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Seasonality of violent and property crime in Nigeria: Some Preliminary Findings

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Abstract

This study examines seasonal patterns of crime in two Nigerian cities with varying weather conditions. Using residents' perception of crime data, break-ins are perceived to occur more frequently in the low quality neighbourhoods in Benin City, whereas in Minna, it is perceived to occur regularly in the high quality neighbourhoods. Overall results show that Minna, with warmer climate has higher levels and seasonal variations for violent crime (assaults) while Benin City, with colder climates has higher levels and seasonal variations for property crimes (break-ins). It is apparent from this study that seasonal patterns of crime in one place may not translate effectively into another. Hence, continuous researches into seasonal analysis of crimes are justifiable in the security planning efforts to ensure an environment that is suitable for living, working and recreating.

Introduction

Crime as well as factors driving it has been researched in a multiplicity of areas and methods worldwide. The majority of these researches attempt to explain crime by examining socio-economic and demographic aspects such as age, sex, race, geographic location, and income status among others (See Shaw & McKay, 1942; Weisburd et al., 2004; Eck, Clarke, & Guerette, 2007; Groff, Weisburd, & Yang, 2010; Johnson & Bowers, 2010; Badiora 2012; 2016). However, these variables change slowly over time and may not be able to effectively explain short-term variations in crime rates. Furthermore, most of these analyses generally focus on long periods of time, considering units of analysis such as daytime, weekdays, months and years. They ignore the large range of variation in crime incidences within each daytime, weekday, months and years that is seen when smaller units of analysis are examined. With all these inadequacies, scholars believe that one aspect of the physical environment which in addition to socio-economic and demographic aspects that may have better explanation of crime occurrences and major impact on social

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behaviour is the weather condition of our social and physical environments (Jacob, Lefgren & Moretti, 2007).

The study of seasonal variations in crime occurrence has long been a subject of interest of researchers in criminology (See Literature Review and Theoretical Framework). It is popularly believed in many of these literatures that weather conditions can precipitate negative or positive emotional responses. Debate on crime seasonality applied temperature aggression theory to explain annual variations in criminal offences (See Literature Review and Theoretical Framework). However, based on the principles of temperature aggression theory, it is only able to account for violent crime. To provide for these shortcomings, Cohen and Felson (1979) developed routine activities theory (See Literature Review and Theoretical Framework) and researches have since found that seasonal maximums exist for other crime types, and that routine activities theory can account for these (Hipp et al., 2004).

Majority of the literature that has investigated seasonal variation in crime are from advanced countries (e.g. Hipp et al., 2004; Linning. et al. 2016) with very few studies in Southern Africa (e.g. Rotton & Cohn, 2004; Breetzke & Cohn, 2012; Breetzke, 2015). Although these studies have enhanced understanding of crime seasonality throughout the world, there still exist many more unanswered questions in Africa and less developed context, particularly in Nigeria. In other words, very little is known about seasonal variations of crime in Nigeria. As seasonal variation in crime is becoming more prominent in the literature but consist primarily of researches conducted in the United States and Europe, it would benefit through this study from further investigation in a Nigerian context. Besides, Nigeria's location in the tropical zone means that the seasonal patterns are significantly different from those of the United States, Europe and South Africa, with the coldest days falling in the months of July and August and the warmest occurring in December and January.

As such, this study seeks to explore whether what is already known about seasonal fluctuation of crime is true about Nigeria. This idea is examined in two Nigerian cities; Benin and Minna, regarding the following research questions: What seasonal crime patterns are generated in these cities? Are there any possible inter and intra cities variations in seasonal crime levels? Based on these research questions, this study contributes to the existing body of literature in an attempt to provide empirical facts to correlate weather conditions and crime in Nigeria environment. Though some research has investigated many more cities in like analysis, this study contributes to the literature by comparing localities with different weather conditions. The uniqueness of this study is also in the use of residents' perceptual data to investigate whether crime incidences vary periodically throughout the year. This is because of the concern regarding the accuracy of police data in Nigeria. Furthermore, most prior research into crime and seasonality has examined the phenomenon at a citywide level and has either assumed spatial homogeneity of seasonal crime across a city. There has been almost no research examining the intra city and intercity variation of crime by seasons in cities with different climates. This study relates seasonal crime levels to the neighbourhood characteristics of cities under study. This is perhaps, the first study to investigate the crime-seasonality relationship at a neighbourhood level in Nigeria and in the tropical region. This study believes that a better understanding of how various crimes fluctuate through the year can lead to more efficient policy implementations. This research can assist the government in knowing when to implement crime prevention initiatives as well as when to evaluate them. In essence, this study will give police departments a chance to adjust their man power appropriately based on the short term increase or decrease in demands for their service.

Literature review and theoretical framework

As highlighted earlier in the introductory part, the two types of theories that are commonly used to explain seasonal variations of crime are temperature/aggression (T/A) theories of Quételet, (1969) and routine activity (RA) theory of Cohen & Felson (1979). Temperature/aggression theories offer a more psychological explanation for the increase or decrease in crime during certain seasons of the year. These theories suggest that hot temperatures lead to an increase discomfort in individuals, and thus increase the likelihood of aggression. Essentially, the relationship between an aversive event (such as a hot day) and aggression is mediated by the negative affect generated by these types of emotions (Quételet, 1969).

