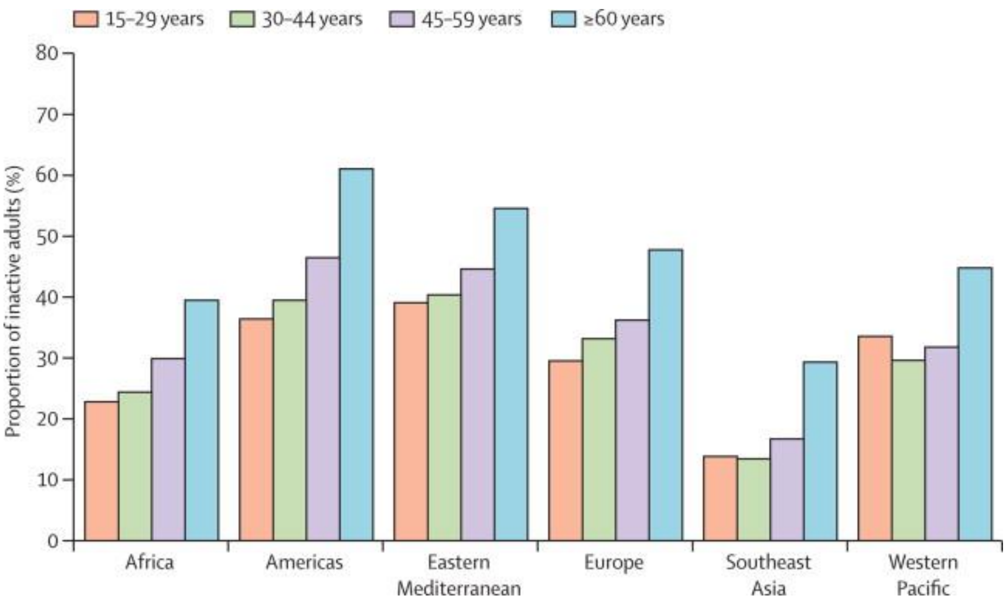


Figure 1. Physical inactivity in age groups by WHO region (Hallal et al. 2012).

Along with renewed efforts in nutrition, tobacco and alcohol control, there is therefore no doubt that an increase in daily physical activity is one of the most important public health goals globally. In order to attain this objective, one of the problems often mentioned is the difficulty to find sufficient time during a modern urban day to practice so-called leisure time physical activity. Thus, the often quoted minimum threshold of "30 to 60 minutes of medium intensity physical activity on most days of the week" (Tudor-Locke et al. 2011) remains unattainable for around half of the population in most industrialised and emerging countries throughout the world.

Nutrition is often considered to be the main driver of the obesity epidemic. However, recent research indicates that the lack of physical activity may be playing an even more important role. In the UK, people are eating less now than they did in 1970. According to the British National Food Survey, the average daily intake was 2560 calories per person in 1970 and only 1750 calories in 2000. But in 1967, some 77% of adults walked for at least 30 minutes every day, compared with only 42% in 2010. In Switzerland, the latest federal report on nutrition (OFSP 2012) observed that overweight and obesity have increased over the past 30 years while overall nutritional levels have not changed and levels of physical activity have plummeted.

Despite such clear evidence that insufficient physical activity is driving the epidemic of overweight and obesity, most campaigns continue to promote diet-based interventions rather than daily walking (Harrison 2014). However, unhealthy behaviours such as overeating and under-exercising are often correlated with each other (Chiolero et al. 2006), so our emphasis on physical activity and walking does not imply any complacency on our part regarding nutrition or other factors underlying the epidemic.

1.6 Research gaps

Despite the high numbers of articles related to walking in the scientific literature, putative research gaps have been identified. Regarding quantitative approaches to walking, a study focussing on two medium-sized cities in Canada (Spinney, Millward, and Scott 2012; Millward, Spinney, and Scott 2013) recently defined time-decay and distance-decay functions for walking. These are respectively the times and distances after which the mode share of walking decreases significantly. Although the concepts of time-decay or distance-decay are not new and have been applied to other transport modes (Fotheringham 1981), their application to walking represents an important progress for research on the subject. To our knowledge, there has been no confirmation study on the results found in Canada, and no similar study has been carried out in Europe.

With a more qualitative approach, Rachel Thomas and co-workers at Le Cresson, based in Grenoble, France, have argued that each bout of walking constitutes a unique cognitive and sensory experience between walker and environment (Thomas 2010). They have also suggested that walking has the capacity to anchor a person to his or her urban environment, at a practical and physical level but also at social, perceptive and affective levels. It follows that walking in itself is a worthy topic for sociological investigation. Rachel Thomas favours a new, direct approach, which implies asking walkers to describe their experience while they walk through various areas (Thomas 2007). We believe that the Cresson team has identified an important element here, which is worthy of further research. In particular, the way in which a walker interacts with his or her urban environment on an individual and day-to-day level has not been studied in depth in Switzerland, and requires a qualitative approach.

Regarding the public health aspects of walking, most of the articles and research projects in the international literature concentrate on road safety (Mendoza et al. 2012; Luoma and Peltola 2013; Lubbe and Davidsson 2015), on sub-populations with health conditions such as heart disease (Shiue 2015), type 2 diabetes (Cuaderes, Lamb, and Alger 2014) or other chronic conditions (Van Eikeren et al. 2008; Barriga, Rodrigues, and Barbara 2014; Pau et al. 2014) or on groups considered to be at a disadvantage such as the elderly (Mosallanezhad et al. 2014; Van Holle et al. 2014) or schoolchildren (Rothman et al. 2014; Napier et al. 2011; Chillon et al. 2014). It is also striking that, in the public health literature, there is considerable research about people who do not walk enough (Owen et al. 2014; Kikuchi et al. 2014; Kozo et al. 2012; Proper et al. 2011; Salmon et al. 2011; Thorp et al. 2011), but very little – perhaps even nothing – on people who walk more than the recommended levels. Investigating such "frequent walkers" would be a novel way of approaching research on walking. Indeed, the scientific community now knows quite a lot about why sedentary people do not walk, but does not know why some of the other people continue to walk despite circumstances which are sometimes far from ideal.

