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The Paradox of "Eyes on the Street": Pedestrian Density and Fear of Crime in Yaoundé, Cameroon

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Abstract: Most studies highlighting the link between the urban environment and fear of crime (FoC) have focused on less populated spaces in urban areas, and concluded that the presence of activities and people in a space makes its users more confident. This study analyses the paradoxical phenomenon of FoC in occupied public spaces in the setting of Yaoundé, Cameroon. To this end, this study analyses the relationship between intersection level, pedestrian density and perceived FoC. The results of the multi-level binary logistic regression demonstrate that women, vulnerable age groups, people with a weak sense of community and high-income people tend to express a higher level of FoC. Among the major FoC theories, these results confirm the theories of physical vulnerability and social networks and invalidate the theory of social vulnerability in the local context. The results also reveal that the relationship between "pedestrian density" and FoC seems to be a convex curve with the minimum value, implying that the concept of 'eyes on the street' is not valid in places where pedestrian density exceeds a specific threshold. This suggests that policy makers and planners should consider pedestrian density when designing public spaces, not only to secure wellbeing, but also due to the impact it can have on perceived FoC among those who use such spaces.

Keywords: street life; pedestrian density; fear of crime; quality of life; density threshold theory

1. Introduction

The observation that 'insecurity is everywhere in the city of Yaoundé' was made two decades ago as part of the *Diagnostic Study of Urban Crime in Yaoundé, Cameroon* and remains relevant today [1]. According to the 2017 report of the National Institute of Statistics (INS in French), the safety situation has deteriorated throughout the country over time. From 2013 to 2016, the number of crimes recorded by the police and related to property offences ('thefts and stolen goods', 'robberies with firearms and assaults in taxis' and 'home and business robberies', etc.) rose from 29,632 to 53,142, representing an increase of approximately 80%. In the same period, crimes relating to physical injury (homicide, assault, etc.) rose from 6084 to 11944, representing an increase of approximately 96% [2] (p. 173), a figure that continues to increase in the various urban centres. This security crisis reflects the urban context in Cameroonian cities, which are marked by the proliferation of slums, increased youth unemployment, aggravation of urban disorder, the spread of informal activities, deterioration of existing urban infrastructure, etc. [3], all of which contribute to residents' fear of crime (FoC) and low quality of life. To address this scourge, State interventions have focused on increasing security equipment, including the police reform resulting from Decree No. 2002/003 of 4 January 2002 on strengthening police intervention in the fight against urban crime, creating new gendarmerie units in Yaoundé by Presidential Decree of 2 October

2001, as well as the establishment of Special Rapid Intervention Units. Most of these interventions started in 1998 when Cameroon was preparing to apply for the hosting of the African Union summit and the security issue was a major factor in the choice of the country to host the summit. More recent actions have also been taken to install CCTV and improve public lighting at certain points considered criminogenic in urban centres. In August 2019, the political and security authorities inaugurated the CCTV command centre of the national police in Yaoundé. Despite these efforts, the situation on the ground remains extremely worrying, raising the question of the relevance of the diagnosis and the proposed solutions. In fact, apart from the few actions listed above, the strategy adopted at the national level has not considered the role of better land management in reduction of FoC.

Previous studies have demonstrated that certain defensible characteristics of space and territoriality have contributed significantly to reducing the level of perceived FoC [4] (p. 81). One of the first and most widespread studies on the subject was conducted in the 1960s under the doctrine of situational prevention, which took shape in the United States under the leadership of Jane Jacobs. Jacobs considers that safety in public space is guaranteed "when a street has what it takes to open up to the outside world, when, in this street, the public domain is clearly distinguished from the private domain and when activities, such as eyes, are sufficiently numerous . . . " [5] (p. 34). According to Jacobs, therefore, the securing of a space does not depend primarily on police presence, but is held together by a complex and almost unconscious network of the population itself. She goes on to argue that a well-frequented city street is likely to be a safe street, whereas a deserted city street tends to be dangerous. Considering the example of well-lit subways, she also notes that light alone is not sufficient to guarantee safety in a space. Effective eyes are also required. For example, in darkened theatres where eyes are present, crime is almost non-existent. Thus, according to Jacobs, the presence of 'eyes on the street' can guarantee safety and thereby reduce FoC. The link between crime and FoC is made based on the findings of numerous studies that have concluded that the higher the level of crime in a community, the more likely it is that community members tend to express a greater FoC compared to communities with comparatively lower levels of crime [6,7]. For example, using British Crime Survey data, Brunton-Smith found that recorded crime has a direct and independent effect on FoC at the individual level [7]. Similar results are obtained by Markowitz et al. [8] and Wyant [9]. However, by referring to the statistical data on crime and FoC in the city of Yaoundé, particularly the Central Post Office area, which is the largest crossroads in the city centre, the results obtained are relatively mixed. Indeed, despite being densely populated with people, activities, and even police stations, this area continues to be perceived as a dangerous space [10]. The populations of the city of Yaoundé who converge daily in the city centre to conduct their activities feel insecure in a space that would a priori be secure due to the considerable number of people, activities, and police stations; hence, the paradox of the 'eyes on the street' concept exists in the context of Yaoundé.