There are several versions of T/A theories. These differ mainly as to their views of the shape of the relationship between temperature and aggression. The first is the Negative Affect Escape (NAE) Model developed by Baron (1978); Baron & Bell (1976) and Bell (1992). These researchers concluded that negative affect (feelings of irritation, annoyance, or discomfort) and violent acts increase as temperature increases up to a certain inflection point. On exceeding this inflection point, the model predicts a decrease in violence as temperature increases because a person's escape motives (avoiding the heat) will override their aggressive motives. In contrast, Anderson & Anderson (1998) developed the General Affective Aggression Model (GAM). This is a complex model that takes many factors such as temperature into account. This model asserts that there are input factors, such as personal and situational variables, that determine a person's arousal, state of affect, and cognitions. Contrary to the NAE model, this model predicts a steady linear relationship between temperature and violence with no inflection point (Rotton & Cohn 2000). Social Escape/Avoidance (SEA) Theory is closely related to Routine Activity Theory and the NAE Model. It suggests that people will attempt to avoid conditions that could lead to negative affect. Therefore, days with extreme temperatures (both hot and cold) should lead to lower amounts of social interaction, which leads to lesser amounts of violent crime (Rotton & Cohn 2000; Cohn et al. 2004). According to Cohn and Rotton's social escape and avoidance (SEA) theory, their theory was developed in an attempt to integrate psychological theories of aggression, such as the GAM and NAE models, with criminological models such as the RA theory.

Cohen and Felson (1979) developed the Routine Activity (RA) theory to explain why crimes occur. RA theory employs a social explanation to explain seasonal oscillations in crime. It focuses on opportunities and risk, rather than on offender motivation, and is based on the idea that for an understanding of criminal behaviour, one needs to understand how individuals routinely use their time (Breetzke and Cohn, 2012). This theory postulates that individuals generally follow strict daily, weekly, and even monthly routines, which affects opportunities for crime and risk of victimization (Brunsdon, Corcoran, Higgs, & Ware, 2009). Some of these routine activities are obligatory, with a reasonably fixed duration, and are difficult to change, such as work while other activities are discretionary such as socializing, and individuals have a greater amount of choice as to whether they will engage in these activities and when they will occur (LeBeau & Corcoran, 1990; Breetzke and Cohn, 2012).

Routine Activity (RA) theory also states that for a crime to occur, three elements must converge in time and space. These elements are motivated offender, suitable target, and the absence of a capable guardian against criminal behaviour (Cohen and Felson, 1979). The guardian here was not usually a police officer or security agent but rather anybody whose presence or proximity would either prevent or discourage a crime from happening. Therefore, the landlord, tenant, housewife or doorman, a neighbour or co-worker among others would tend to serve as guardian by being present. Guardianship is

often unintentional and may not be prepared for, yet still has a powerful impact against crime (Badiora, 2012). Therefore, most importantly, it is when there is no form of guardians that a target is especially subject to the risk of criminal attack. In the routine activity approach, the term target is preferred over victim, who might be completely absent from the scene of the crime. For instance, the owner of a motor vehicle is normally away when a burglar takes it. The car is the target and it is the absence of the owner and other guardians that makes the theft easier. Targets of crime can be a person or an object, whose position in space or time puts it at more or less risk of criminal attack.

It should be noted at this juncture that changing weather conditions can play an important role in changing the routine activities of individuals (particularly those that are discretionary) and can possibly impact the likelihood of the convergence of motivated offender, suitable target, and the absence of a capable guardian against criminal behaviour. For instance, when the weather condition is warmer, people are more likely to embark on journey to public places. This increase in social contact leads to more people being victimized, and thus predicts an increase in violence to be directly related to an increase in temperature. The likelihood of residential break-ins may also increase. This may be possible as homes are left without capable guardians since their occupants are outdoors, making them more suitable targets. Similarly, cold weather conditions may encourage residents to stay at home, thereby, increasing crime as result of reduced capable guardians caused by decrease in the number of people in the streets. For instance, during cold seasons, during the day, people are more likely to be indoors. The very few people on streets increase the likelihood that victims and offenders will come into contact with each other in a situation that capable guidance is not present. Cold weather conditions may also encourage in decreasing the amount of suitable targets for property crimes and reducing the likelihood of violent crimes that require contact between victim and offender. In summary, RA notions put forward that seasonal variations in individual behavioural patterns help to account for seasonal differences in levels of crime.

Using the assumptions of the theories discussed above, studies around the World for more than ten decades now have evaluated seasonal variation in crime incidences. The results are sometimes contradictory. Earlier studies have consistently found statistically significant peaks for assault in the summer months (Cohn, 1990; Harries et al., 1984; Michael & Zumpe, 1983). Researchers often attribute these trends to both heightened aggression levels, as a consequence of high temperatures, and more increased engagement in recreational activities outside of the home (Breetzke & Cohn, 2012; Cohn & Rotton, 1997; Uittenbogaard & Ceccato, 2012). In essence, occurrence of criminal and subsequent victimization occurs when large groups of exasperated and/or aggressive people gather in specific places during these times. With respect to sexual assault, some studies have found significant peaks for rapes in the summer months (Michael & Zumpe, 1983; Perry & Simpson, 1987) while others have not found statistically significant relationships between rape and higher temperatures (DeFronzo, 1984). These inconsistencies are said to be due to offenders' preferred selection of victim, whether criminals choose to offend against strangers or acquaintances, and whether or not they assault the same victims on multiple occasions (Leclerc, Wortley, & Smallbone, 2010; Maguire & Brookman, 2009).

Unlike assault, little agreement exists regarding offending patterns of homicides (Cohn, 1990). While American cities (Harries et al., 1984; Yan 2000; McDowall et al., 2012), Canada (Dagum, Huot, & Morry, 1988), and Israel (Landau & Fridman, 1993) were unable to identify concrete statistical evidence for a single seasonal peak, some research has found distinct summer increases of homicides in Finland (Hakko (2000), Sao Paulo, Brazil (Ceccato, 2005); United kingdom (Hird & Ruparel, 2007) and Tshwane, South Africa (Breetzke & Cohn, 2012). Researchers have argued that these seasonal variations

could be due to individually motivating factors and that the victims were often known to the offenders (Landau & Fridman, 1993). Furthermore, Hipp et al. (2004) generated a hypothesis based on temperature aggression theory in a test designed to contrast the explanatory capacities of temperature aggression and routine activities theory. The hypothesis states that because seasonal variation is due to higher temperatures that lead to violent behaviour, "there (would) not be a seasonal effect for property crime rates" because the offences are not aggressive in nature (Hipp et al., 2004, p. 1338). After applying a latent curve model on 3 years' worth of uniform crime data, they found statistically significant fluctuations for violent crimes.