Investigating the articulation of transport-inspired and health-inspired public policies in favour of walking with the practical problems associated with integrating walking into daily routines is a complex interdisciplinary task. Only a handful of recent articles can be found investigating such situations in Canada (McCormack et al. 2010), the USA (Morrow et al. 2011), the UK (Middleton 2011; Procter et al. 2014) or Scandinavia (Lindelöw et al. 2014). One of the only identified articles of this type concerning continental Europe was a study on active commuting by students in

Madrid, Spain (Molina-Garcia, Sallis, and Castillo 2014). It therefore appears timely to carry out a study in a Swiss urban context which would concentrate not on a particular population such as schoolchildren, students or older citizens, but on the general population of walkers.

Despite numerous online searches and exchanges with experts on walking in Switzerland and elsewhere, we found no publications referring to healthy people who walk extensively. Investigating such people, defined as frequent walkers, implies a significant reversal of the public health research logic: we will be deliberately seeking out people who are non-sedentary in the midst of an epidemic of sedentariness. Although this seems to be a novel idea in the field of urban walking, investigating people with purportedly favourable characteristics is not unheard of in research. For example there is interest across various fields for hardiness (Sindik and Adzija 2013) and resistance to stress (Cooper, Clinard, and Morrison 2015), as well as for resilience in individuals (Chan, Chan, and Kee 2013; Vilete et al. 2014) or populations (Norris, Tracy, and Galea 2009). To our knowledge, this interest has not yet spilled over into research on walking.

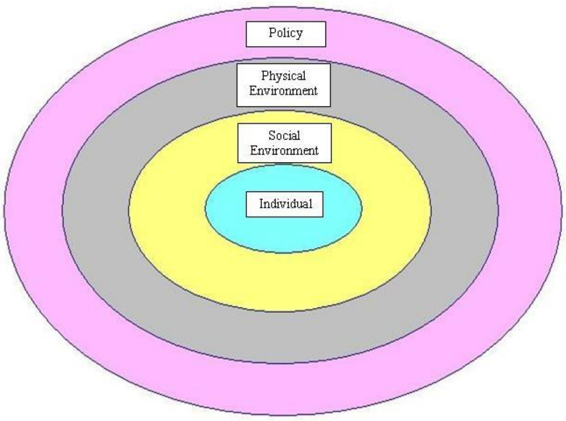
Several intervention studies were also identified in the literature. These include pedometer-based interventions (Choi et al. 2007; Wallmann and Froboese 2011) and other campaigns aiming at increasing daily walking (Williams et al. 2008; Leahey et al. 2010; Barwais, Cuddihy, and Tomson 2013). Such studies seek to modify reality, whereas this project proposes to observe reality, using an observational and phenomenological approach.

2. Methods

Walking is a human behaviour and therefore amenable to the tools of social psychology (Duvall 2011). Social psychology is distinguished from other fields by its focus on social processes and the mechanisms by which social support and social isolation contribute to health, and by the investigation of attitude and behaviour change processes that help understand when and how people may change their health behaviours (Taylor 2011). Social psychology is rich in conceptual frameworks such as the Theory of planned behaviour or the Theory of reasoned action (Ajzen 1991), as well as the Trans-theoretical model with its stages of change through which people may progress in order to attain healthier behaviours (Prochaska and Velicer 1997). Social psychology frameworks have been used to study urban mobility (Anable and Gatersleben 2005) or behaviours such as smoking which are also concerned with individual choices made under the influence of social, cultural and regulatory environments (Wakefield et al. 2014; Jacobson and Banerjee 2005).

We believe that a social psychology approach to walking is useful for this project, because mode choice need not – and in our view should not – be approached without taking the social, cultural and regulatory environment into account. Social psychology frameworks have recently been used for investigating body-weight management (Johnson et al. 2013; Wu and Chu) and even for promoting walking and cycling (Dill, Mohr, and Ma 2014). This project uses the so-called socio-ecological model to guide the research progress. This model is derived from social psychology principles and an example of it is shown in Figure 2.

Figure 2 The social-ecological model

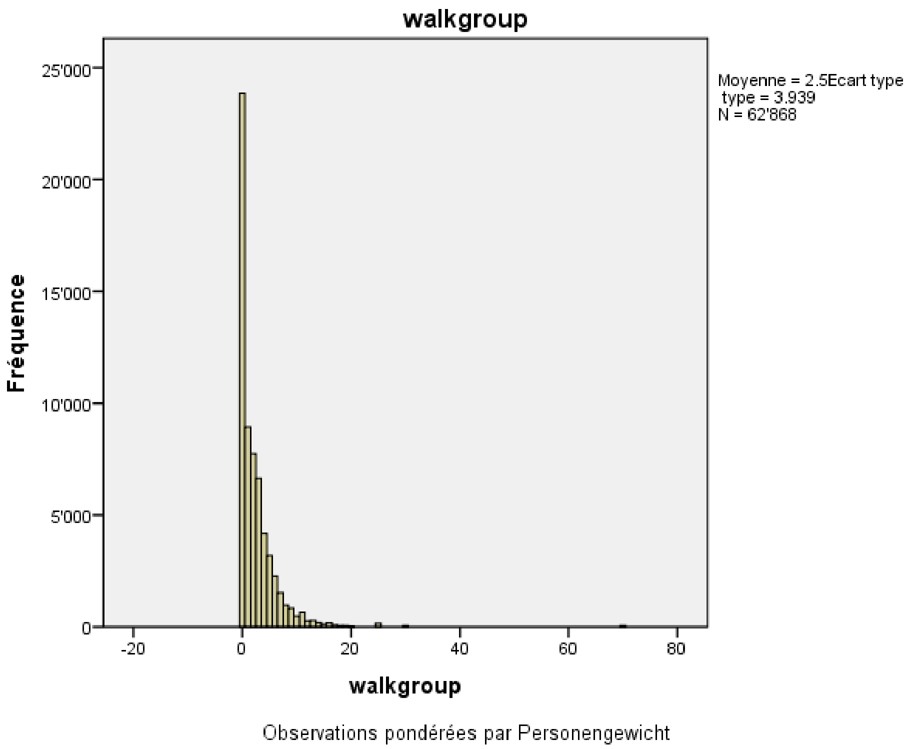


Source: VCAA (Victorian curriculum and assessment authority)

