Not really a quiet stroll. The perception of insecurity during pedestrian trips in Dakar (Senegal)

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Abstract

This paper aims to analyze the personal and environmental factors that influence the perception of insecurity in the case of walking trips in Dakar (Senegal), according to the travel situation (daytime / night-time, inside / outside one's neighborhood). The empirical analysis is based on data from the household mobility survey carried out in 2015 (3,176 households and 13,415 individuals aged 11 years and over). Descriptive and multivariate statistical analyses (a multiple correspondence analysis and logit models) highlight significant differences in the perception of insecurity according to the travel situation (day / night; individuals' own neighborhood / elsewhere) and the characteristics of individuals, their household and residential neighborhood. The travel situation strongly influences the prevalence of the feeling of fear and has allowed us to identify a gradient in the perception of insecurity. Among the socio-demographic characteristics, gender plays a pre-eminent role and having previously been the victim of a robbery or assault while waiting for public transport increases the probability of feeling fear. The contextual determinants (public lighting, characteristics of sidewalks; social homogeneity, isolation, and dangerousness of one's neighborhood) show that a degraded or insufficiently developed urban environment adversely affects urban dwellers' feelings of insecurity. Economic resources, whether those of the individual or their household, play a less important role. Our results argue for greater consideration of the perception of insecurity when considering the mobility practices of urban dwellers in sub-Saharan Africa, especially with regard to pedestrian trips.

Keywords: Personal security; Walking; Travel situation; Individual and contextual factors; Multivariate analysis

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1. Introduction

In both the cities of the North and the South, the ways travel needs are met and mobility is achieved are influenced by many factors. These relate in particular to the personal characteristics of urban dwellers (age, gender, employment status, position in the household, physical capacities, etc.), the characteristics of their household (composition, income, etc.), and of their daily environment (accessibility, public transport services, depending on their residential location). Together, these determine a range of personal resources such as having access to a personal vehicle, the availability and affordability of public transport services, knowledge about transport services. These can be called on to successfully perform daily mobility but if any of these resources are lacking they can become constraints, or difficulties, with regard to mobility.

Personal security may be considered to be one of the resources that determine the use of transport modes. Admittedly, highlighting the fear of being assaulted may in some cases be a way of justifying mobility practices that are influenced by other determinants (Pearlstein and Wachs, 1982; Mattioli, 2014). While such biases exist, many studies focusing mainly on cities of the North show that the perception of security is an essential aspect of travel. A negative perception of travel risk, and more generally risk in public spaces, can lead individuals to think about not doing some activities, or not helping dependents such as children and young people to do them (Gülgönen and Corona, 2015; INEGI, 2018; Monqid, 2014; Porter et al., 2010; Ureta, 2008). A feeling of insecurity limits the use of transport modes and access to urban services, which in turn can restrict the positive impact of transport provision on social exclusion (Newton, 2004).

The issue of personal security also plays a role in the context of walking trips. Ureta (2008) observed that in Santiago du Chili, perceived insecurity limited the amount of walking. Based in particular on findings from Loukaitou-Sideris (2006) and McDonald (2008), Zhang (2016) argued that a decrease in the crime rate increases potential use of non-motorized modes, such as walking. The feeling of insecurity during pedestrian trips is also increased by a lack of lighting and infrastructure for pedestrians (Anand and Tiwari, 2006; Kruger and Landman, 2008). Similarly, Piatkowski et al. (2019) showed that in four North-American cities, areas that are free from crime and the presence of more street lights are factors that enable walking.

The literature on walking as a means of transport has become more abundant in recent years, especially in the countries of the North. This is mainly due to public health recommendations to do physical exercise and replace the use of motorized modes by walking. However, the effects of insecurity during pedestrian travel have not been sufficiently studied, either in the case of end-to-end walking trips or walking as part of intermodal trips (Newton, 2014). As far as the cities of sub-Saharan Africa are concerned, in view of the importance of walking in the mobility patterns and everyday life of the inhabitants, Behrens (2005), Diaz Olvera et al. (2013) and Sietchiping et al. (2012) vigorously advocate considering insecurity issues when investigating this travel mode and developing and evaluating transport policies.

This paper thus aims to analyze the factors that influence the perception of insecurity in the case of walking trips in Dakar (Senegal) and addresses the following issues:

- Does the perception of insecurity vary according to the travel situation, in particular between daytime and night-time trips and between trips inside and outside one's neighborhood?
- To what extent is the perception of insecurity shared by city-dwellers?

- What are the respective effects of personal factors (gender, income, personal experience of insecurity, etc.) and contextual factors (characteristics of one's residential neighborhood, condition of sidewalks)? In particular, is the perception of insecurity more frequent among low-income groups whose mobility relies heavily on walking?

Our empirical analysis is based on data from the household mobility survey carried out in 2015 for the Dakar public transport organizing authority (CETUD - Conseil Exécutif des Transports Urbains de Dakar), for which 3,176 households in the Dakar region were interviewed (Sitrass-Curem, 2016).

The main part of the paper begins with a literature review (Section 2) on personal security, with particular reference to walking trips, in order to highlight mobility-related issues. The data we have used and the urban context of Dakar are then presented (Section 3). This is followed by descriptive and multivariate statistical analyses (Section 4) which highlight significant differences in the perception of insecurity according to the travel situation, the characteristics of individuals, their household and residential neighborhood. Finally, in the conclusion (Section 5), we highlight the main results from the empirical analysis and make suggestions for future research agendas.