Overall, the study of population density as a factor influencing crime level, and therefore FoC has received considerable attention from researchers [11]. However, previous studies have had mixed results. While Schuessler [12] and McPherson [13] found a positive correlation between population density and crime level, other authors such as Kvalseth [14] found a negative correlation. More recent studies with advanced technology in data collection techniques dissociated the mobile and residential populations for more relevant analyses. Thus, by referring to the mobile population, these studies showed that these population categories had a considerable impact on crime rates [15–17]. Malleson et al. explored the impact of ambient population measures on crime hotspots in London and showed that areas that were less conducive to attracting volumes of people (predominantly residential areas) had a higher proportion of crime attractors to stimulate crime [18]. Meanwhile, at the national level, little research has been conducted on this issue [19] (p. 54) and in most of the planning documents and strategies implemented by the Ministry of Housing and Urban Development, the issue of FoC is overlooked. The purpose of this study is to analyse the paradoxical phenomenon of FoC in spaces that conform to the principles of security planning in the setting of Yaoundé city. More specifically, it aims to investigate the relationship between FoC and pedestrian density of intersection. Referring to the

mixed results of previous studies, and taking into account the paradox observed in our study area, we thus postulate that: 'high pedestrian density increases FoC at a congested intersection with higher density than a certain threshold level'.

2. Literature Review

2.1. Fear of Crime and Its Determinants

The definition of 'Fear of Crime' is not unanimously accepted by researchers, perhaps because our understanding of FoC is largely based on how it is measured rather than how it really is [20] (p. 658). Put simply, FoC can be understood as a set of emotional reactions that occur out of fear of being a victim of certain types of crime [21] (p. 126) or symbols associated with the crime [22] (p. 23). Considered as such, FoC would be the result of a coherent process. However, several studies have shown that this is not the case. One of the 'paradoxes' identified by scientific experiments is the great difference between the low victimisation of certain categories of people (such as women and the elderly) and their particularly high FoC [23] (p. 160). In a defining and otherwise widely accepted approach, Shepherdson [24] (p. 1) and Lee [25] (p. 33) argue that FoC is not a 'coherent' entity, but 'an experience or set of experiences that are deeply individual'. In an earlier definition, Skogan noted the existence of a link between FoC and a broader set of modern anxieties, 'a diffuse psychological construct affected by a number of aspects of urban life' [26] (p. 14). Thus, in this study, we define FoC as an individual's emotional and physiological response when confronted with symbols associated with crime.

The concept of FoC was first introduced in the 1960s [27] (p. 33). Originally discussed by criminologists, it has gradually become an area of growing interest for researchers [28] (p. 14). A significant number of studies have demonstrated that certain defensible characteristics of space and territoriality contribute significantly to reducing the level of perceived FoC [4] (p. 81). For example, from the 1970s onwards, Oscar Newman's work brought crime closer to its physical context (the neighbourhood, house, company, and public space). Newman focused mainly on how urban planning and architectural devices can reduce or prevent crime and FoC from occurring and his numerous publications from 1972 to 1996 enabled him to explore in greater depth how space management can lead to FoC control [6]. This work by Newman and criminologist C. Ray Jeffery, based on previous publications by authors such as Elizabeth Wood [7], Jane Jacobs [4], and Schlomo Angel [8], gave birth to the concept of Crime Prevention Through Environmental Design (CPTED) in the early 1970s, which was considered to be a crime prevention approach that can help reduce feelings of FoC through natural, mechanical, and procedural means [3] (p. 81). Furthermore, these studies cumulatively made it possible to deduce five different theories of FoC. Although these theories have been widely accepted by all researchers, the prevailing debate has focused on how to construct a measure of FoC, what indicators should be considered [29] (p. 8), what the causes of FoC may be, and how to mitigate them [27] (p. 18). Factors influencing the level of FoC identified in previous studies have been summarised by Austin et al. [30] (p. 418) into three main areas of interest: (1) demographic effects, (2) victimisation experiences, and (3) neighbourhood and urban condition. In his report for the Auburn City Council, Shepherdson detailed the following factors: gender, age, socio-economic status, prior victimisation, ethnicity, media, neighbourhood factors, lack of neighbourhood cohesion, specific locations, and global insecurity [24]. Overall, however, little research has been conducted to examine how the overcrowding of a space influences the level of perceived FoC. This lack of interest is understandable since many previous studies have concluded that a space is more secure if there are 'eyes on the street'. However, this statement is still the case, which led to the idea of this study, to address the issue of FoC in densely exploited and occupied urban spaces.

2.2. Pedestrian Density and Fear of Crime

Although few studies have analysed the association between FoC and pedestrian density in a given space, several studies have focused more broadly on the relationship between crime and density.

In 2010, with the support of the U.S. Department of Justice Office of Community Oriented Policing Services (the COPS Office), Khadija et al. published a guide on street robberies [31]. According to the authors, the density of pedestrians influences where robberies occur on the street. However, since the densest activity centres are subject to more extensive surveillance, very few robberies are recorded in these areas. In the peripheries, on the other hand, the reduced number of robberies is justified by the reduced number of targets. Thus, the areas most targeted by offenders are located between these two extremes. While it is true that 'extensive surveillance' and 'number of targets' defined by Khadija et al. actually influence the offender who wishes to move to the criminal act, what is not clear is the degree of influence of these parameters, since some parameters are obviously minimised and ultimately give the impression that they no longer really count. For example, Bernasco et al. in their study utilise the discrete choice framework to assess which criteria motivate the location decisions of street robbers [32]. The authors identified several other criteria: (1) the proximity of the crime scene to the offenders' place of residence, (2) the accessibility of the crime scene, and (3) the presence of legal and illegal cash economies [32]. For this reason, we disagree with the approach adopted by Khadija et al., particularly with regard to the link between population density and the level of crime on a given street.