In practice, our preliminary analyses were carried out on SPSS. Using the MRMT2010 dataset, we selected walking bouts (*Etappen.sav*) and aggregated them by creating unique identifiers for each person. Then these walking bouts were summed and moved to another file (*Zielpersonen.sav*) which contained the characteristics of the people participating in the survey.

3. Results

According to our preliminary results, the average Swiss person walked 2.1 km on the reference day. This value conceals considerable inter-individual differences, since fully 38% of the participant population did not declare any walking at all. Among the 62% of people who did walk, the average distance was 3.3 km. Even among walkers, variety is considerable, since the standard deviation is 3.7, i.e. greater than the mean value itself. It follows that the distribution is not a normal one. Indeed, it can be seen that skewness is 3.48 and kurtosis is 24.3 for walkers (if non-walkers are included the distribution is even more non-normal). Looking at graphs and histograms for both distributions (respectively of all participants and of those who walked on the reference day) it can be seen that the distributions are positively skewed, i.e. they have a long tail to the right. It follows that mode, median and mean follow each other from left to right: they are respectively 0, 0.8 and 2.1 for all respondents and 2, 2.2 and 3.3 for walkers.



Graph 1. Graph showing the number of kilometres walked per person on the reference day. The distribution is evidently far from normal. (Data: MRMT2010)

Leaving aside all non-walkers, the 39’002 walkers in the sample have a lopsided distribution of walking distances over the reference day. Pearson’s estimate for asymmetry (or skewness) is both positive and high, at 3.8 whereas standard deviation is at 3.3. These results might lead us to abandon extreme values of walking more than 20 km, because we believe that the chances of them being outliers is high.

It should be emphasised that our preliminary results are in keeping with published results by OFS, whereby total distances covered on the reference day were on average 2.8 km for “soft transport” (walking and cycling), 24.4 km by private motorised vehicle, 8.6 km by public transport, a further 0.9 km being categorised as "other". According to our calculations, it follows that Swiss people generally cover between 2 and 2.1 km on foot and around .8 km by bicycle, further confirming, if necessary, that in Switzerland walking is far more important for public health and for transport than cycling.

As well as the 38% of the sample who did no walking on the reference day, a further 14%, 12% and 10% did less than 1 km, between 1 and 2 km, and between 2 and 3 km, respectively). Some 12% of the sample walked between 3 and 5 km. Frequent walkers were defined as having walked between 5 and 10 km on the reference day, and accounted for 10% of the sample. Very frequent walkers, defined as having walked between 10 and 20 km, represented around 3% of the sample and those having walked even more than that (between 20 km and the highest level, booked at over 60 km) were only 0.5% of the sample and were considered outliers or errors.

So the total of frequent walkers and very frequent walkers is in the range of 12-13% in Switzerland according to this sample. This is higher than was anticipated in the description which was submitted to the FNS for this project. We were expecting anything in the range of 2-12% so we are at the top of that bracket. However, the statistics being derived from self-declaration, the true value may be lower. Indeed, several studies have shown that it is common for respondents to over-estimate their walking and physical activity in general.

In terms of numbers, around 8000 respondents (taking weighting into account) could be considered frequent or very frequent walkers. Given the general sampling coefficient in MRMT2010 which is approximately 125, there are probably around 1 million frequent walkers in Switzerland. This does show to what extent frequent walking, or frequent walkers, are far more common than many people probably think. It will be the task of the qualitative phase to make sense out of how so many frequent walkers can be active in Switzerland without anyone really paying attention to them.

It is interesting to note that the latest Swiss Health Survey (hereafter SHS2012) lists respondents by level of physical activity in 3 groups: active, partially active and non-active. These categories account for respectively 73%, 17% and 11% of the population. But despite the class of "actives" being almost three times the size of the other two classes, no effort is made to investigate the upper reaches of active people, where not only sportsmen and sportswomen but also frequent walkers are likely to be found. Active people are defined in the context of SHS2012 as having accomplished at least 150 minutes of medium-intensity physical activity in the previous week, or at least 2 bouts of intense physical activity.

As regards daily transportation, SHS2012 gives results which cannot be directly compared to MRMT2010 because up to three transport modes could be selected as the preferred mode for "daily travel". The total of all answers is therefore over 100%. Nevertheless, it is interesting to note that only 44% of respondents listed walking and 19% listed cycling in this context. It is not known how many listed both walking and cycling, but we can extract the information that around 56% of the Swiss population in the SHS2012 survey did not use walking for transport on a regular basis.