A number of results have provided further support for routine activities theory as well as evidence for the existence of crime seasonality for property crimes. Hipp et al., (2004) after applying a latent curve model; it found statistically significant oscillations for property crimes. Besides, studies have found burglaries to peak during the summer months (Cohn & Rotton, 2000; McDowall et al., 2012; Linning et al. 2015). This could be attributed to the fact that in summertime, relaxation activities of people make them to stay away from their homes, thus removing capable guardianship of their property. This provides suitable target selection for motivated offenders (Chimbos, 1973; Hamilton-Smith & Kent, 2009). Nonetheless, other research has indicated that residential burglary drops to the lowest annual levels in the summer months and is instead at its highest in February and March (Farrell & Pease, 1994).

While Cohn and Rotton (2000) found that robberies peaked, McDowall et al. (2012) found that all crimes except robbery peaked in the summer months. More explicitly, McDowall et al. (2012) observed that robberies were highest in December but were also peak in the summer. Michael and Zumpe (1983) found that only five of their 16 American locations had statistically significant strides for robbery and that they peaked in November/December. Landau and Fridman (1993) found that in Israel, robberies peaked in the winter months and attributed these findings to monetary drives based on increased unemployment and necessities. Besides, they explained that the colder weather present in winter months reduced the number of people in the streets (i.e., capable guardians), thus increasing the suitability of targets who were present. They also believed that shortened daylight hours put potential victims at an increased likelihood of victimization (Landau & Fridman, 1993). However, some contradictory results have argued that the winter months provide increased opportunities due to peak shopping times for the Christmas holidays (Andresen & Malleson, 2013). Therefore, robberies may also be largely attributed to the concentration of activities on the street (Loukaitou-Sideris, 1999).

Farrell and Pease (1994) found no distinctive seasonal trend for motor vehicle theft (MVT). As an alternative, they only observed a drop in demands for service to police. They attributed this to a change in recording practices. Also, Cohen et al. (2003) discovered a cancelling-out effect in their assessment of MVT. The statistically significant predictive variables revealed contrasting effects on the dependent variable, thus invalidating any annual peaks (Cohen at al., 2003). Distinct seasonal peaks for MVT over a 24-year period were found across 88 American cities (McDowall et al., 2012). The months that the crime count jagged, nonetheless, differed once controlled for average monthly temperatures. When using the raw crime data, offences peaked in August and reached their lowest in February. However, when temperature was accounted for in the model, motor vehicle thefts were highest in December-January and lowest in the spring and early summer (McDowall et al., 2012). When exploring trends within each of the 88 American cities, they found that cities with large annual temperature changes (e.g., Minneapolis, Minnesota) exhibited more distinct seasonal trends for MVT than cities (e.g., Honolulu, Hawaii) with more consistent ambient temperatures (McDowall et al., 2012). In a similar vein, Linning

et. all (2012) having used data containing different property crime types in two Canadian cities with differing climates found that cities that experience greater variations in weather throughout the year have more distinct increases of property offences in the summer months and that different climate variables affect certain crime types.

In summary, it can be deduced that much of the research on seasonality has not come to a consensus on the temporal trends of various crime types. This provides strong support for the need for additional comparisons of cities. Based on the above literature, there is still a need for further research on crime patterns, particularly from the tropical region. As such, this study seeks to explore the relationship between crime and weather conditions using residents' perception data from different residential districts of Benin City and Minna, Nigeria.

Climate characteristics of Benin City and Minna

The study area covers two major cities (Benin and Minna) in Nigeria: a country located in the West of Africa (See Figure 1.1) on latitudes 4º 0' to 14º 0' North and between longitudes 2º2' and 14 º 30' East. Nigeria lies within the tropical zone and enjoys a truly tropical humid climate, which is dominated by West African monsoon system. Nigeria experiences two broad seasons: wet and dry seasons. The wet season starts from April through October and a dry season from November through March. In the wet season, moisture-laden south eastern wind from the Atlantic brings cloudy and rainy weather, whereas in the dry season, the dry north eastern wind from the Sahara (harmattan) brings dusty and fair weather. The prevalence of these alternating winds over the country influences is linked to the movement of the Inter-Tropical Convergence Zone (ITCZ) north and south of the equator. There are, however, wide variations in climate in different regions of the country with topographic relief being a major factor. Seasonal mean temperatures throughout Nigeria are consistently over 200C with diurnal variations more pronounced than seasonal ones. In general, temperatures are lower in the wet season than in the dry season, and vary little from the coast to inland areas. The wettest month in Nigeria is June in southern and the wettest area is the east coast, parts of which receive over 4000 mm rainfall annually. Regions along the coast in Southern Nigeria receive about 1800 mm rainfall annually, which decreases to about 500 to 1000 mm in Northern Nigeria ((Nigerian Meteorological Agency, 2016).