Our position is more or less justified by the results obtained by Chen et al. [33], who, on the basis of statistical data from a Chinese city (not specified by the authors), examined the impact of a floating population on residential burglaries. Using a negative binominal model and a geographically weighted Poisson regression model, the authors found that 'the floating population of other provinces has a significant positive impact on residential burglaries, while the impact of the floating population of the same province on burglaries varies across the city' [33] (p. 13).

Using a similar approach to that presented above, Lee et al. [34] also studied the relationship between crime and population flow in a Korean city. By overlaying the sedentary and floating population hotspots and crime hotspots of the city under study, the authors found that there is a strong correlation between the two types of hotspot (0.5297 with r = 0.71) but no correlation between the sedentary population hotspots and crime (0.0948 with r = −0.13). The authors thus conclude that, 'Given the population flow pattern of urban residents, high population density in particular time periods and spaces may greatly affect crime occurrence' [34] (p. 7). Another important result of Lee et al.'s work is the location of criminal acts. According to the authors, the areas or activities of people who have changed significantly based on their location are the most vulnerable. These are specifically those areas between residential and commercial areas [34] (p. 10). Although these results were obtained in an analysis related to crime and not to FoC, we believe that they are quite revealing insofar as, crime and FoC variables are positively linked [28,35–40].

However, concerning studies on the FoC itself, there are theoretical studies to understand how urban design, urban planning and management influence the fear of crime. Examples include approaches such as Crime Prevention Through Environmental Design (CPTED) [41] and Crime Prevention through Urban Design and Planning (CP-UDP) [42].

Also, using applications and crowdsourcing to collect more accurate spatial and temporal data, Solymosi et al. explored the fear of crime based on people's experiences in their immediate environment. This approach allows the authors to inform evidence-based policy making and urban planning for safer places [43] (p. 35). Additionally, by applying digital sketch maps and statistical GIS methods, Jakobi et al. found both in coincidences and opposite correlations of crime statistics and perception of unsafe places [44].

2.3. Fear of Crime in the Context of Yaoundé

In recent years, Cameroon has been facing major security crises. The northern regions of the country are under attack from the terrorist group Boko Haram, while the eastern border faces threats from gangs and armed groups scouring neighbouring countries but making incursions into Cameroon [45] (p. 3). In addition to these two major crises, there is also the crisis in the North-West

and South-West Regions. According to the International Crisis Group report, in 20 months, the conflict has killed 1850 people, displaced 530,000 internally, and displaced tens of thousands of refugees [46].

These crises have had a significant impact on the FoC situation in the city of Yaoundé. Although there are no up-to-date data to quantify the phenomenon, exchanges with experts and heads of security services demonstrate that the feeling of insecurity is increasing in the city. This opinion must be taken with great care. Indeed, it is generally accepted that security officials often tend to exaggerate the real situation on the field. However, to support their position, they refer to the significant migratory inflows to the capital city of refugees from other regions and neighbouring countries [45].

Even before these crises, however, the security situation was already in bad shape. In 2001, all actors (populations, civil society, and religious leaders) were already calling for the government to take responsibility for security, an issue that was considered to be of great concern [1] (p. 28). The 2014 national survey conducted as part of the Governance, Peace and Security (GPS) programme, which included a representative sample of 4926 randomly selected households, found that 29% of adults had been victims of assault or robbery in the 12 months preceding the survey. This investigation also revealed that most crimes and misdemeanours are not reported and when they are, it is not necessarily to the authorities in charge of security (police and gendarmerie) but to acquaintances who may be friends or relatives. In addition, 7% of the households surveyed consider that the risk of being a victim of crime is high, while 21% think it is rather high. Another important result of this survey is the feeling of mistrust in interpersonal relationships. Indeed, approximately half of the households surveyed (49%) said that they did not trust most of the people around them [47] (p. xi). In a survey organised as part of the diagnostic study of urban crime in Yaoundé, 89% of respondents stated that their neighbourhood is not safe [1] (p. 91). This widespread sense of insecurity may explain the ineffectiveness of Jacobs' principle of presumption of general support for people [5] (p. 55).

3. Data and Methods

3.1. Study Area and Data Collection Method

The study area covers five intersections in Yaoundé, Cameroon: (1) Central Post Office, (2) Carrefour Bata, (3) Carrefour Mokolo, (4) Vog-Ada, and (5) Etam Bafia (Figure 1). These hubs were selected on the basis of criteria such as: compliance with CPTED principles, the presence of a nearby police station, and relatively high density. At each intersection, a spatial delimitation of the area considered in the study was carried out as shown in Figure 1.

For contextual and efficiency reasons, we opted for data collection by the paper-based method, entitled Interview Paper and Pencil (IPC). The on-field interview in the study areas was conducted for three weekdays (8, 9, and 11) on July 2019. To control for potential impacts of brightness level on FoC, the interview was conducted only during the daytime (from 10 a.m. to 6 p.m.). To carry out the data collection in the field, a team of 5 interviewers consisting of 2 male urban planners and 3 female social science students were involved, and they were divided into two teams with one urban planner each.

Because the target population of this study was pedestrians on the five intersections, it was difficult to apply any pre-designed systematic sampling techniques. In addition, due to the severely congested local context, probability sampling method like stratified or random sampling could not be applied either. Accordingly, we had to adopt a non-probability sampling method, the so-called 'street corner sampling'. That is, each interviewer team approached the pedestrians present on the sidewalk (within red lines in Figure 1), asking for their consent before submitting the questionnaire. Although we did not count the exact number of people we approached, a significant number of them did not wish to respond to the questionnaire. Great care was taken to avoid any form of discrimination on the basis of age, ethnicity or any other discriminatory characteristics of the respondents, as the objective of the interviewers was to obtain the opinion of as many people as possible. Finally, a total of 186 pedestrians were surveyed. However, only 185 samples were used in the analysis because one respondent did not want to continue with the survey after completing the first part of the questionnaire.