Statistics		
Total walking distance (rdist)		
N	Valid	62868
	Missing	0
Mean		2.06
Median		.80
Mode		0
Standard deviation		3.324
Asymmetry		3.776
Asymmetry standard error		.010
Kurtosis		27.982
Kurtosis standard error		.020
Percentiles	25	.00
	50	.80
	75	2.98

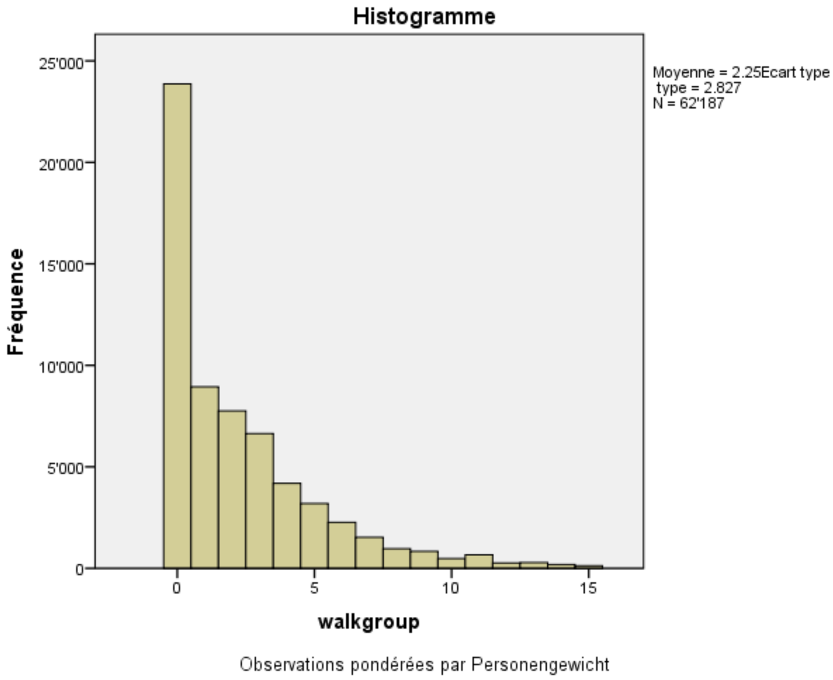
Table 1. Basic characterisation of the distribution of walking distances in the Swiss population (data: MRMT2010)

Category	Frequency	Percent
Did not walk	23866	38.0
Walked < 1 km	8944	14.2
Walked 1-2 km	7758	12.3
Walked 2-3 km	6635	10.6
Walked 3-5 km	7381	11.7
Frequent walkers (5-10 km)	6074	9.7
Very frequent walkers	1944	3.1
Outliers (> 20 km)	266	.4
Total	62868	100.0

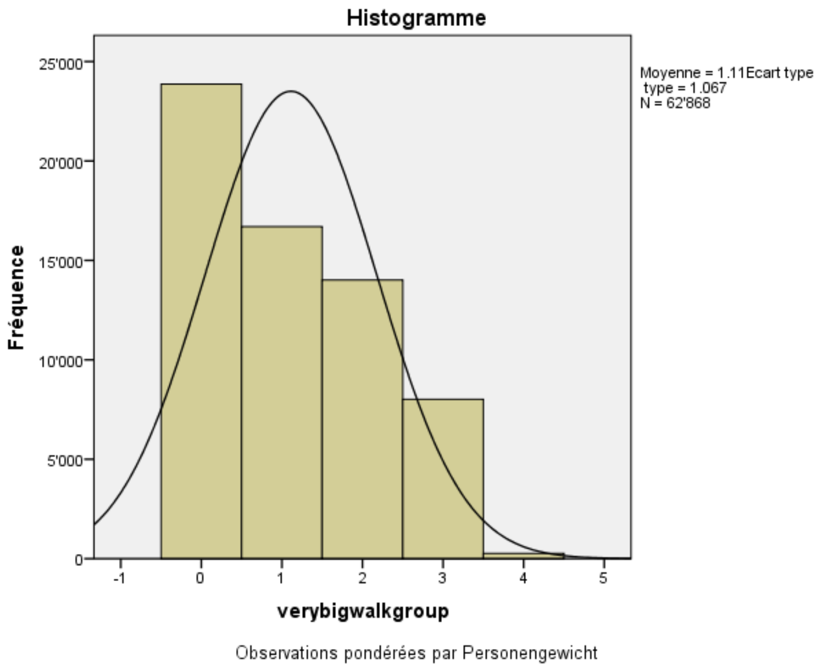
Table 2. One example of how walkers could be grouped into categories, based on their walking behaviour on the reference day. (Data: MRMT2010)

Category	Frequency	Percent
No walking	23866	38.0
< 2 km	16702	26.6
2-5 km	14016	22.3
5-20 km	8018	12.8
> 20 km	266	0.4
Total	62868	100.0

Table 3. Another example of how walkers could be grouped into categories. It can be seen that frequent walkers represent around 12.8% of the sample. (Data: MRMT2010)



Graph 2. Number of people who walked x kilometres on the reference day (x axis: number of kilometres walked, regrouped per km, 0 = 0 km walked; 1 = between 0 and 1 km walked; etc.). Data: MRMT2010.



Graph 3. Histogram of walking behaviour. (Data: MRMT2010)
N.B. The superimposed curve was generated by the computer programme (on SPSS) as an approximation of the bell curve which would have been expected if the distribution had been normal. However the histogram shows very clearly that the distribution is not normal at all.

Key:
0: no walking;
1: < 2 km;
2: 2-5 km;
3: 5-20 km

	Non walkers	Little walkers (< 2 km)	Medium walkers (2-5 km)	Great walkers (5-20 km)	Total
German	17015	11391	9965	5935	44306
	38.4%	25.7%	22.5%	13.4%	100.0%
French	5746	4395	3398	1722	15261
	37.7%	28.8%	22.3%	11.3%	100.0%
Italian	1040	857	599	322	2818
	36.9%	30.4%	21.3%	11.4%	100.0%
Rhaeto-rumantch	65	58	54	40	217
	30.0%	26.7%	24.9%	18.4%	100.0%
Total	23866	16701	14016	8019	62602
	38.1%	26.7%	22.4%	12.8%	100.0%

Table 4. Preliminary investigations around differences between linguistic regions. Distance walked on reference day, according to residence in linguistic areas in Switzerland