2. Literature review

Many studies on personal insecurity in transport mention lack of data as a barrier to knowledge in this area. The lack of consensus among institutions about the definition of incidents (theft of money or property, with or without violence, physical or verbal assaults, intimidation, sexual harassment, etc.), the methodologies for collecting data on them, and the frequent non-reporting of incidents by victims explain these shortcomings (INEGI, 2018; Loukaitou-Sideris, 2006; Newton, 2014; Pereyra et al., 2018; Zhang, 2016). In Buenos Aires, Pereyra et al. (2018) found that less than 30% of female interviewees that were victims or witnesses of harassment in public transport reported the incident to the police, the driver or the transport enterprise. The location of offences is another difficulty, particularly in public transport. Newton (2008) observed that the analysis of personal security in public transport focuses mainly on criminal events that occur at or around bus stops and much less on those that occur during the journey in the vehicle. One of the reasons given for this is the difficulty of identifying the exact location of an attack in a moving vehicle. An incident at a bus stop may be recorded differently by the police and the transport operator, and the latter may ignore it on the grounds that it took place in the public space. The definition of public space may include, in addition to the street, places such as department stores, restaurants, sports clubs, etc. (Maillochon, 2004). In Mexico, the 2017-2018 National survey of victimization and perception of public security (ENVIPE), presents the statistics on robberies and assaults under the single heading “in the street or on public transport” (INEGI, 2018). Finally, obtaining or collecting data to make a detailed study of the explanatory factors of crime incidents can also be a difficult task (Loukaitou-Sideris et al., 2001 for crimes at bus stops in Los Angeles; Newton, 2008 for bus crimes in England).

However, when we consider personal insecurity in transport we cannot limit ourselves to experienced insecurity. It also involves transport users' perception of the risky situations they encounter when travelling. Individuals’ perception of insecurity is based not only on their actual experiences as victims but also on events they have observed as witnesses and, more generally, on knowledge of various incidents that are reported by word of mouth or the media, sometimes in an exaggerated form (Pearlstein and Wachs, 1982, concerning the use of buses in Los Angeles). Fear can be socially produced (Loukaitou-Sideris, 2006) and the perception of danger on transport and in public spaces may therefore be associated only to a minor degree with personal experience of an assault or the observed crime rate (Carro et al., 2010; Currie et al., 2010; Hirschfield, 2008; Jackson and Gray, 2010). Both perceived insecurity and experienced insecurity are very closely linked to the personal characteristics of individuals and the environment in which their trip takes place.

Among the specific characteristics of the city dweller, gender is one of the main determinants. On the one hand, women are more prone to certain forms of insecurity. Thus, their risk of being sexually harassed or

physically assaulted by men is highlighted in many urban environments (Anand and Tiwari, 2006; Dunckel-Graglia, 2013, Hancock, 2006; Mejia-Dorantes, 2018; Paul, 2011; Pereyra et al., 2018; Turner, 2012). In public transport, vehicle overcrowding and jostling at stops to board vehicles increase the risk of being touched and assaulted by male passengers, but drivers and conductors can also be involved (Harrison, 2012; Mejia-Dorantes, 2018; Page and Oni, 2002; Peters, 2011; Tillous, 2017; Viswanath and Mehrotra, 2007). On the other hand, women's strong perception of insecurity on transport appears to be consistent with more general findings on the determinants of perceived insecurity (Austin et al., 2002). In line with the general observation that "Safety and security in public transport are crucial issues which disproportionately affect women" (Peters, 2011: 9), some studies show that many women do not feel safe when using public transport, during the walking segments of these trips and more broadly when they are in public spaces, such as bus stops or stations. These findings apply to urban environments both in the North (Clifton and Livi, 2005; Loukaitou-Sideris, 2006; Yavuz and Welch, 2010) and in the South (Anand and Tiwari, 2006; Monqid, 2011; Paul, 2011; Pereyra et al., 2018; Peters, 2011; Suman et al., 2017; Turner, 2012; Uteng, 2012; World Bank, 2011).

Groups other than women may also feel vulnerable during their trips. Examples include children and young people, the poor, people with disabilities and the elderly (Carro et al., 2010; Delbosc and Currie, 2012; Loukaitou-Sideris and Eck, 2007; Newton and Ceccato, 2015). Like women, school pupils are potentially the target of assaults, taunts and harassment. In the African contexts studied by Porter et al. (2010), child and youth mobility practices consist mainly of moving in groups and avoiding "inappropriate spaces" (op. cit.:802) and after dark.

The contextual determinants that have been identified relate to the characteristics of the neighborhood of residence and to the immediate environment throughout the trip. Perceived danger depends on the socio-economic make-up of the neighborhood of residence (poverty, social homogeneity of the population, high immigrant rates), the level of residential turnover or commuting, the degree of social cohesion and trust in neighbors (Delbosc and Currie, 2012; Hirschfield, 2008). Land use mix seems to affect the number of crimes around public transport stops or stations (Zhang, 2016), while the effect of density is less clear (Loukaitou-Sideris et al., 2001). Isolated locations increase fear of crime but many researchers note that a large number of incidents take place in high density areas (Maillochon, 2004 concerning women in France). More broadly, the quality of the environment affects perceived insecurity. Degraded buildings, the presence of graffiti or garbage and the absence of police surveillance increase the feeling of insecurity (Hirschfield, 2008). Perceived insecurity is also nourished by a lack of pedestrian infrastructure such as pathways, walkways and street lighting, and by obstacles such as bushes or tunnels that hinder visibility or that may be used as a hiding spot (Anand and Tiwari, 2006 for Delhi ; Kruger and Landman, 2008 for South African cities; Loukaitou-Sideris, 2006 for the USA).

Finally, two intangible characteristics of the immediate environment in which the trip is made are also identified in the literature. Personal insecurity during travel, whether experienced or perceived, involves first and foremost concrete travel situations. The mode of transport used is of course one of the determining characteristics of these situations, but time and space are two other key factors (Ceccato and Uittenbogaard, 2014). The time of day modifies the perception of insecurity, which becomes greater at night, but other temporal variables such as peak/off-peak hour or working day/weekend may also do so[1] (Pereyra et al., 2018; Soto Villagran, 2012). Travelling in an unfamiliar or completely unknown space also adds to the sense of danger (Hirschfield, 2008) and, obviously, the fear of getting lost when far from home, particularly for young people (Porter et al., 2010). In contrast, various population groups may see their neighborhood of residence as a space where the risk of aggression is lower, which encourages walking (Kinda, 1987; Monqid, 2014).