Apart from this, to preserve as many observations as possible, a mean imputation approach was applied when treated minor missing values in two variables: Income Level and Sense of Community (Table 1).

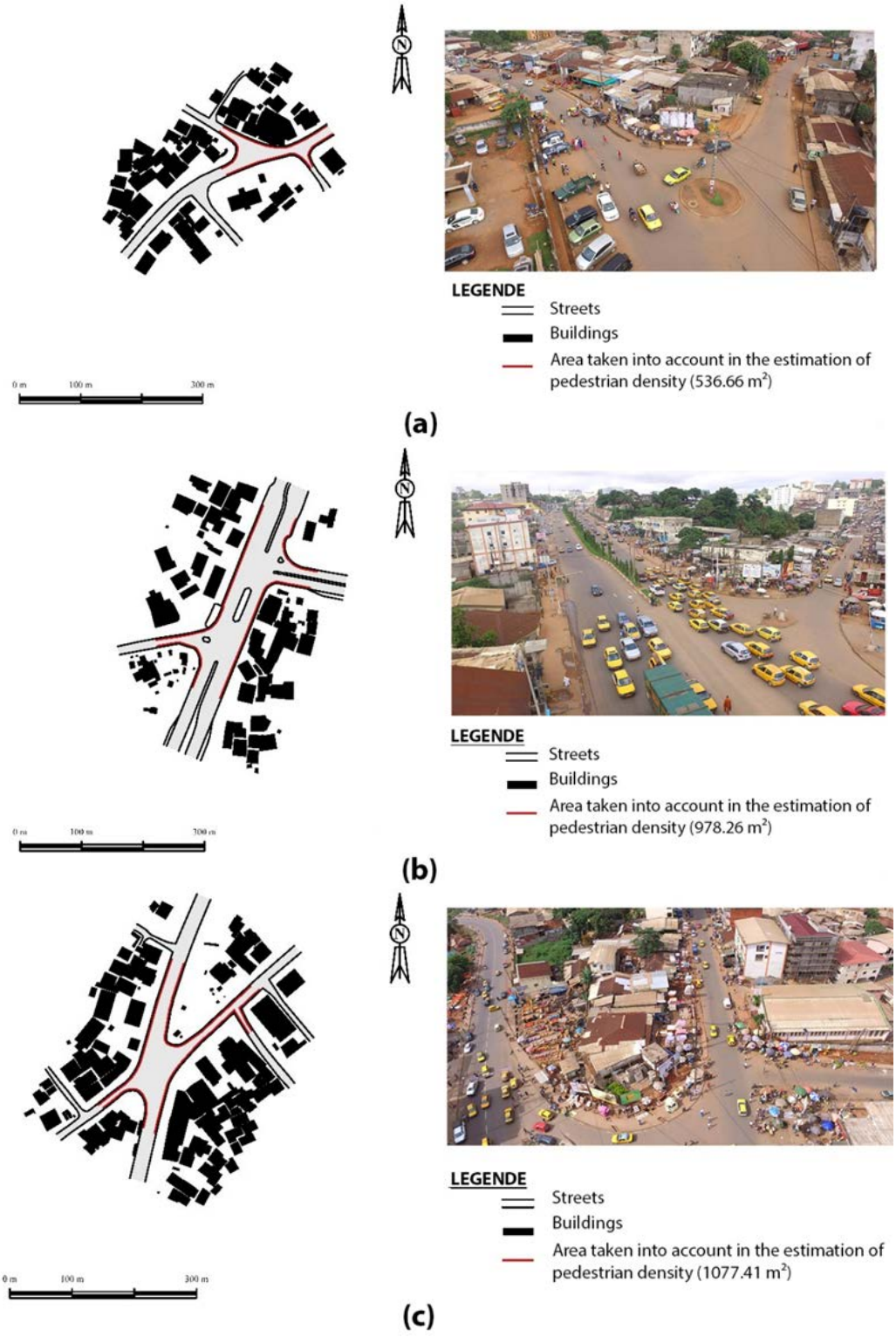

Figure 1. *Cont.*

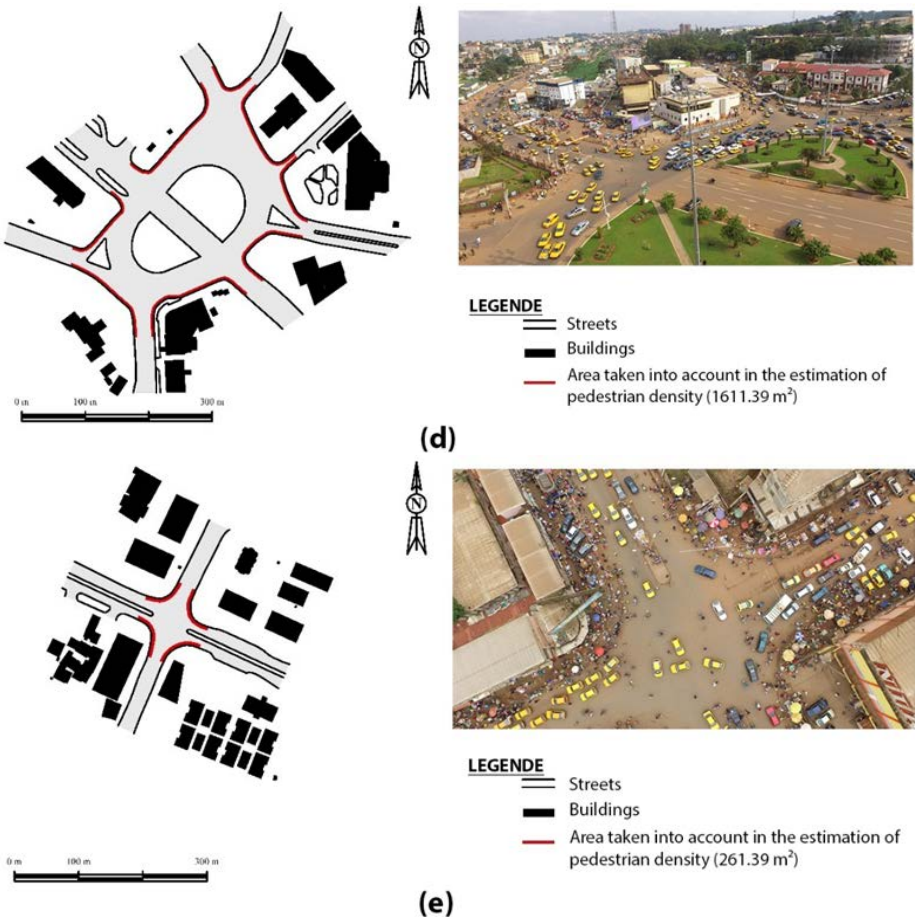

Figure 1. Intersection map: (**a**) Etam-Bafia (**b**) Bata (**c**) Vog-Mbi (**d**) Central Post (**e**) Mokolo. Note: We used several photos for each intersection to count people. The images presented above only aim to show the whole area of each intersection we are interested in.

Table 1. Definitions and descriptive statistics of the variables.

Variable	Description	Mean	S.D.	% of Cases = 1
Dependent Variable				
Fear of crime	Perceived FoC defined using two questions (yes = 1) (See Table 2)			28.1%
Individual-level independent variables				
Female	Reference group is male			25.4%
Vulnerable age group	Minors and the elderly (under 20 or 50 or more)			10.3%
Single	Reference group is married, divorced, and widowed			71.9%
Religion				
Christian	Reference group is other religions			72.4%
Muslim	Reference group is other religions			16.2%
High income HH	Larger HH income than average ($117)			44.9%
Victimisation experience				
Heard of a crime	Reference group is 'no experience'			10.8%
As a witness	Reference group is 'no experience'			35.7%
As a victim	Reference group is 'no experience'			38.4%
Strong sense of community	Reference group is weak sense of community			41.6%
Positive stance on CCTV	Agreed that CCTV could reduce fear of crime (yes = 1)			65.9%
Time of the day	Time of the day at which the survey was conducted (between 10 a.m. to 6 p.m.)	14.362	2.256	
Good weather	Weather condition was good when the survey was conducted (yes = 1)			88.1%
Intersection-level independent variables				
Pedestrian density	Number of people on the sidewalk divided by its area (person/m^2)	0.719	0.437	
Pedestrian density^2	Pedestrian density squared	0.707	0.857	
Bus stop	Presence of bus stops at the intersection (Presence = 1)			39.50%
N = 185				

Table 2. Interviewees' responses on the two questions regarding Fear of Crime (FoC).

		Are You Frightened to Cross the Intersection?		Total (Count)
		No (Count)	Yes (Count)	
Do you feel like making a detour if approaching the intersection?	**No**	133	**14**	147
	Yes	**6**	**32**	38
Total (count)		139	46	185

Note: Bold cases were defined as people who felt FoC.