Benin City is located in the Southern Nigeria (See Figure 1). It is bounded by latitude $6^0$30' N, 6^0 06'N and longitudes 5^0 30' E and 5^0 45' E. The city has an estimated land area of 500 square kilometres, with an estimated mean annual rainfall of over 2000 mm and average temperature of 26^0C (Nigerian Meteorological Agency, 2016). Benin City experiences two major seasons per year; wet and dry seasons. These can further be subdivided into four different periods. First, the long rainy season (beginning of raining season and rain maximum**)**. This starts in March and lasts till the end of July, with a peak period in June. Second, the short dry season (break: short period of cease in rain). This is experienced in August for 3 to 4 weeks. However, the real dry period known as "August break" is generally observed in the last two weeks of August. Third, the short rainy season (ending of raining season), which is the brief wet period that follows the "August break" from early September to Mid-October, with a peak period at the end of September. Fourth, the long dry season, which starts from late October and lasts till early March with peak dry conditions between early December and late February. The period witnesses the prevailing influences of the dry and dusty north-east winds, as well as the 'harmattan' conditions. Vegetation growth is generally hampered, grasses are dry and leaves fall from deciduous trees due to reduced moisture.

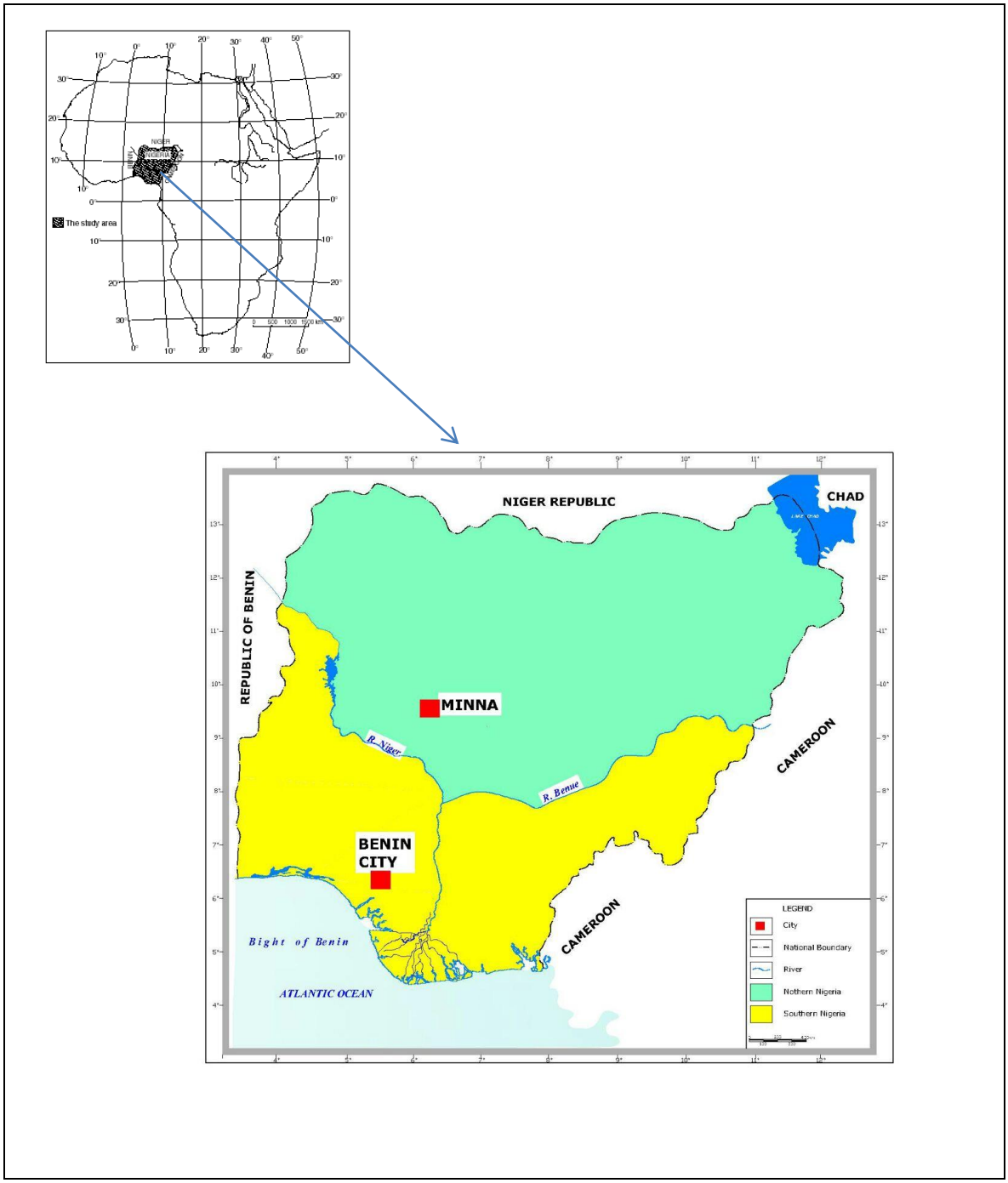

Figure 1: Map of Nigeria, showing Minna (Northern Nigeria) and Benin City (Southern Nigeria)
Figure 1.1: Map of Africa, showing Nigeria.

As shown in Figure 1, Minna is located in the Northern Nigeria on latitude 9^0 27′N and longitude 6^0 33'E. Minna occupies a land area of 88km, with average annual temperature of 29ºC. The Average daily sunlight duration is 9 hours while mean annual rainfall is 72mm which comes between June to October (Nigerian Meteorological Agency, 2016). Minna enjoys relatively warm temperature. Minna is characterized by two distinct seasons; rainy

and dry seasons. However, the rainy season in Minna starts from May through October and dry season from December to March with the two seasons often separated by somewhat transitional periods in April and November. While, the months of February and March typify the peak of the dry season, with very high temperatures, the rains climax is usually in August. The months of November through January are marked by cold and dry weather conditions (the harmattan) under the influence of the northeast trade wind. Unlike Benin City, the long rainy season (beginning of raining season and rain maximum) is typically in May, June and July while the short dry season (break: short period of cease in rain) is usually in August ending. The short rainy season (ending of raining season) is in late September and October while the long dry season occurs in November to May.