[1] On a different time scale, Gough (2008) notes that the fear of robberies is greater when employed people have been paid.

The literature review thus shows that personal insecurity during travel is likely to vary according to the travel situation as defined by three attributes: the mode of transport, the time of travel and the places in which it takes place. In each of these situations, it is potentially determined by three types of factors:

- the characteristics of the individual,
- the individual's experienced insecurity,
- contextual factors that reflect the individual's environment.

Based on a household travel survey carried out in Dakar in 2015, this paper seeks to study the effects of these determinants on the perception of personal insecurity during walking trips. Paradoxically walking trips have been less studied in the literature than public transport trips, whereas in the cities of the South walking is a very frequent mode of travel. Dakar is, from this point of view, particularly representative of the situation in sub-Saharan African cities, where walking is by far the most widely used transport mode (Diaz Olvera et al., 2013).

3. Data and study context

While perceived and experienced insecurity are frequently analyzed using qualitative methods (qualitative interviews, first-hand reports), they can also be addressed by questions in household questionnaire surveys (Garrett and Ahmed, 2004). A recent household mobility survey conducted in Dakar, the capital of Senegal, provides an opportunity to assess the scale of walking in the city and to address the perceived insecurity associated with it.

3.1 EMTASUD, a recent household mobility survey conducted in Dakar

This survey was conducted in May and June 2015. It is known as Dakar Survey on Mobility, Transport and Access to Urban Services (Enquête Mobilité, Transports et Accès aux Services Urbains de Dakar – EMTASUD 2015) and was conducted for the Executive Board for Public Transport in Dakar (Conseil Exécutif des Transports Urbains de Dakar – CETUD; Sitrass-Curem, 2016). It is based on socio-spatial stratification of the city into 41 areas. A two-stage sample selection process was conducted: 419 census districts were selected from the 41 strata, followed by the random selection of households. The interviews were conducted by trained staff in the homes of 3,176 households in which individuals aged 11 years and over (13,415) were interviewed individually.

As is customary in this type of survey, the collected data is used to characterize households (composition, dwelling, assets including vehicles, neighborhood environment, etc.) and their members (personal characteristics, education, job, activity status, personal income, opinions on transport modes, etc.). Individuals also provided information on each trip they had made the day before the interview (purpose, origin and destination, departure and arrival time, number of segments, transport modes).

A section of the individual questionnaire addressed the issue of insecurity during travel. The respondents' experience of insecurity (aggression, harassment, robbery) over the last 18 months was elicited for public transport only, with a distinction between two cases, on board vehicles and in public spaces, at stops. Experience of insecurity at stops will be considered in the analysis below as one of the potential explanatory factors for perceived insecurity.

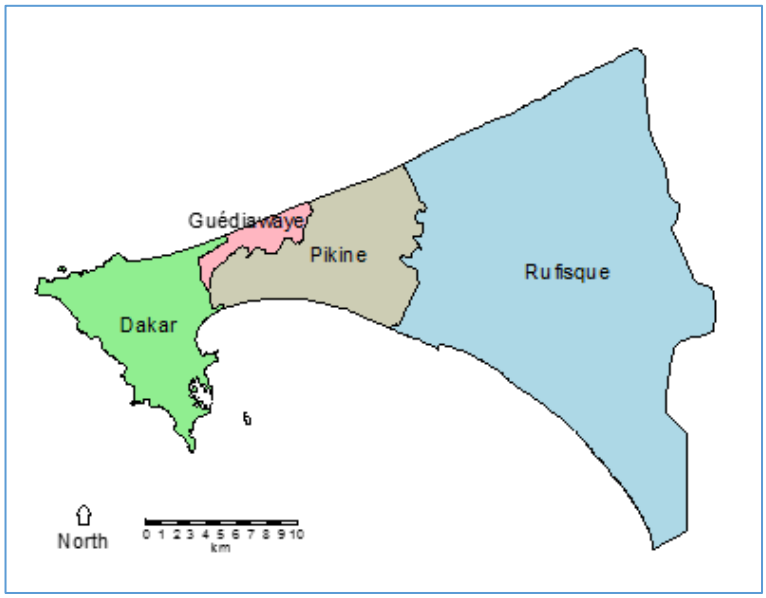
The perception of insecurity was assessed through two sets of questions (of the form "Are you afraid of being robbed or assaulted when you travel alone?"), which distinguished between the daytime and night-time periods, the mode of transport (walking, public transport, car). For walking, these questions were duplicated, with a systematic distinction between whether the space visited was within or outside the respondent's residential district. This set of questions therefore makes it possible to identify the perception of insecurity related to pedestrian travel for four different "walking situations": during the day in one's residential neighborhood, at night in one's residential neighborhood, during the day elsewhere, and at night elsewhere.

3.2 Dakar, high urban growth and low provision of motorized transport

The Dakar region, which is the area occupied by the Dakar metropolis, consists of four departments[2]: Dakar, Guédiawaye, Pikine and Rufisque (Fig. 1). With more than 3 million inhabitants in 2013 compared to 1.3 million in 1988, its population has more than doubled in 25 years (ANSD, 2014; Sakho, 2002; Syscom, 2001). The population growth rate has slowed in the 21st century (an increase of 3% per year between 2000 and 2013 compared to 4.2% between 1988 and 2000). The shape of the Cape Verde peninsula, where the Dakar region is located, has a major influence on the direction of urbanization and the layout of roads, imposing uni-directional development towards Pikine, Guédiawaye and Rufisque (Sakho, 2002; Sakho, 2014). Population growth is high in the departments of Rufisque and Pikine. The latter, in particular, is now more populated than the department of Dakar (Table 1).