Each survey had an average duration of 30 min including the time taken to explain the purpose of the survey to the respondent. The questionnaire was structured into two main parts: (1) perceived FoC and (2) general socio-demographics, respectively served as dependent and control variables in the analysis. Details are described in Section 3.2. (Variables and Model Specification).

To measure intersection-level key test variable (i.e., 'pedestrian density'), we used aerial photographs (snapshot) taken by drone on the same day with the interview. Because a single still image cannot capture whole area of each intersection, we took 4 (Bata and Etam-Bafia) to 17 (Central Post) photos for each area and stitched them to count pedestrians on the sidewalk. Every photo had a resolution high enough to distinguish a person. We calculated the surface area of the sidewalk using the city map produced as part of the Yaoundé City Master Plan and available in AutoCAD format.

In our multi-level analysis, the number of clusters were very small, just five. However, Austin's Monte Carlo study suggested that five or less clusters can be considered, "as long as the number of subjects per cluster exceeds approximately 30" [48] (p. 18), and this study met this minimum requirement.

3.2. Variables and Model Specification

As shown above, the data of this study are nested (i.e., pedestrians nested within intersections). While FoC and other socio-demographics are measured in individual level, pedestrian density is measured at the intersection level. Therefore, we applied hierarchical linear modelling (particularly, multi-level binary logistic regression analysis) using the IBM SPSS 25 software.

Level-1 variables include dependent variable and control variables. The dependent variable, 'fear of crime', was defined using two dichotomous choice questions: (1) "are you frightened to cross the intersection?" and (2) "do you feel like making a detour if approaching the intersection?" (see Table 2). Both questions were selected based on the results of previous study [49], in which they concluded that an individual's level of FoC could be observed and understood at different psychological levels such as perception, cognition, and behaviour. Namely, the two questions were designed to capture these three dimensions of individual perception of FoC. By our operational definition, the pedestrians who answered "yes" to any of the two questions were defined as feeling FoC. Because respondents were likely to say "yes" to the above two questions due to the fear of traffic accidents, we asked them to answer the questions, considering only fear of crime before asking.