Neighbourhood structures of Benin City and Minna

Nigerian traditional cities (such as Benin City and Minna) were first built as residential locations with security walls surrounding them in the early part of the origin. However, developmental activities in these cities brought about growth outside the city wall and this growth outside the town wall then produced two cities in one: the traditional and the modern city. Onibokun (1985) submitted that the combination of these two parts in Nigerian Traditional cities revealed three contrasting zones linked to three historical periods. These are the pre-colonial development, the zone between pre-colonial and post independent residential development and the post independent development. These zones are associated with the core, the transition and the suburban.

Each of this zone is observed to be internally homogeneous in terms of physical layout, socio-economic status and environmental amenities available among others. These sub-divisions had been observed by previous studies to be the characteristics of Nigerian towns and cities. Towns and cities in Nigeria where these zones are identifiable include among others Ilorin (Akorede 1974); Ibadan (Onokerhoraye 1977; Adigun 2012); Lagos (Agbola 1997; Oduwaye 2003); Ogbomosho (Afon 2005) and Ile-Ife (Badiora 2012). In addition to these are newly developed government reservation areas (GRAs), and the government and privately-owned planned residential areas. These zones and newly developed government reservation areas (GRAs), and the government and privately-owned planned residential areas are associated with low, medium and high density/quality residential areas.

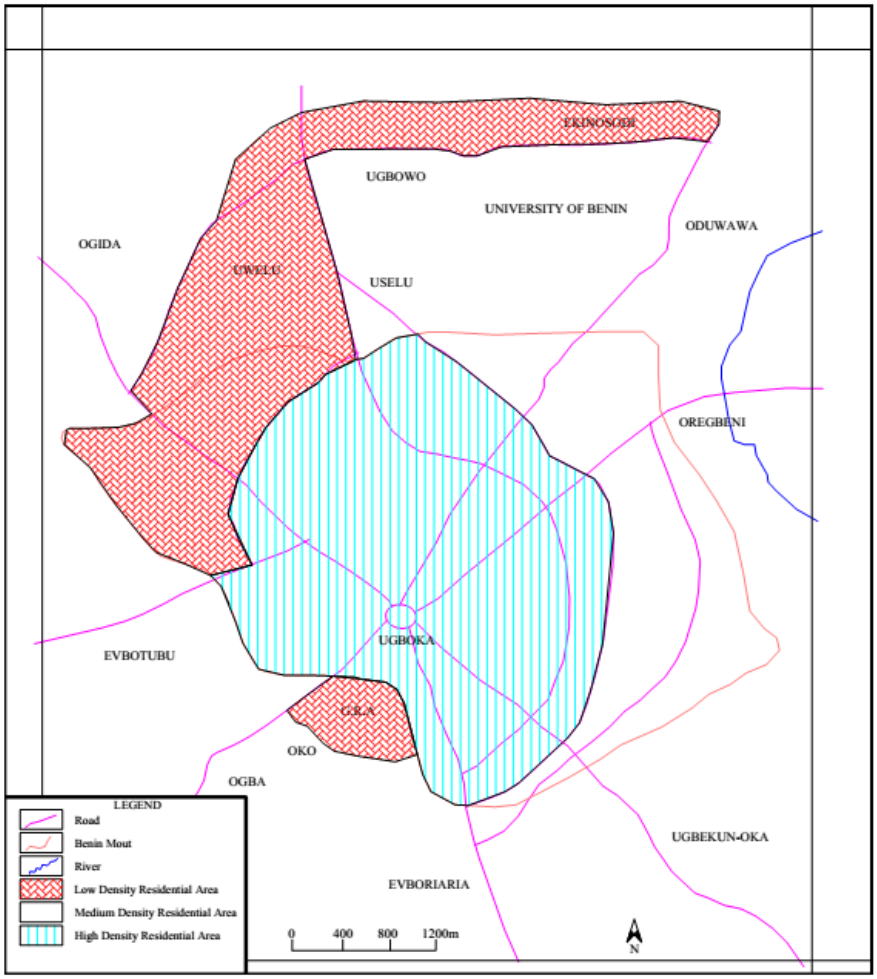

Figure 2: Map of Benin indicating the high, medium and low density neighbourhood

Low quality or high density residential areas are usually located in the central area of pre-colonial neighbourhoods. These areas are often occupied by the first group of immigrants. It is usually with a density of over 300 persons per hectare (Coker, Awokola, Olomolaiye and Booth 2007). Such districts are found in Iwegie, Eguddase, Ogbelaka, Igbesanwa, Urubi, Wire Road, Upper Mission Area and Iyaro and are low-quality high density residential areas in Benin City (see Figure 2) while Minna Central, Sabo Gara, Nassarawa, Makere, Limawa, Dutse, Kura, Gwari and Fadipe are low quality residential areas in Minna (see Figure 3).

The most distinguished physical features of these areas are that they are largely unplanned, lacking good access roads. Building and population densities in these areas are very high with over 50% of plots built-up (Oduwaye 2013). The houses in this zone are closely built together and connected to one another with foot paths. The local streets inside the area have a non-distributed structure with few possibilities for through traffic. This made majority of the buildings to lack accessibility to road. Houses in this zone are mainly of traditional system made from indigenous materials. Residents engage in primary and traditional occupations such as farming and petty trading activities. Most of the areas in this place did not enjoy modern physical panning regulations. The physical environment is low in standard as depicted in housing construction techniques and materials as well as

layout and the facilities available. These areas are therefore predominantly of high-density population and high plot coverage; majority of the people here belong to the low income groups.