Undeveloped areas, which are often unsuitable for housing, are rapidly becoming urbanized while the southern tip of the peninsula brings together many administrative, economic and service activities. The separation between the places where people work and where they live is particularly marked and Dakar appears to be a "compartmentalized city" (Lombard et al., 2006:199). In 2000, 60% of the working population were employed in Dakar and 15 years later, this proportion is still high (58%), despite an increase in jobs in Pikine (from 23% to 26%). Very rapid urbanization and population growth, and the lack of public facilities and jobs on the periphery intensify the need for motorized travel in spite of which household motor vehicle ownership remains limited, as does public transport provision.

Figure 1. The Region of Dakar



Source: the authors

Table 1. Distribution of the population of the Region of Dakar according to the department in 2002-2013 (%)

	2002	2013
Dakar	40.3	36.5
Guédiawaye	12.1	10.5
Pikine	35.2	37.3
Rufisque	12.3	15.6
Region of Dakar (million inhabitants)	2.19	3.05

Source: ANSD, 2014, population censuses. Calculations by the authors

[2] The "department" is Senegal's second administrative level.

Sub-Saharan African cities are characterized by very low car ownership rates (Diaz Olvera et al., 2013), and the region of Dakar is no exception. Although household car ownership is increasing, it is still very low: 12% of households had a car in 2000 and 15% in 2015. Ownership of cars remains restricted to better-off households and most of the residents thus have no car at their disposal. The ownership of two-wheelers (motorcycles in particular) is still marginal (Diaz Olvera et al., 2016).

Public transport (PT) is characterized by its diversity in terms of the size of vehicles and the characteristics of the operators (public / private; formal / informal; small-scale operators / large firms), although the demarcation between the types is not always clear. According to the household mobility survey, the quality of service provided by public transport is often considered to be unsatisfactory by users and it is deemed too expensive for most household budgets (Sitrass-Curem, 2016). The provision of motorized transport is far from covering the city's mobility needs, which reinforces the dominant role of walking for the mobility practices of Dakar's inhabitants.

3.3 Walking in Dakar, the pre-eminent means of transport

End-to-end walking trips account for 70% of the average of 3.3 daily trips made from Monday to Saturday[3]. However, walking is often difficult and the majority of city dwellers report experiencing problems, either because of the poor condition or absence of sidewalks (58% of respondents), their congestion (63%), a lack of lighting (63%), flooding (58%), odors and waste (56%) as well as the risk of accidents (51%).

In spite of the overall dominance of walking, its role varies according to the characteristics of individuals or their households. Walking thus accounts for a higher proportion of women's travel (74%) than men's (66%). These differentials are partly due to the way in which the two genders are distributed between activity statuses, as these structure the activities individuals perform, their location, and the modes used to travel to them. The modal share of walking is also very sensitive to individuals' economic situation which determines access to both private transport modes and public transport. It thus decreases from 79% among individuals belonging to households in the first quintile[4], the poorest, to 55% among those in the last quintile.

The pre-eminence of walking reflects the importance that activities carried out in one's residential neighborhood and surrounding areas have in urban lifestyles. A breakdown of the Dakar region into 220 neighborhoods shows that 54% of all people's trips remain within the boundaries of their residential neighborhood, and this is almost exclusively by foot (95%). Walking is used in 65% of trips that are entirely outside the individual's residential neighborhood: these trips are mainly made in areas that are close to the place of activity (work, study or other). On the other hand, walking is used for only a third of trips between individuals' residential neighborhood and another neighborhood.

These figures are a low estimate of the true significance of walking in urban lifestyles. Almost two-thirds of public transport trips also required walking trips of more than 5 minutes at the origin and/or destination. This proportion also indicates that PT-related walking does not only involve very short journeys.

Walking is therefore an essential part of the daily mobility of city dwellers. To what extent does it raise security concerns for some or all of them?

4. The determinants of perceived insecurity

We have studied perceived insecurity in three stages. First, we analyzed how four individual-specific determinants - gender, age group, disability, economic resources - and per capita household income affect perceived insecurity during pedestrian trips. We then performed a multiple correspondence analysis to

[3] For individuals aged 11 years old and over.
[4] Per capita income quintiles.

include other determinants (experienced insecurity, characteristics of the home environment), and offer a graphic representation of the links between these potential explanatory factors and perceived insecurity during pedestrian trips made on one's own. Finally, logit models were applied to identify the most active factors in the perception of the insecurity when walking and the role played by the economic dimension.

4.1 Individual determinants of perceived insecurity

Perceived insecurity during a walking trip varies considerably according to the situation, in terms of the place and time, in which the trip takes place. Whether a trip takes place at night-time as opposed to the daytime, or in remote spaces as opposed to one's residential neighborhood, are two factors that increase the proportion of individuals who report fear of robbery or assault during their pedestrian trips (Table 2). The effects of these factors are cumulative: while one in ten individuals are afraid when walking during the day in their neighborhood, seven out of ten report being afraid when walking at night outside their neighborhood. An indicator that measures the perceived insecurity gradient thus allows us to distinguish between urban dwellers who report that they never experience fear (26% of the population), those who experience fear at night when outside their neighborhood (19%), those who experience fear at night when walking in any location (36%), those who experience fear when walking at night everywhere and during the day outside their neighborhood (10%), and finally those who report fear in all situations (9%).

Table 2. Percentage of individuals perceiving insecurity in four walking situations, according to individual and household characteristics

	Neighborhood, daytime	Elsewhere daytime	Neighborhood, at night	Elsewhere at night
Men	6.7	21.8	36.2	59.4
Women	13.4	36.4	56.2	78.6
Disabled No	9.7	29.0	46.3	69.5
Disabled Yes	17.3	37.5	54.1	71.6
Young (<25 years)	10.3	30.1	49.4	71.8
Middle-aged (25-59 years)	10.4	29.8	46.0	69.5
Elderly (60 years and over)	10.1	27.7	43.4	62.6
Low, or no personal income	10.7	29.4	51.9	72.1
Medium or high personal income	10.1	30.0	43.8	68.3
Household income				
1st quintile	10.4	24.3	54.3	71.1
2nd quintile	10.6	27.1	51.0	68.7
3rd quintile	9.0	30.0	43.0	69.9
4th quintile	11.7	34.3	45.0	69.9
5th quintile	10.1	35.0	38.8	69.1
All	*10.3*	*29.7*	*47.0*	*69.7*

Source: EMTASUD 2015, calculations by the authors.