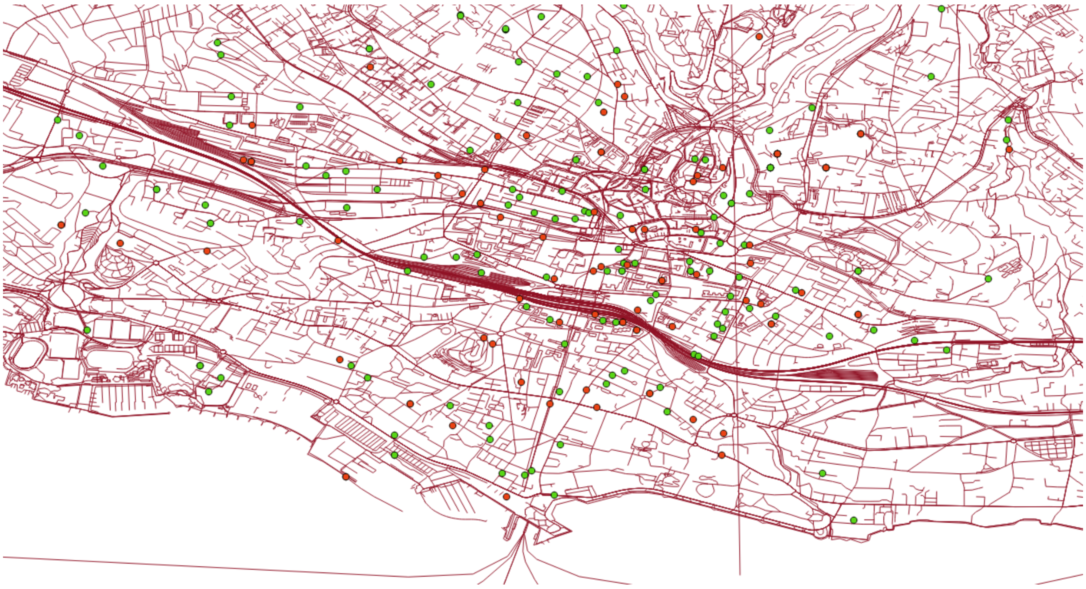
Preliminary investigations show that there are significant inter-regional differences between language areas in Switzerland (see table above). Further investigations are underway in order to determine if some of these differences can be controlled for by investigating the effects of other variables (such as the urban/rural ratios which are known to be higher in French-speaking Switzerland compared to other areas).

Finally, we subdivided the sample into 7 groups, which can be seen in the table underneath. These groups had significantly different transport behaviours on the reference day.

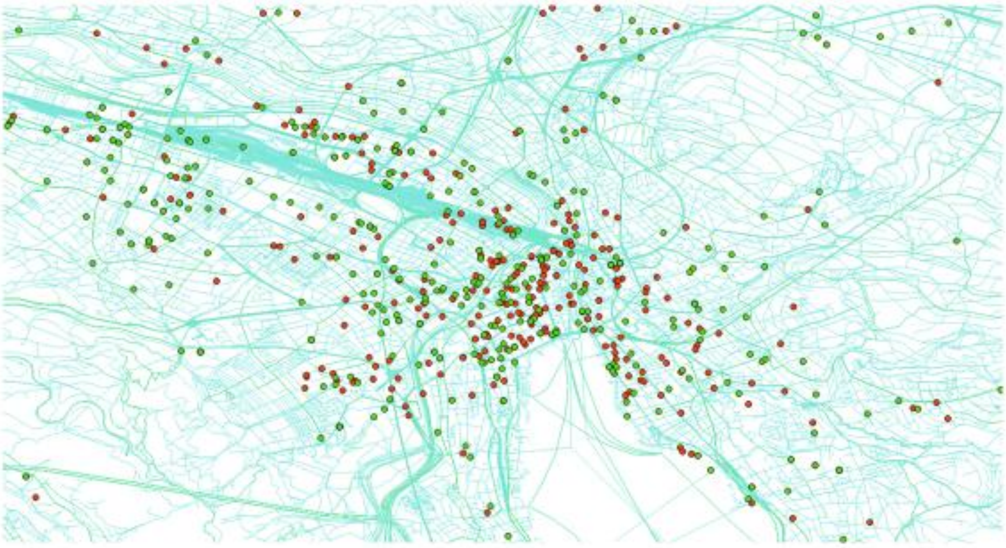
Typology	Numbers	Percent
Stayed at home	7252	11.5
Cycled but did not walk	2495	4.0
Drove car or scooter, but did not walk	14120	22.5
Little walkers < 2 km	16702	26.6
Medium walkers 2-5 km	14016	22.3
Great walkers 5-20 km	8018	12.8
Outliers (walk >20km)	266	0.4
Total	62868	100.0

Table 5. Walking behaviour in small groups, compared to other behaviours on the reference day.

At this stage, we attempted to transfer the "grands marcheurs" (5-20 km) and the exclusive car drivers into Q-GIS. An example is given below for the city of Lausanne and another for the city of Zurich. In these illustrations, frequent walkers are in red and the car drivers are in green. At this stage, we realised that if the two groups were dissimilar in size (in this case, car drivers were 76% more numerous than frequent walkers) then the spatial display might be somewhat misleading. At this stage, we also realised that there were 6 sets of coordinates in the dataset: WGS84 and CH1903, for place of residence, place of work and place of study.



Map 1. Map of Lausanne with basic city grid. Red dots = walkers. Green dots = drivers.



Map 2. Map of Zurich with basic city grid. Red dots = walkers. Green dots = non-walking drivers.

4. Discussion and conclusion

The fact that the average person in Switzerland walks around 2 to 2.1 km per day was already well known. What was not known is the distribution of walking in the population. Thanks to the data and the illustrations in the Results section, we can see that the distribution is heavily skewed to the right: close to 40% of the population did not walk at all on the reference day. As can be seen in the histograms (Graphs 1-3), the distribution is far from normal. This may have consequences when exploring what explanatory variables might be pressed into service in order to try to explain what is going on. After all, walking is a basic human and biological process, and it was not foreseen that so many people would be either non-walkers or very limited walkers on a randomly determined reference day.