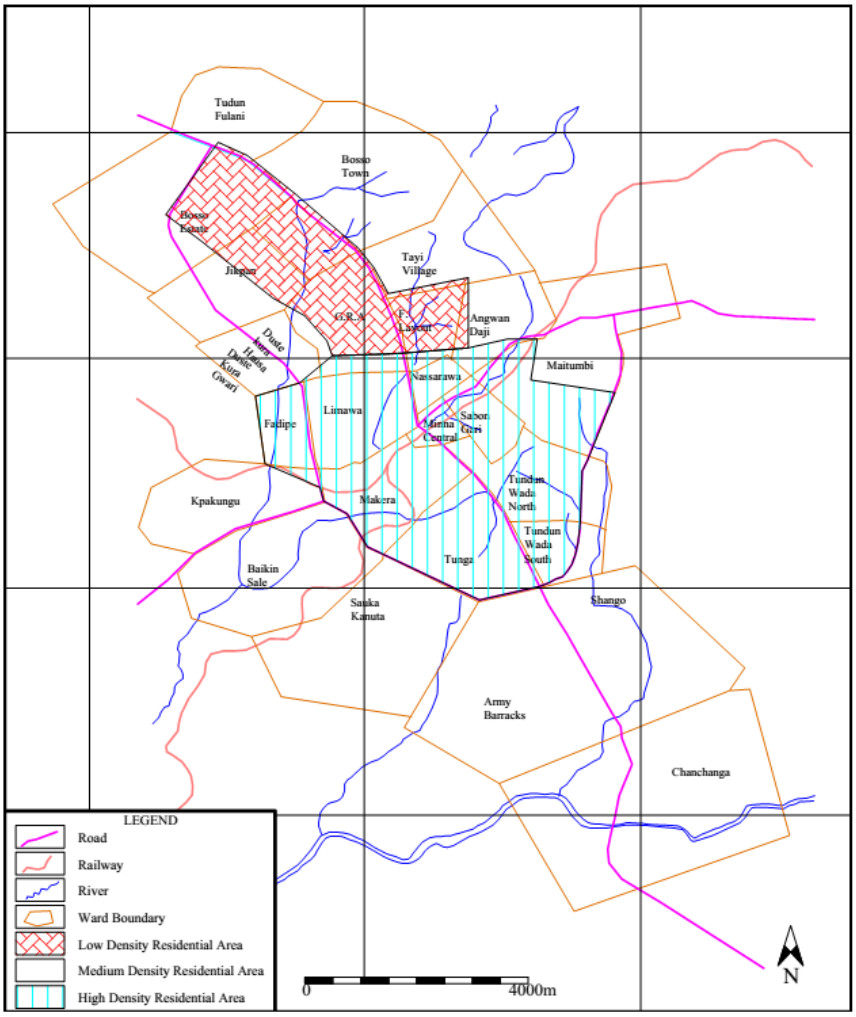

Figure 3*:* Map of Minna indicating the high, medium and low neighbourhood

Medium quality or medium density residential areas are usually planned and laid out after establishment of the British rule. They were developed to satisfy the needs of middle grade income households in the formal sector. The Medium density residential district usually with a population density of 100 to 300 persons per hectare (Coker et al. 2007; Efe and Eyefia 2014). Such districts are found in Benin at Uguisi, Ugbeku, Uzebu, Evbuoriaria, Aduwawa, Ugbowo, Okhoro Quarters, Ikpoba Slope, Ikpoba Hill, Airport Road and Ekewan. Others include Second East Circular Area, Ewe, Lawani, Murtala Mohammed Way, Siluko Road, Textile Mill Area, Agbor Road, Saponba, Oka, Oliha, Uselu and Ehaipen (See Figure 2). Kpakwgu, Tunga, Gwari, Maitunbi, Jikpan, Barikui, Sale, Anguan Dagi, Tayi Village, Tundu Fulani, Shango, Bosso Town and Chanchaga are medium-density residential districts in Minna (See Figure 3).

Dominant housing types here are bungalows, and semi-detached two-storey buildings of concrete block wall with comparatively low population density. The most important physical feature is that this new areas were developed through planning schemes. They can therefore be referred to as areas with a layout/developmental plan and modern day planning regulations. The local streets inside the area have a distributed structure with few possibilities for through traffic. Status and ethnic compositions are mixed as this area is being occupied majorly by indigenes and non-indigene employed in the formal sector of the town. Building density in these areas are moderate, thus they are classified as medium density areas.

High quality or low density residential areas are high quality districts usually well laid out. They are not common in the old growing pre-colonial towns except those, which were once provisional headquarters. Low-density residential districts with less than 100 persons per hectare (Coker 2007; Efe and Eyefia 2014) encompasses such wards as Ihimmwinin, Iyekoba, Upper Sapoba Road, Channel 55, Ogida, Upper Siluko, Uwelu and Ekinosodi in Benin City (see Figure 2) while Minna GRA, F-Layout and Bosso Estate are in this category in Minna Town (See Figure 3).

These areas were developed through a well constituted layout plan. The ethnic composition is heterogeneous and so also are the building types. Majority of residents in this area engaged in white collar jobs such as professionals, business men and top civil service and government functionaries. The supply of urban environmental services is favourable towards this area. It has high quality of landscape architecture, streets layout with planned distributed structure and possibilities for through traffic. It features house types such as flat and duplexes. In general, it is a quiet housing area. The area consists of row houses, some with a small front garden and most of the homes have small private open space. Furthermore, various facilities can be found in these areas. There is a local supermarket and variety shop. Moreover, snack bars, restaurants, hairdressing salons, meat shops, travel agencies, medical services, hotels, car repair garages and several other services are scattered around in the area.

Methods, data and findings

The study used data from residents' perception of crime occurrence in different seasons of the year; namely, the long rainy season (beginning of raining season and rain maximum), the short dry season (break: short period of cease in rain), the short rainy season (ending of raining season), and the long dry season (*see section on climate condition of the study area*). Data were obtained through the stratification of Benin City and Minna into the high, medium and low density areas in order to reveal the relationship between seasonal levels and neighbourhood patterns of crime.