As shown by the literature review, fear of insecurity is more frequently reported by women than men, and the disparity between men and women is wider at night. Even in the familiar space of the residential neighborhood, more than one in two women and one in three men express anxiety about walking at night. In brief, 37% of men but only 17% of women report never experiencing fear when making walking trips. Conversely, 5% of men and 11% of women report experiencing fear in all situations.

In line with the findings of our literature review, other factors have less impact than those that are related to gender.

Having a disability which makes travel difficult (which is the case for 9.6% of women and 6.4% of men) leads more people to perceive a risk of insecurity. This effect is more pronounced for walking during the

day (with the highest relative differences being among women: +7 percentage points). For both women and men, the differences are much smaller for walking at night.

Age and personal income only play a role in the case of night-time trips. The feeling of fear is lower among older individuals and those with resources of their own. The gap between the youngest (under 25 years of age) and oldest (60 years of age and over) individuals is at least 6 percentage points, both within and outside the residential neighborhood. Between people without any resources or very low resources and those who are better off, the difference is 4 percentage points for trips outside one's neighborhood and 8 for trips inside it.

The impact of the household's economic resources appears to be restricted to two situations for which it plays contrary roles. For night-time walking trips in one's residential neighborhood, the negative perception of security decreases with income (from 54% to 39% for the population as a whole). On the other hand, for daytime trips outside the neighborhood, it increases with household resources (from 24% to 35%). This may reflect the contrast, for the wealthiest groups, between degraded outside spaces and the relative tranquility of their residential neighborhood, but it may also reflect mobility that is more targeted towards the city than towards the residential neighborhood, and consequently greater exposure to the risk of theft or assault outside the neighborhood.

The above-mentioned impact of the household's economic resources reveals the importance of contextual characteristics with regard to perceived insecurity. The literature review had already shown that factors of various kinds could influence perceived insecurity, over and above the individual's own characteristics. A multiple correspondence analysis reveals numerous effects and the interlinkages between them.

4.2 Individual and contextual determinants: a representation of the interlinkages between them

The literature review revealed multiple determinants of perceived insecurity, related either to the individual's characteristics, or to their individual experience of personal insecurity, or to contextual factors related to their everyday environment. We were able to examine eleven factors on the basis of the available data: five related to individual determinants, one to the individual's experience of insecurity, and five to the environment.

Individual determinants, which were the subject of our preliminary analysis, were divided into sociodemographic and socioeconomic subcategories:

1. individual socio-demographic characteristics (gender, age, disability);
2. individual and household economic characteristics (whether or not individuals have economic resources of their own, the economic resources of their household).

The individual's experienced insecurity is measured by a single variable: whether or not the individual has been a victim of assault, harassment or theft while waiting for public transport.

Contextual determinants were defined either at the individual level or the collective level of the neighborhood of residence:

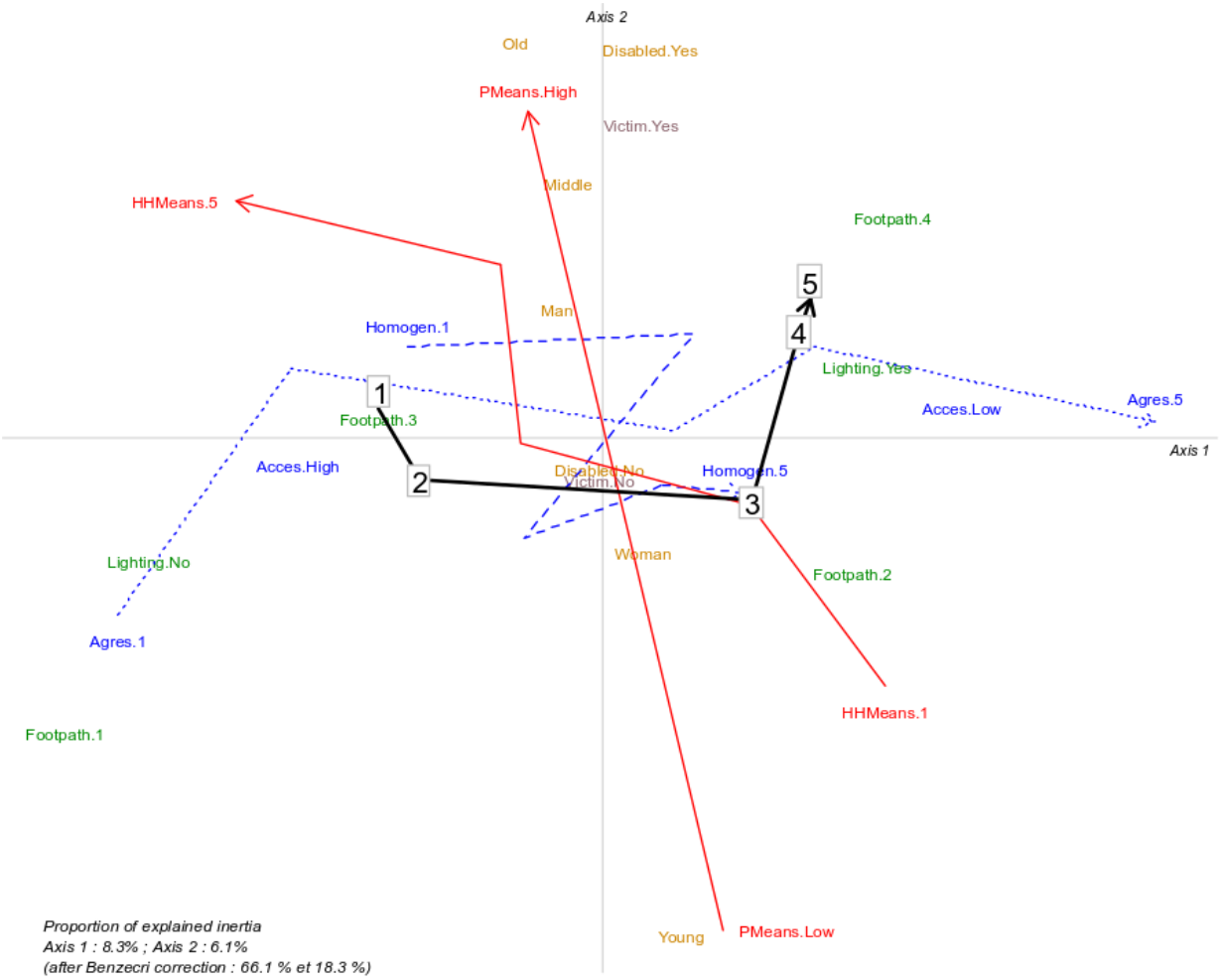
1. the individual's perception of the urban setting in relation to pedestrian mobility (lack of night-time lighting, characteristics of sidewalks);
2. the particular features of the neighborhood of residence, as they emerge from the aggregation of the statements made by households (the problem of theft and assault, isolation, level of economic homogeneity).