After consideration of the data, it was decided to create a group of “frequent walkers”, defined as having walked at least 150% of the average walking in the sample, i.e. 3.1 km, on the reference day. This group formed around 23% of the sample and enabled us to have similar numbers of non-walking drivers and frequent walkers. This will be an advantage for visualising the results during the spatial analysis which will be carried out on Q-GIS in a later phase of the project. Maps showing the scatter of these two sub-populations have been presented for Zurich and Lausanne, where it will be seen that, in cities, the two sub-populations are remarkably intermixed.

The policy implications of this work are that several clearly defined groups of walkers and non-walkers probably exist in Switzerland, therefore public policy messages should be tailored for these various groups. Up to now, campaigns have encouraged people to walk more, without much consideration of the initial mobility behaviour of the participants. Or, when a baseline was defined, it was defined only in terms of walking behaviour (e.g. number of steps per day) and not in terms of general mobility behaviour. Whereas, as we have seen, there are at least 4 very different categories of people who hardly walk at all: those who cycle (4% of the population on the reverence day), those who drive, those who stay at home, and those who do walk but very little.

We would therefore suggest tailoring messages for these various groups. This is possible because there is an important precedent: web sites such as stop-tabac.ch (operated by the University of Geneva) have shown that it is possible to devise a web-based interactive system which takes into account the characteristics of smokers in order to encourage them to change their behaviour – in that case, to give up or at least strongly reduce smoking. We encourage the Swiss health authorities to finance a pilot project in order to investigate this avenue of electronically-assisted prevention, which in our view holds strong potential for improving public health in Switzerland, with interesting spin-off effects for the environment and for urban living as a whole.

5. References

Agrawal, A.W. and P. Schimek. 2007. Extent and correlates of walking in the USA. *Transportation Research Part D: Transport and Environment* **12:548-563**.

Alfonzo, M.; Z. Guo; L. Lin; and K. Day. 2014. Walking, obesity and urban design in Chinese neighborhoods. *Preventive Medicine* **69, Supplement:S79-S85**.

Barriga, S.; F. Rodrigues; and C. Barbara. 2014. Factors that influence physical activity in the daily life of male patients with chronic obstructive pulmonary disease. *Revista Portuguesa De Pneumologia* **20:131-137**.

Barwais, F.A.; T.F. Cuddihy; and L.M. Tomson. 2013. Physical activity, sedentary behavior and total wellness changes among sedentary adults: a 4-week randomized controlled trial. *Health and Quality of Life Outcomes* **11:8**.

Chan, A.O.; Y.H. Chan; and J.P. Kee. 2013. Exposure to crises and resiliency of health care workers in Singapore. In *Occup Med (Lond)*, 141-144. England.

Chillon, P.; D. Hales; A. Vaughn; Z. Gizlice; A. Ni; and D.S. Ward. 2014. A cross-sectional study of demographic, environmental and parental barriers to active school travel among children in the United States. *International Journal of Behavioral Nutrition and Physical Activity* **11**.

Chiolero, A.; V. Wietlisbach; C. Ruffieux; F. Paccaud; and J. Cornuz. 2006. Clustering of risk behaviors with cigarette consumption: A population-based survey. *Preventive Medicine* **42:348-353**.

Choi, B.C.K.; A.W.P. Pak; J.C.L. Choi; and E.C.L. Choi. 2007. Achieving the daily step goal of 10,000 steps: The experience of a Canadian family attached to pedometers. *Clinical and Investigative Medicine* **30:E108-E113**.

Cleland, V.J.; A. Timperio; and D. Crawford. 2008. Are perceptions of the physical and social environment associated with mothers' walking for leisure and for transport? A longitudinal study. *Preventive Medicine* **47:188-193**.

Cooper, M.A.; C.T. Clinard; and K.E. Morrison. 2015. Neurobiological mechanisms supporting experience-dependent resistance to social stress. *Neuroscience* **291C:1-14**.

Cuaderes, E.; W.L. Lamb; and A. Alger. 2014. The Older Adult with Diabetes: Peripheral Neuropathy and Walking for Health. *Nursing Clinics of North America* **49:171-181**.

Darker, C.D.; M. Larkin; and D.P. French. 2007. An exploration of walking behaviour—An interpretative phenomenological approach. *Social Science & Medicine* **65:2172-2183**.

Finucane, M.M.; G.A. Stevens; M.J. Cowan; G. Danaei; J.K. Lin; C.J. Paciorek; G.M. Singh; H.R. Gutierrez; Y. Lu; A.N. Bahalim; F. Farzadfar; L.M. Riley; and M. Ezzati. 2011. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. In *Lancet*, 557-567. England: 2011 Elsevier Ltd.

Forsyth, A.; J. Michael Oakes; B. Lee; and K.H. Schmitz. 2009. The built environment, walking, and physical activity: Is the environment more important to some people than others? *Transportation Research Part D: Transport and Environment* **14:42-49**.

Fotheringham, A.S. 1981. Spatial structure and distance-decay parameters. Annals of the Association of American Geographers, 71(3), pp. 425–436

Hallal, P.C.; M.R. Azevedo; F.F. Reichert; F.V. Siqueira; C.L. Araújo; and C.G. Victora. 2005. Who, when, and how much? Epidemiology of walking in a middle-income country. *American journal of preventive medicine* **28:156-161**.

Harrison, N. 2014. Obesity and public health campaigning. *The Lancet Diabetes & Endocrinology* **2:109**.

Hovell, M.F.; J.F. Sallis; C.R. Hofstetter; V.M. Spry; P. Faucher; and C.J. Caspersen. 1989. Identifying correlates of walking for exercise: An epidemiologic prerequisite for physical activity promotion. *Preventive Medicine* **18:856-866**.