Preliminary survey revealed that there were 102, 178 and 48 streets in the high, medium and low densities, respectively in Benin City and 98, 181 and 52 in Minna. One of every five streets (20%) in each residential area was selected using systematic sampling. A total of 242 streets were selected consisting of 68 in Benin City and 66 in Minna. There were 1207, 1415 and 503 buildings in the high, medium and low density areas respectively, of Benin City and 1026, 1357 and 375 in Minna. Every tenth building (10%) was selected using systematic sampling after the first building was chosen randomly. Questionnaire was administered on a household head on each floor of the selected buildings. A total of 591 copies of questionnaire were administered while 352 were retrieved (approximately 60%) comprising 201 in Benin City and 151 in Minna. Information elicited included perception on crime incidences in different seasons of the year. Descriptive and inferential statistics such as mean weight average and analysis of variance were employed for data analysis.

In order to determine the residents' perception of crime occurrence in different seasons of the year, residents were provided with a list of crime identified in the literature. They were further instructed to indicate the rate of occurrence of each of the identified crime type. Residents were to express their opinion using one of the five Likert scales of 'very frequent' (VF), 'frequent' (F), 'just frequent' (JF), 'not frequent' (NF) and 'not at all frequent' (NAF) in occurrence.

The analyses of the ratings indicated by the residents from the Likert's scales adopted evolved into an index called "the Mean" (M). To arrive at M, weight value of 5,4,3,2 and 1 were respectively attached to 'very frequent' (VF), 'frequent' (F), 'just frequent' (JF), 'not frequent' (NF) and 'not at all frequent' (NAF). The index for each type of crime was arrived at by dividing the Summation of Weight Value (SWV) by the total number of responses. The SWV for each type was obtained through the addition of the product of the number of responses to each type and the respective weight value attached to each rating. This is mathematically expressed as:

$$\mathbf{SWV} = \sum_{i=1}^{5} x_i y_i \qquad \text{.............................. (1)}$$

Where:

SWV= Summation of Weight value;

x_i = number of respondents to rating i;

y_i = the weight assigned to a value (i=1, 2, 3, 4, 5).

The index for each identified crime type thus takes a value of between 5 and 1. The nearer the value to 5, the higher is the occurrence that residents attached to such crime type under consideration.

$$\mathbf{M} = \frac{SRV}{\sum_{1}^{5} x_i} \qquad \text{.............................. (2)}$$

The Analysis of variance (ANOVA) was used to determine significant difference in the mean (M) at seasonal and neighbourhood levels. ANOVA has the following test statistics:

$$F = \frac{MST}{MSE} \qquad \text{.............................. (3)}$$

Where, F = ANOVA Coefficient, MST = Mean sum of squares due to treatment, MSE = Mean sum of squares due to error.

Formula for MST is given below:

MST= $\frac{SST}{p-1}$

SST = $\sum n\,(x\text{-}x)^2$ ………………………….. (4)

Where, SST = Sum of squares due to treatment, p = Total number of populations, n = Total number of samples in a population.

Formula for MSE is given below:

MSE = $\frac{SSE}{N-p}$ ………………………….. (5)

SST = $\sum (n\text{-}1)\,S^2$

Where, SSE = Sum of squares due to error, S = Standard deviation of the samples, N = Total number of observations.

Four crime types, comprising two violent and two property crimes were considered. On the violent crime, we focus on assaults and grievous bodily harm and wounding (GBHW). In Nigeria, assaults could involve a victim being attacked, physically beaten, or victimized in a frightening way by an attacker who does not cart away anything from the victim or intentional unlawful physical attack with the objective of committing an indecency (i.e. sexual harassments or rape)**.** Grievous bodily harm and wounding (GBHW) is similar to assault but is a more serious crime as the offender has intent in addition to assault, to cause grievous bodily harm/wounding to the victim. On property crime, we considered break-ins and robberies. Break-ins involve forceful entry into properties (residential or commercial) without consent and most times confrontational circumstances with a view to committing theft. Robbery (armed and unarmed) on the other hand, is unlawful taking of property, without consent and under confrontational circumstances, from the immediate possession of a person, accompanied by force, or threat of force, and/or by placing the victim in fear. These explanations imply that property must be carted away.

As shown in Table 1 and 2, levels of assault as well as grievous bodily harm and wounding (GBHW) were perceived to be generally higher in Minna when compared to Benin City. The computed mean assaults in Benin City follows a seasonal pattern with levels of assault perceived to be highest during the months of long dry season (November to March) and lowest during the months of the long raining seasons (April and July). The results of the one-way analysis of variance showed significant difference in levels of overall assault in different seasons of the year (F = 11.55; p=.00). This likely indicates that the levels of assault in the dry seasons differ considerably from the levels of assault found in the raining seasons of the year. Respondents further perceived that high density residential neighbourhoods had greater assault rates in long dry season (M=4.11), whereas, assaults peaked in the medium and low density areas respectively, in short dry season (M=3.51) and short raining seasons (M=3.41). Further analysis revealed that differences in the perceived levels of assault in the different residential neighbourhoods of Benin City

were statistically significant (F = 21.01; p=.01). This perhaps, indicates that different residential areas in Benin City experience different levels of assaults throughout the seasons in a year.

Similar to what was obtainable in Benin City, levels of assault in Minna also follows a seasonal pattern although, the highest level of assault was perceived in December to May and perceived to be low during the months of June and July. Findings further revealed that all three residential neighbourhoods had highest levels of assault in the long dry season (November to May). The mean level of assault as perceived by the respondents was 4.21, 4.19 and 4.07 respectively, in the high, medium and low density areas. Unlike Benin City, the results of the analysis of variance neither showed significant differences in different seasons of the year (F = 5.01; p=.13) nor in the different residential densities (F = 4.97; p=.07). It was generally perceived both in Benin City and Minna that the low quality neighbourhoods exhibited highest levels of assault when compared with the medium and high quality neighbourhoods (See Table 1 and 2).