Figure 2 presents the first plane resulting from a multiple correspondence analysis[5] between these eleven determinants and the composite indicator that expresses the gradient of perception of pedestrian

[5] Multiple Correspondence Analysis portrays graphically the patterns of relationships between at least three categorical variables (Abdi and Valentin, 2007). If two levels of variables are frequently associated among the

insecurity. The projection of the perception of insecurity on this first plane complies with a well-known pattern (Guttman, 1953). The first axis (horizontal) shows its gradient, with zero or low levels on the left and high levels on the right. The second axis (vertical) contrasts extreme perceptions (no fear or generalized fear at the top) with intermediate values (fear in the case of night-time trips at the bottom). The first axis thus orders individuals or groups of individuals according to their level of fear, while the second axis reveals a greater or lesser sensitivity to the risks of night-time travel.

Figure 2. First factorial plane of the multiple correspondence analysis



2—3 Perceived insecurity in walking situations: 1=never; 2=night-time, elsewhere; 3=night-time, everywhere; 4=night-time, everywhere + daytime, elsewhere; 5=all time, everywhere

. Sociodemographic: Gender (Woman, Man); Age (Young, Middle, Old); Disability (Disabled.No, Disabled.Yes)

. Socioeconomic: Household purchasing power (5 quintiles, HHMeans.1→ HHMeans.5); Personal income (PMeans.Low, PMeans.High)

. Experience of insecurity (Victim.No, Victim.Yes)

. Personal perception of context: Lack of lighting disturbance (Lighting.No, Lighting.Yes); Footpath disturbance (Footpath.1=no problem, Footpath.2=lack or bad state of footpaths, Footpath.3=flooding or odors, Footpath.4=all problems)

. Collective views on neighbourhood: Level of insecurity (5 quintiles, Agres.1 → Agres.5); Accessibility (Acces.Low, Acces.High); Economic homogeneity (5 quintiles, Homogen.1 → Homogen.5)

Example of interpretation: people reporting many issues related to footpaths (Footpath.4) perceive insecurity for all travel situations (box 5, all time, everywhere) more frequently than other city dwellers; conversely, people living in a neighborhood with high accessibility (Acces.High) are simultaneously inclined never to perceive insecurity (box 1) or to do so only rarely (box 2, at night-time, elsewhere). Source: EMTASUD 2015, calculations by the authors.

Among the contextual determinants, the characteristics of the neighborhood are mainly associated with the first axis and therefore with the gradient of perceived insecurity. The residents of high-accessibility

population, they will be near each other in the figure. If the association between them is weak, they will be distant from each other.

neighborhoods and those of areas where the risk of aggression is low feel less insecure than those in low-accessibility neighborhoods with a high risk of aggression. The role of the degree of economic homogeneity appears more complex in view of its colliding trajectory, although the most homogeneous neighborhoods appear to be the most likely to generate fear among their residents.

Personal perceptions of walking conditions are also strongly associated with the first axis. A lack of urban lighting and poor quality sidewalks increase the perception of insecurity.

The second axis, which shows the sensitivity to travel at night, is more influenced by personal socio-demographic characteristics and personal experience of insecurity. The perception of insecurity is higher among women, young people and individuals with few or no resources, due to increased sensitivity to insecurity during travel at night. It is also higher for daytime travel, for people with disabilities and for those who have been victims of theft or assault.

Finally, the two economic indicators have similar effects. Greater personal economic resources result in less sensitivity to insecurity, especially during trips at night. While the individual's own resources have a greater impact on the relative level of fear at night versus during the day, the household's economic resources appear to be correlated with the entire gradient of the perception of insecurity.

The perception of insecurity during pedestrian trips is therefore higher among the inhabitants of isolated, unsafe and poorly lit areas, among the residents of the city with low resources, among people with disabilities and among women. Certain categories of the population are more sensitive to the risks encountered at night.

4.3 Modelling perceived insecurity

However, while there are links between perceived insecurity and the various determinants we have considered, the latter are themselves fairly closely linked to each other. Thus, one in two women has few or no personal resources, while this applies to only one in three men. Similarly, 30% of the wealthiest households live in the most peaceful neighborhoods and only 11% live in the neighborhoods that are perceived as the most dangerous. On the other hand, for poor households (Q1), the percentages are 17 and 26% respectively. Logistic regression is a suitable statistical tool for explaining the values taken on by a binary variable because of its ability to disentangle the interactions between the potential effects of various determinants. We therefore estimated a logit model (Table 3) for each of the four travel situations: the reference modality of the dependent variable is stating that one feels fear in the situation in question; the independent variables are the eleven determinants presented and analyzed in sub-section 4.2.