Kang, B.; A.V. Moudon; P.M. Hurvitz; L. Reichley; and B.E. Saelens. 2013. Walking objectively measured: classifying accelerometer data with GPS and travel diaries. *Med Sci Sports Exerc* **45:1419-1428**.

Kikuchi, H.; S. Inoue; T. Sugiyama; N. Owen; K. Oka; T. Nakaya; and T. Shimomitsu. 2014. Distinct associations of different sedentary behaviors with health-related attributes among older adults. *Prev Med* **67:335-339**.

Kozo, J.; J.F. Sallis; T.L. Conway; J. Kerr; K. Cain; B.E. Saelens; L.D. Frank; and N. Owen. 2012. Sedentary behaviors of adults in relation to neighborhood walkability and income. *Health Psychol* **31:704-713**.

Leahey, T.M.; M.M. Crane; A.M. Pinto; B. Weinberg; R. Kumar; and R.R. Wing. 2010. Effect of teammates on changes in physical activity in a statewide campaign. *Preventive Medicine* **51:45-49**.

Lin, L. and A.V. Moudon. 2010. Objective versus subjective measures of the built environment, which are most effective in capturing associations with walking? *Health & Place* **16:339-348**.

Lindelöw, D.; Å. Svensson; C. Sternudd; and M. Johansson. 2014. What limits the pedestrian? Exploring perceptions of walking in the built environment and in the context of every-day life. *Journal of Transport & Health* **1:223-231**.

Lubbe, N. and J. Davidsson. 2015. Drivers' comfort boundaries in pedestrian crossings: A study in driver braking characteristics as a function of pedestrian walking speed. *Safety Science* **75:100-106**.

Luoma, J. and H. Peltola. 2013. Does facing traffic improve pedestrian safety? *Accident Analysis & Prevention* **50:1207-1210**.

McCormack, G.R.; C. Friedenreich; A. Shiell; B. Giles-Corti; and P.K. Doyle-Baker. 2010. Sex- and age-specific seasonal variations in physical activity among adults. *Journal of Epidemiology and Community Health* **64**.

McCormack, G.R. and A. Shiell. 2011. In search of causality: a systematic review of the relationship between the built environment and physical activity among adults. In *Int J Behav Nutr Phys Act*, 125. England.

Mendoza, J.A.; K. Watson; T.-A. Chen; T. Baranowski; T.A. Nicklas; D.K. Uscanga; and M.J. Hanfling. 2012. Impact of a pilot walking school bus intervention on children's pedestrian safety behaviors: A pilot study. *Health & Place* **18:24-30**.

Middleton, J. 2011. "I'm on autopilot, I just follow the route": exploring the habits, routines, and decision-making practices of everyday urban mobilities. *Environment and Planning A* **43:2857-2877**.

Millward, H.; J. Spinney; and D. Scott. 2013. Active-transport walking behavior: destinations, durations, distances. *Journal of Transport Geography* **28:101-110**.

Molina-Garcia, J.; J.F. Sallis; and I. Castillo. 2014. Active Commuting and Sociodemographic Factors Among University Students in Spain. *Journal of Physical Activity & Health* **11:359-363**.

Morrow, J.R.; T.M. Bain; G.M. Frierson; E. Trudelle-Jackson; and W.L. Haskell. 2011. Long-Term Tracking of Physical Activity Behaviors in Women: The WIN Study. *Medicine and Science in Sports and Exercise* **43:165-170**.

Mosallanezhad, Z.; M. Salavati; G.R. Sotoudeh; L. Nilsson Wikmar; and K. Frändin. 2014. Walking habits and health-related factors in 75-year-old Iranian women and men. *Archives of Gerontology and Geriatrics* **58:320-326**.

Napier, M.A.; B.B. Brown; C.M. Werner; and J. Gallimore. 2011. Walking to school: Community design and child and parent barriers. *Journal of Environmental Psychology* **31:45-51**.

Norris, F.H.; M. Tracy; and S. Galea. 2009. Looking for resilience: Understanding the longitudinal trajectories of responses to stress. *Social Science & Medicine* **68:2190-2198**.

OFS and ARE. 2012. 2010 Swiss Micro-census on Mobility and Transport. www.bfs.admin.ch/bfs/portal/fr/index/themen/11/07/01/02.html.

OFSP. 2012. **6th Swiss Nutrition Report. Swiss Federal Office of Public Health.** www.bag.admin.ch/themen/ernaehrung_bewegung/13259/13359/index.html?lang=en.

Owen, N.; J. Salmon; M.J. Koohsari; G. Turrell; and B. Giles-Corti. 2014. Sedentary behaviour and health: mapping environmental and social contexts to underpin chronic disease prevention. *Br J Sports Med* **48:174-177**.

Pas, E. and F. Koppelman. 1986. An examination of the determinants of day-to-day variability in individuals' urban travel behavior. *Transportation* **13:183-200**.

Pau, M.; G. Coghe; C. Atzeni; F. Corona; G. Pilloni; M.G. Marrosu; E. Cocco; and M. Galli. 2014. Novel characterization of gait impairments in people with multiple sclerosis by means of the gait profile score. *Journal of the Neurological Sciences* **345:159-163**.

Procter, S.; N. Mutrie; A. Davis; and S. Audrey. 2014. Views and experiences of behaviour change techniques to encourage walking to work: a qualitative study. *Bmc Public Health* **14:13**.

Proper, K.I.; A.S. Singh; W. van Mechelen; and M.J.M. Chinapaw. 2011. Sedentary Behaviors and Health Outcomes Among Adults: A Systematic Review of Prospective Studies. *American Journal of Preventive Medicine* **40:174-182**.

Ravalet, E.; D. Christie; S. Munafò; and V. Kaufmann. 2013. D'un quartier à l'autre: analyse quantitative de la marche dans la Suisse urbaine. Colloque international francophone piéton. Montréal 20-22 novembre 2013.