The other level-1 variables include various control variables deduced from the five theories of FoC summarised in the work of Vilalta [50] and other literatures suggested below.

(1) *Victimisation theory*: this theory is based on the assumption that people who have previously been victimised by crime are likely to suffer from a higher level of FoC than those who have not [35,51]. Regarding this, we applied the 'victimisation experience' variables, which was measured by the following question: "have you ever been a victim of a crime, personally witnessed a crime, or heard of a crime in your surroundings?".

(2) *Physical vulnerability theory*: based on an analysis at the individual level, the theory of physical vulnerability is the feeling that people with physical limitations are likely to exhibit a higher level of FoC. With respect to this theory, previous studies have demonstrated that women and the elderly expressed the highest levels of FoC [35,50]. We also applied 'gender (female)' and 'vulnerable age group' variables. Based on the legal age of adulthood and average retirement age in Cameroon, a vulnerable age group was defined as the minor (under 20) and the elderly (50 or more).

(3) *Social vulnerability theory*: this theory is based on the assumption that socially vulnerable people, including minorities, low-income people [52], and the least educated [53], tend to express a higher level of FoC. The variables considered in most of the research related to this theory are education levels, income, occupation, and unemployment [53–55]. For the purposes of this study, the variable considered is 'income level'. This variable was measured by asking respondents if their monthly income was higher than the average gross monthly income per inhabitant of $117 (67500 F CFA) in Cameroon.

(4) *Social disorder theory*: the theory predicts that a neighbourhood's physical condition; social composition; function; and reputation (vagrancy of adolescents, outdoor drug sales, street fights, graffiti-covered walls, empty and dilapidated housing, dirty sidewalks, etc.) have an impact on the residents' FoC. Regarding this theory, previous researches considered age structure of the local population, criminal activity, proportion of vacant houses, poverty levels, and family structure variables [50]. In view of the local context characterised by a general state of degradation of almost all the intersections, this theory was not taken into account in this study.

(5) *Social network theory*: there are two schools of thought underlying this theory. The first group argues that people in the socially connected communities express a lower level of FoC due to the informal social control by the community [56]. Conversely, the other group suggests that the rapid spread of victimisation news in connected communities makes people perceive a higher level of FoC [35]. In this study, we linked the variable 'sense of community' to this theory. Using a 5-point Likert scale, respondents were asked the following question: "do you feel like a member of this community?" We then defined 'agree (4)' or 'strongly agree (5)' as a strong sense of community.

In addition to them, marital status, religion, stance on CCTV, time of the day, and weather condition were applied as level-1 control variables.

As explained above, level-2 (i.e., intersection level) variables include our key test variable: 'pedestrian density'. This was defined as the number of people on the sidewalk captured by drone photographs divided by its area (person/m^2). To test the potential non-linearity discussed in Section 1, we took quadratic regression forms by applying both density and density squared variables. Table 1 shows the definitions and descriptive statistics of the variables.

4. Results

4.1. Descriptive Statistics

Table 2 shows that only 25% and 20% of respondents were afraid to cross the intersection and felt like making a detour to avoid crossing intersection. Based on this, only 52 respondents (approximately 28%) were defined as people who felt FoC at the intersections. Considering the increasingly degraded security situation throughout the country [45] and UN-Habitat's report that found that 89% of people in Yaoundé considered their neighbourhood to be unsafe [1] (p. 91), the low percentage of people reporting FoC was well below our expectations. However, the relatively small percentage obtained could be explained by the fact that our survey was conducted in a public place. Most of the persons surveyed were at the intersections in question, and felt more or less comfortable using these spaces.

Table 3 describes the frequencies of reporting FoC and the pedestrian density by intersection. The result of Fisher's exact test showed that the proportion of people who felt FoC significantly

varied across intersections at 0.01 probability level. However, the relationship between the proportion of people who felt FoC and the pedestrian density of intersection was not significantly associated (p = 0.104) although they showed quite high positive correlation (0.800). Thus, we need to test this hypothetical relationship that 'high pedestrian density increases FoC at a congested intersection with higher density than a certain threshold level' after controlling for other factors.

Table 3. Fear of crime and pedestrian density by intersection.

Intersection	Number of Respondents	Fear of Crime (Yes = 1)	Fear of Crime (No = 0)	Area (m^2)	Pedestrian Density (Person/m^2)
Bata	34	5 (14.70%)	29 (85.29%)	978.26	0.46
Etam-Bafia	45	14 (31.11%)	31 (68.89%)	536.66	0.30
Mokolo	33	18 (54.54%)	15 (45.45%)	261.39	1.58
Central Post	38	8 (21.05%)	30 (78.95%)	1611.39	0.79
Vog-Mbi	35	7 (20.00%)	28 (80.00%)	1077.41	0.62
Total	185	52 (28.10%)	133 (71.89%)	4465.11	0.67

Note: The proportion of people who felt FoC significantly varied across intersections at 0.01 probability level (results of Fisher's exact test). The proportion of people who felt FoC and the pedestrian density of intersection was positively associated (Pearson correlation = 0.800), but the significance level was marginal (p = 0.104).

4.2. Results of Multi-Level Binary Logistic Regression Analysis

Table 4 presents the results of multi-level binary logistic regression models of FoC. Model 1 is an intercept-only (unconditional) model and Models 2 and 3 are random intercept models with different set of independent variables.

Table 4. Multi-level binary logistic regression models of 'fear of crime'.