The effect of gender on perceived insecurity remains very significant in each of the four walking situations, even once its interlinkages with the other determinants of insecurity included in the models have been taken into account. The fear of being robbed or assaulted during a walking trip is systematically higher for women than for men, the differential being even greater for night-time trips. The effects of disability and age are less resilient since in some situations they are not significant and when they are, they are systematically weaker than those of gender. Having a disability increases the likelihood of feeling fear when walking in one's neighborhood both in the day and at night, but also elsewhere during the day. The lack of an effect at night outside one's neighborhood could be explained by the fact that disabled people simply do not make trips of this type. The effect of disability thus seems all the more marked the more the situation is collectively regarded as safe. Age plays a role mainly for night-time trips, with the risk of fear decreasing with age, both in the area of residence and elsewhere. As with persons with disabilities, the rarity of night-time travel among the elderly may explain this result. Having been the victim of a criminal act while waiting for public transport increases individuals' sense of insecurity[6]. This effect is more pronounced outside the neighborhood, both during the day and at night.

[6] The effect is only significant at the 10% level for “night-time trips in one’s own neighborhood”.

Table 3. Logit models of perceived insecurity in four walking situations

	Neighborhood, daytime	Neighborhood, at night	Elsewhere daytime	Elsewhere at night
Constant	0.02***	0.10***	0.10***	0.52***
	(0.01, 0.02)	(0.08, 0.11)	(0.09, 0.13)	(0.44, 0.62)
Gender (ref=Male)				
Female	2.14***	2.52***	2.06***	2.60***
	(1.89, 2.42)	(2.33, 2.73)	(1.90, 2.24)	(2.40, 2.82)
Age (ref=Young)				
Middle-aged	0.93	0.87**	0.89*	0.84***
	(0.81, 1.07)	(0.79, 0.95)	(0.81, 0.98)	(0.76, 0.93)
Elderly	0.96	0.79**	0.88	0.70***
	(0.76, 1.21)	(0.68, 0.92)	(0.75, 1.04)	(0.60, 0.82)
Disability (ref=Without)				
With	1.53***	1.26**	1.26**	0.95
	(1.26, 1.85)	(1.09, 1.46)	(1.09, 1.46)	(0.82, 1.11)
Experience of insecurity (ref=No)				
Yes	1.29**	1.11	1.58***	1.19**
	(1.09, 1.52)	(0.98, 1.25)	(1.40, 1.77)	(1.05, 1.35)
Disturbance due to lack of lighting (ref=No)				
Yes	1.11	1.56***	0.96	1.23***
	(0.96, 1.28)	(1.42, 1.70)	(0.87, 1.05)	(1.13, 1.35)
Disturbance due to state of sidewalks (ref=Without)				
Yes, flooding, odors	1.29*	1.42***	1.65***	1.91***
	(1.03, 1.61)	(1.25, 1.62)	(1.43, 1.91)	(1.69, 2.16)
Yes, lack, state, maintenance	1.43***	1.36***	2.37***	2.54***
	(1.16, 1.77)	(1.20, 1.54)	(2.08, 2.72)	(2.26, 2.86)
Yes, all disturbances	1.94***	2.10***	2.76***	3.63***
	(1.57, 2.41)	(1.83, 2.40)	(2.39, 3.19)	(3.18, 4.16)
Dangerousness of neighborhood of residence (quintiles, ref=Q1)				
Q2	2.49***	2.20***	1.38***	1.18**
	(2.01, 3.10)	(1.95, 2.49)	(1.22, 1.55)	(1.04, 1.32)
Q3	3.51***	2.69***	1.27***	1.12
	(2.84, 4.37)	(2.38, 3.05)	(1.12, 1.44)	(0.99, 1.26)
Q4	3.63***	3.18***	1.57***	1.30***
	(2.91, 4.54)	(2.80, 3.62)	(1.37, 1.79)	(1.14, 1.48)
Q5	4.21***	4.42***	1.52***	1.11
	(3.33, 5.35)	(3.83, 5.10)	(1.31, 1.76)	(0.96, 1.29)
Isolation of neighborhood (ref=Low)				
High	0.72***	1.36***	0.73***	1.21***
	(0.63, 0.83)	(1.25, 1.49)	(0.67, 0.80)	(1.10, 1.33)
Economic homogeneity of neighborhood (ref=Q1)				
Q2	1.04	0.99	0.91	0.90
	(0.86, 1.27)	(0.88, 1.12)	(0.81, 1.03)	(0.79, 1.02)
Q3	0.98	1.17*	0.82**	1.01
	(0.80, 1.20)	(1.03, 1.33)	(0.72, 0.93)	(0.89, 1.16)
Q4	1.96***	1.70***	1.01	0.96
	(1.64, 2.34)	(1.51, 1.92)	(0.90, 1.15)	(0.85, 1.09)
Q5	1.63***	1.34***	0.95	0.70***
	(1.35, 1.96)	(1.18, 1.51)	(0.83, 1.07)	(0.62, 0.79)
Household income (ref=Q1)				
Q2	0.82*	0.87*	1.05	1.01
	(0.69, 0.97)	(0.78, 0.98)	(0.93, 1.19)	(0.90, 1.13)
Q3	0.89	0.90	1.14*	1.04
	(0.75, 1.06)	(0.80, 1.01)	(1.01, 1.29)	(0.92, 1.17)
Q4	0.99	1.00	1.40***	1.04
	(0.83, 1.19)	(0.88, 1.13)	(1.24, 1.60)	(0.92, 1.18)
Q5	1.25*	1.07	1.95***	1.57***
	(1.03, 1.51)	(0.94, 1.22)	(1.70, 2.23)	(1.36, 1.80)
Personal income (ref=Zero or low)				
Moderate or high	1.02	0.88**	1.03	0.95
	(0.89, 1.17)	(0.80, 0.96)	(0.94, 1.13)	(0.87, 1.05)
Observations	13026	13026	13026	13026
Log Likelihood ratio test (prob.)	<0.001	<0.001	<0.001	<0.001
Akaike Information Criterion	8394.1	15690.9	14911.2	14956.1

Source: EMTASUD 2015, calculations by the authors. *p<0.05; **p<0.01; ***p<0.001

Over and above the individual's personal attributes, contextual determinants, whether they reflect the city-dweller's own perception or a collective opinion about the characteristics of the neighborhood, also influence the perception of the risks he or she might incur.