Rothman, L.; T. To; R. Buliung; C. Macarthur; and A. Howard. 2014. Influence of social and built environment features on children walking to school: An observational study. *Preventive Medicine* **60:10-15**.

Saelens, B.E.; J.F. Sallis; J.B. Black; and D. Chen. 2003. Neighborhood-based differences in physical activity: an environment scale evaluation. *Am J Public Health* **93:1552-1558**.

Salmon, J.; M.S. Tremblay; S.J. Marshall; and C. Hume. 2011. Health risks, correlates, and interventions to reduce sedentary behavior in young people. *Am J Prev Med* **41:197-206**.

Shiue, I. 2015. *International Journal of Cardiology* **179:375-377**.

Sindik, J. and M. Adzija. 2013. Hardiness and situation efficacy at elite basketball players. *Coll Antropol* **37:65-74**.

Spinney, J.E.; H. Millward; and D. Scott. 2012. Walking for transport versus recreation: a comparison of participants, timing, and locations. In *J Phys Act Health*, 153-162. United States.

Spinney, J.E.L.; H. Millward; and D.M. Scott. 2011. Measuring active living in Canada: A time-use perspective. *Social Science Research* **40:685-694**.

Spissu, E.; A. Pinjari; C. Bhat; R. Pendyala; and K. Axhausen. 2009. An analysis of weekly out-of-home discretionary activity participation and time-use behavior. *Transportation* **36:483-510**.

Thomas, R. 2007. La marche en ville. Une histoire de sens. Walk in the city. An history of senses. L'espace Geographique 1(1), pp.15-26.

———. 2010. Marcher en ville. Faire corps, prendre corps, donner corps aux ambiances urbaines.

Thorp, A.A.; N. Owen; M. Neuhaus; and D.W. Dunstan. 2011. Sedentary Behaviors and Subsequent Health Outcomes in Adults: A Systematic Review of Longitudinal Studies, 1996–2011. *American Journal of Preventive Medicine* **41:207-215**.

Tudor-Locke, C.; C.L. Craig; W.J. Brown; S.A. Clemes; K. De Cocker; B. Giles-Corti; Y. Hatano; S. Inoue; S.M. Matsudo; N. Mutrie; J.M. Oppert; D.A. Rowe; M.D. Schmidt; G.M. Schofield; J.C. Spence; P.J. Teixeira; M.A. Tully; and S.N. Blair. 2011. How many steps/day are enough? For adults. In *Int J Behav Nutr Phys Act*, 79. England.

Turrell, G.; M. Haynes; L.-A. Wilson; and B. Giles-Corti. 2013. Can the built environment reduce health inequalities? A study of neighbourhood socioeconomic disadvantage and walking for transport. *Health & Place* **19:89-98**.

Vale, D.S. 2013. Does commuting time tolerance impede sustainable urban mobility? Analysing the impacts on commuting behaviour as a result of workplace relocation to a mixed-use centre in Lisbon. *Journal of Transport Geography* **32:38-48**.

Van Eikeren, F.J.M.; R.S.J. Reijmers; H.J. Kleinveld; A. Minten; J.P. Ter Bruggen; and B.R. Bloem. 2008. P2.094 Nordic walking improves mobility in Parkinson's disease. *Parkinsonism & Related Disorders* **14, Supplement 1:S67**.

Van Holle, V.; J. Van Cauwenberg; D. Van Dyck; B. Deforche; N. Van de Weghe; and I. De Bourdeaudhuij. 2014. Relationship between neighborhood walkability and older adults' physical activity: results from the Belgian Environmental Physical Activity Study in Seniors (BEPAS Seniors). *International Journal of Behavioral Nutrition and Physical Activity* **11**.

Van Ommeren, J. and P. Rietveld. 2005. The commuting time paradox. *Journal of Urban Economics* **58:437-454**.

Vilete, L.; I. Figueira; S.B. Andreoli; W. Ribeiro; M.I. Quintana; J. de Jesus Mari; and E.S. Coutinho. 2014. Resilience to trauma in the two largest cities of Brazil: a cross-sectional study. In *BMC Psychiatry*, 257. England.

Viry, G.; V. Kaufmann; and E. Ravalet. 2015. High mobility over the life course: evidence from a longitudinal study in Europe Symposium" internal migration and commuting in international perspective", University of Hamburg and BiB.

Viry, G. and V.E. Kaufmann. 2015, in Press. Mobile Europe: high mobility, work and personal life.

Von der Mühll, D. 2004. Mobilité douce: nostalgie passéiste ou perspective d'avenir? In: Les territoires de la mobilité - L'aire du temps. Vodoz, L., Pfister Giauque, B., Jemelin, C. (Eds.). PPUR, Lausanne.

Wallmann, B. and I. Froboese. 2011. Intervention effects of 3000 steps more per day. *Wiener Klinische Wochenschrift* **123:369-377**.

WHO. 2000. Obesity: preventing and managing the global epidemic. WHO Technical Report Series 894. www.who.int/nutrition/publications/obesity/WHO_TRS_894.

Williams, D.M.; C.E. Matthews; C. Rutt; M.A. Napolitano; and B.H. Marcus. 2008. Interventions to increase walking behavior. *Medicine and Science in Sports and Exercise* **40:S567-S573**.

Yang, L.; J. Panter; S.J. Griffin; and D. Ogilvie. 2012. Associations between active commuting and physical activity in working adults: Cross-sectional results from the Commuting and Health in Cambridge study. *Preventive Medicine*.

Yang, Y. and A.V. Diez-Roux. 2012. Walking Distance by Trip Purpose and Population Subgroups. *American Journal of Preventive Medicine* **43:11-19**.

Zahavi, Y. and A. Talvitie. 1980. Regularities in travel time and money expenditures. Transportation Research Record 750, pp. 13–19.