	Model 1: Unconditional Model			Model 2: Random Intercept Model with Level-1 Variables			Model 3: Random Intercept Model with Level-1 and -2 Variables		
	B	p	Exp(B)	B	p	Exp(B)	B	p	Exp(B)
Fixed effects									
Intercept (grand mean)	−0.981	0.004 ***	0.375	−2.279	0.223	0.102	0.520	0.854	1.682
Individual-level variables									
Female				1.122	0.009 ***	3.071	1.107	0.011 **	3.025
Vulnerable age group				1.631	0.008 ***	5.108	1.654	0.010 ***	5.228
Single				−0.137	0.756	0.872	−0.128	0.779	0.880
Religion									
Christianity				0.407	0.563	1.503	0.367	0.608	1.443
Muslim				0.135	0.871	1.144	0.047	0.955	1.048
High income HH				0.721	0.088 *	2.057	0.719	0.096 *	2.052
Victimisation experience									
Heard of a crime				0.417	0.600	1.518	0.211	0.798	1.235
As a witness				0.512	0.408	1.669	0.405	0.525	1.499
As a victim				0.251	0.683	1.286	0.154	0.804	1.167
Strong sense of community				−0.997	0.022 **	0.369	−0.977	0.028 **	0.376
Activity in the target area				0.313	0.478	1.367	0.176	0.693	1.192
Positive stance on CCTV				−0.015	0.863	0.985	0.020	0.827	1.020
Time of day				0.248	0.714	1.281	0.455	0.515	1.576
Good weather									
Intersection-level variables									
Pedestrian density							−11.864	0.085 *	0.000
Pedestrian density^2							6.627	0.065 *	755.157
Bus Stop (Presence = 1)							1.439	0.221	4.219
Random effects									
Level-2 variance	0.420	0.290		0.373	0.358		0.061	0.879	
ICC	0.113			0.102			0.018		

Note: Number of observations = 185; number of clusters = 5; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$; ICC: intraclass correlation; In multi-level logit models, level-1 variance is assumed to be $\pi^2/3$ [57].

In the intercept-only model result, intraclass correlation (ICC) was 0.113. This means that 11.3 percent of the probability of feeling FoC is attributable to differences between intersections.

However, the insignificant level-2 variance in the model indicates that the usefulness of ICC values as well as the necessity of multi-level analysis are not valid. Thus, we interpret the rest of the result based on the general standard of binary logistic analysis.

First, the results showed that females were more likely to feel insecure than males. The value of odds ratio indicates that female respondents are three times more likely to express FoC than males. This observation is consistent with the result of previous studies [35,39]. This result also suggests that vulnerable age groups (minors and the elderly) tend to express higher level of FoC than middle-aged adults (20 to 49 years old). The odds ratio indicates that the likelihood of expressing FoC is almost five times higher for minors and the elderly than for adults. This result confirms again the theory of physical vulnerability, which states that people who are more physically vulnerable (minors, the elderly, and female) are likely to exhibit a higher level of FoC.

Second, the models revealed that people with a strong sense of community were more likely to feel insecure than people with a weak sense of community. This can be explained by the fact that there is an informal network of mutual support between strongly tied community members. It follows the same logic as Social Network Theory, which states that communities in which members are better connected are more effective collectively in reducing FoC.

Thirdly, the coefficient of the 'income level' variable showed that the respondents with higher monthly income than the average (about $117 per person) expressed higher level of FoC. This result contrasts with the principle of social vulnerability, which is based on the assumption that socially vulnerable people, particularly minorities and low-income people, express a higher level of FoC [52]. This can be explained by the local context that, as high-income people are in the minority, they must take a greater effort to secure their goods and properties. In fact, in the city, or even in the country as a whole, a high rate of poverty, unemployment, and crime overflows. The findings explained so far are true for both models with and without intersection-level variables.

With respect to the intersection-level variables, two density variables showed significant association with FoC at the 0.1 probability level; however, the signs conflicted with each other. This means that the relationships between pedestrian density of intersection and the expressed FoC seem to be convex curves with the minimum value. Meanwhile, the choice to include the two variables ("density" and "density squared") in our model comes from the fact that the results obtained by introducing each of these variables separately proved not to be significant. Indeed, when we introduce only the variable "density" in Model 3 and remove the variable "density squared", we obtain a coefficient equal to 0.899 and a p-value equal to 0.257 for this variable. On the other hand, when we introduce only the variable "density squared" and remove the variable "density", we obtain a coefficient equal to 0.501 and a p-value equal to 0.196 for this variable. Although the p-values are not statistically significant at a 0.1 probability level, both variables commonly showed positive signs, in contrast to the results in Model 3. This means that when we control for one of them, the other's effects can be more accurately identified. This also reveals that the quadratic regression approach of this study is more effective than the general approach using single density variable to identify the non-linear relationships between the key variables. Thus, we can conclude that Jacob's concept of 'eyes on the street' is not valid in places where pedestrian density exceeds a certain threshold level like Yaoundé city intersections considered in this study. We discuss the implication of this result in the following section.