The disturbance that individuals report feeling when walking increases the prevalence of the feeling of insecurity. Obviously, the lack of lighting does not affect perceived risk during daytime walking trips, but it has a very strong impact when walking at night. The absence or poor condition of sidewalks, crowded sidewalks and issues such as floods or odors all tend to increase the prevalence of the feeling of fear, more so outside one's neighborhood than within it.

The three contextual characteristics that relate to the neighborhood of residence have a differentiated impact on the individual's perception of insecurity. The perceived dangerousness of the neighborhood strongly influences the prevalence of feelings of insecurity. The effect is more pronounced during the day than at night and obviously in one's neighborhood than outside it. The isolation of the neighborhood has the opposite effect in the day and at night, both in the case of walking within the neighborhood and outside it. During the day, isolation increases the risk of feelings of insecurity, while at night it decreases them. The economic homogeneity of the district mainly has an impact on internal trips within the neighborhood, with a high (Q4) or very high (Q5) level of homogeneity increasing the risk of feeling insecurity very markedly.

With regard to these determinants, the impact of the economic status of the individuals is more marginal. Having resources of one's own has a significant effect only on night-time trips inside one's neighborhood, slightly reducing the risk of feeling insecure. For internal movements within the neighborhood, both during the day and at night, the effect of the household's economic resources never achieves significance at the 1% level. In the other hand, the perception of insecurity outside one's neighborhood is higher for the individuals belonging to the wealthiest households, both during the daytime (Q4 and Q5) and at night (Q5).

Logit modelling of the perception of insecurity confirms the existence of effects that vary according to the travel situations and different factors, among which economic resources play a minor role.

5. Conclusion

Our analysis of the issues surrounding the perception of insecurity during pedestrian travel shows the importance of security concerns in the mobility and daily lives of Dakar's inhabitants. As regards their walking journeys made alone outside their district of residence, seven out of ten Dakar residents state that they fear being robbed or assaulted at night, and three out of ten report this during the day. Walking situations in the neighborhood of residence appear to generate less anxiety as within it these proportions decrease to one in two and one in ten, respectively.

The Dakar household mobility survey provides new empirical material for understanding and measuring the impact of some individual and contextual determinants of perceived insecurity. The first lesson we can learn is the importance of considering specific travel situations. The time of travel (day / night) and its location (individuals' own neighborhood / elsewhere) strongly influence the prevalence of the feeling of insecurity and allow us to identify a gradient in the perception of insecurity. It shows that only one in four individuals does not feel any fear in connection with his or her pedestrian movements, while one in ten feels fear in each of the four pedestrian travel situations we have studied.

Because of the lack of relevant data, we were not able to test all the potential determinants identified in the literature review, and we used simplified formulations to model some of them. Nevertheless, we investigated the major determinants, and the effects we found are consistent with the findings in the literature. Among the socio-demographic characteristics, gender plays a dominant role, with the perception of insecurity being systematically more widespread among women than among men. Having previously been the victim of a robbery or assault while waiting for public transport increases the

probability of feeling fear, but the significance of its effect depends on the specific travel situation. The contextual determinants show that a degraded or insufficiently developed urban environment adversely affects urban dwellers' feelings of insecurity. A lack of, or faulty, public lighting, an absence of sidewalks, or whether they are in poor condition or congested, and insanitary roads, all significantly increase the prevalence among the population of the fear of robberies or assaults when walking. This is also the case for the specific features of the neighborhood of residence such as its social homogeneity, its isolation and above all its dangerousness.

With regard to the principal determinants we investigated, economic resources, whether those of the individuals or their household, play a less important role in fostering the perception of insecurity. This more secondary role is already apparent if we cross-reference levels of resources with travel situations. It is more clearly present when modelling is applied to eliminate the effects caused by other factors with which economic resources are strongly correlated (gender, the dangerousness and economic homogeneity of the neighborhood, etc.).

This work could be continued in three ways. Firstly, in order to measure the gradient of the perception of insecurity more accurately, we would need additional data to analyze other travel situations, for example by taking account of the district where people with jobs work or schoolchildren study, by making a distinction between off-peak and peak hours during the day, or by explicitly taking account of walking trips to and from public transport. Secondly, the analyses carried out in this study do not allow us to assess the impacts of perceived insecurity on mobility. To establish and measure this link, data collection based on a household survey that elicits details of respondents' trips on the previous day is not sufficient. Further information would be needed on the adaptation strategies implemented by individuals or households in order to cope with perceived insecurity, or the difficulties they experience in doing so. Finally, there remains scope for exploring linkages between perception and reality (i.e. actual crime rates). But spatialized information on criminality is scarce and the production of reliable data would probably require cross-sectoral collaborations between, for example the police, the justice system, the transport authorities and hospitals.

Insecurity in public spaces constitutes a complex set of issues that cannot be tackled easily, but this study shows that poor pedestrian facilities and lack of street lighting are factors that contribute to a widespread sense of insecurity among urban dwellers. The conditions faced by individuals making walking trips, among whom the poor are over-represented and who also include a significant proportion of women and adolescents, are thus made more challenging. Our results argue for greater consideration of the perception of insecurity when considering the mobility practices of urban dwellers in sub-Saharan Africa, especially with regard to pedestrian trips. Giving more prominence to the improvement of perceived security would increase the favorable outcomes of infrastructure projects, for instance by including the provision or improvement of sidewalks and urban lightning. An improvement in perceived security during travel could also make a significant contribution to the success of policies to limit car use, as a negative perception of personal security discourages both walking and the use of public transport.

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