5. Discussion

There have been widespread ideas that the more people and activities in a space, the more secure it is and therefore the lower the feeling of FoC is. Indeed, in the old influential theorists' works like Wood [58], Jacobs [5], Angel [59], and Newman [60] or even in the recent works of Marzbali et al. [4], this idea remains very present. However, the key finding of this study disputes this preconceived notion. In some selected intersections in the Yaoundé city context, this study revealed that a high pedestrian density at an intersection above a certain threshold contributes to an increased FoC, thereby leading to low quality of life. As explained in Section 2.3., the distinctive contexts in Yaoundé city

such as high crime rate, low level of social capital (mutual trust) [1,45,47], and overcrowded public spaces could be seen as main causes of such discrepancies between previous studies and this study. This suggests another theory that can be considered in understanding FoC, which we have called 'density threshold theory', based on the principle that there is a density threshold beyond which an urban environment affects an individual's feeling of FoC. This theory could have applications in many other fields. For example, the minimum standard for public spaces could be established in terms of occupancy density. One important indicator to be considered would therefore be the 'density threshold' above which the space is considered unsuitable. Similar ideas exist in other areas. In architecture, for example, many countries regulate the maximum number of people per room by setting the Minimum House standards (Korea, UK, and France). In urban planning, the standard of 100 people per acre (248 ppha) is generally considered a necessary minimum for effective transportation and service [61] (p. 149).

The next issue we should consider is how to reduce FoC although Cordner [62] (p. 4) listed the main arguments against the adoption of targeted police measures to do it. FoC is a real phenomenon that deeply affects individuals and the community, and as a result, living continuously in a state of fear can significantly affect quality of life. Thus, it is necessary to take appropriate measures to mitigate this impact. According to the findings of this study, securing enough pedestrian-only spaces (e.g., sidewalk) in intersection areas may be one potentially effective measure in reducing FoC. This would reduce the density of pedestrians. Another measure to preserve pedestrian space is to prohibit all forms of illegal sidewalk occupations including informal activities, illegal parking, and temporary occupation of the sidewalk by vehicles and motor taxis when there are traffic jams. However, this measure must be examined with great caution with regards to the particular case of the prohibition of 'informal activities'. In fact, such activities are essential sources of income for many households, and therefore, in the case of displacement, it is important to take measures to provide displaced persons with fair and just compensation. Another measure to reduce pedestrian density would be to move bus stops away from the intersection and to adopt more appropriate zoning in general to move away from the intersection activities that attract a large density of people, such as markets and shopping centres. Overall, all measures that help reduce the number of people gathered and to encourage a more balanced use of the intersection area would be welcome. However, attention should be paid to the consequences of these measures at the same time. These measures should be targeted for greater effectiveness and adapted to the local context. Thus, more studies targeting specific areas are needed, like this study.

6. Conclusions

This research aimed to explore the paradox of the phenomenon of FoC in areas that meet the principles of security planning. We initially hypothesised that 'high pedestrian density positively influences the feeling of FoC at a congested intersection with higher density than a certain threshold level'. To verify this hypothesis, we first identified the widely accepted theories of FoC and then established the link between the theories and the context prevailing in the city of Yaoundé. This approach enabled us to identify local specificities and to contextualise the different variables that explain an individual's FoC. This then led us to adopt multi-level binary logistic regression analysis as an analytical tool in view of the nature of our variables and the objective of this study.

The key finding of the analysis is that pedestrian density may increase people's FoC in congested public spaces. In fact, the result revealed that the relationships between both key variables seem to be convex curves with the minimum value. The hypothesis is thus confirmed. One of the major implications of this result is the need to consider the density of pedestrians in the design of public spaces, not only in terms of comfort, but also in terms of reducing the feeling of FoC among users of these spaces.

Another significance of this study is that our analysis results confirm the theories of physical vulnerability and social networks and invalidate the theory of social vulnerability among the major FoC theories in the local context. Indeed, physically vulnerable people (particularly female, minors,

and the elderly) or people with a weak sense of community were likely to express higher level of FoC. In contrast, people with lower income than the average tended to lower level of FoC unlike theoretical expectation.

The main difficulty encountered in this study, which is also a limitation, was the data collection and potential selection bias of the sampling method. Due to the reluctance of many people to engage in the interview, some variables showed large gaps between the characteristics of population and sample groups. For example, 75% of the respondents were male. Furthermore, in the age category, only 10% of those surveyed were minors or elderly people.

Another major shortcoming was the limited number of study areas (only five intersections). Although this met the minimum requirement of multi-level analysis [48], the results of the analysis may seem to be unstable. There may be a possibility that the main findings might result from one single intersection's unobserved characteristics. Thus, this paper should be regarded as an exploratory study that identifies the type of the relationship between pedestrian density and the expressed FoC. To confirm this finding and increase its generalizability, we believe that the results of this study need to be compared to further research focusing on diverse study areas.

Lastly, due to the lack of automated pedestrian counting system in the city, and more generally the difficulty of accessing modern data collection techniques (mobile applications, GPS, mobile phone data, etc.), we solely depended on the drone images when we measured pedestrian density. To overcome this, we recommend that future studies collaborate more with the city's security services, which have the advantage of having a pre-existing database as well as automated pedestrian counting system such as static/mobile sensors.

An additional valuable direction for further research would be to find exact density threshold. To create safer environments based on the results of this study, it is important to define the threshold above which the density of pedestrians in a space can be considered a factor in creating FoC among those who use that space. However, the research data and method used in this study did not perfectly allow us to define this threshold. In future research, this objective can be achieved by using virtual reality technologies, which make it possible to reproduce the urban environment virtually and thereby to test the different density hypotheses by asking respondents to express their feelings when immersed in the virtual environment. This approach could also be beneficial in recreating different types of physical environments that are fairly representative of urban diversity and thus take into account the various contexts. In addition, to find exact density threshold, it would be also desirable to use large random samples that cover various urban contexts. We hope that this research, combined with other related research in this field, will be used to establish a new concept: 'Improving the Urban Environment through Density Management' (IUETDM).

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