In Benin City, grievous bodily harm and wounding (GBHW) was perceived to be highest in long dry seasons months of November to March (M=3.90). Respondents also perceived that GBHW usually decreases in mid-August to the end of August (M=3.56) and followed by a gradual decline in the short raining season (M=3.39) and further drops in the long dry season (M=2.99). The results of ANOVA showed significant differences in the perceived levels of GBHW in the seasons of the year (F = 9.55; p=.02). This indicates that the levels of GBHW in the dry seasons differ significantly from the levels of GBHW found in the raining seasons. Respondents' perception of the neighbourhood pattern showed that highest level of GBHW was found in the high (M=3.99), medium (M=3.88) and low density neighbourhoods (M=3.46) during the long dry seasons. Further analysis revealed that perceived levels of GBHW in the different residential neighbourhoods were not statistically significant (F = 0.91; p=.081).

In Minna, respondents perceived that highest rate of GBHW was usually experienced during the short rain season (relatively cold) around end of August (M= 4.17), with the lowest rates in June and July months (cold months) of long rain seasons (M=2.42). Perception with respect to neighbourhood patterns of GBHW showed that the high density residential neighbourhood had highest levels of GBHW in long dry season (M=4.04), whereas, the medium (M=3.94) and low density areas (M=3.42) had their own peak in the short dry season. Unlike Benin City, differences in the perceived levels of GBHW in different seasons of the year was not significant (F = 3.09; p=.11) in Minna. Nonetheless, differences in the perceived residential crime rates (F = 11.21; p=.01) were found to be statistically significant. This indicates that regardless of seasons in a year, different neighbourhoods experience difference levels of GBHW in Minna. In other words, levels of GBHW generally vary across neighbourhoods stratified from the low to high density structures. Nonetheless, this trend does not usually occur in all the seasons of the year.

As shown in Table 1 and Table 2, break-ins and robbery were perceived to be higher in Benin City when compared to Minna. Furthermore, break-ins in Benin City follow a seasonal pattern with perceived levels highest during the long dry season (November to March) and lowest during the low raining seasons (Mid of August to the end of August). Findings from residents' perception further showed that the high (M=4.44), medium (M=4.11) and low (M=4.01) density residential neighbourhoods recorded highest break-ins in long dry seasons and lowest during the long raining seasons (April and July). Significant differences in the perceived levels of break-ins in different seasons of the year was confirmed by the ANOVA computed (F = 16.02; p=.00). This indicates that levels of break-ins in the dry seasons differ considerably from the levels of break-ins identified in the colder months of raining seasons in the year. Furthermore, differences in the perceived

levels of break-ins in different residential neighbourhoods of Benin City were also statistically significant (F = 21.01; p=.01). This indicates that levels of break-ins in Benin City varied seasonally and spatially.

As perceived by respondents, highest levels of break-ins in Minna are usually witnessed in the short dry season (relatively hot) and lowest during the long raining seasons (cold). It was further perceived that the high quality neighbourhoods (M = 4.17) exhibited significantly higher rates of break-ins than neighbourhoods in the medium qualities (M = 3.91) and the low qualities (M=3.71) in the long dry seasons. The results of ANOVA showed significant differences in the perceived levels of break-ins in the different residential densities (F = 11.21; p=.01) of Minna. Conversely, significant differences in the perceived levels of break-ins in the different seasons of the year were not significant. The ANOVA test (F = 3.09; p=.11) confirms this. Hence, break-ins in Minna were spatially patterned regardless of different seasons in a year.

Results from residents' perception of crime showed that robberies follow neither seasonal nor spatial pattern in both Benin City and Minna. Additional measurements yielded by the analysis of variance confirmed this in different seasons in a year in the two cities: Benin City (F = 1.05; p=.21) and Minna (F = 0.19; p=.16) and in different residential neighbourhoods in Benin City (F = 0.61; p=.41) and Minna (F = 0.77; p=.32). However, perceived levels of robbery was highest during the long raining season (very cold) in Benin City (M=4.23) and Minna (M= 4.07). In Benin City, perceived levels of robberies was highest in the medium density neighbourhoods (M=3.99) during the long dry seasons while it was perceived to be at its peak in the high (M=4.21) and low (M=4.11) density neighbourhoods during the short rainy seasons. The perceived neighbourhood distribution of robberies in Minna showed that the high density residential neighbourhood had highest levels of robbery in the short rain seasons (M=3.76), whereas, the medium (M=4.04) and low density areas (M=3.79) had their own peak in the long rain seasons.

Discussion of findings

This article focuses on seasonal variation of violent and properties crime in Benin City and Minna, Nigeria. Not only does the study examine the seasonality of crime, the current study also investigates whether crime seasonality varies significantly within and between the two cities. Although the present study analysed residents' perceptual data, the results of the study extended seasonal effects for assaults in both Benin City and Minna, as predicted by RA and T/A theories. Findings are also consistent with previous research that has found clear seasonal fluctuations in crime rates (see Cohn, 2004, 2006; Téllez et al., 2006; Hird & Ruparel, 2007; Breetzke & Cohn, 2012; Uittenbogaard & Ceccato, 2012 and Shannon et. al 2016) although, all these studies employed official crime statistics.

By comparing the spatial-temporal crime trends in two Nigerian cities with varying climates, it is not a surprise that some similar and divergent trends emerged. Results shows that cities with warmer climates (Minna) have higher level and higher seasonal cycles for violent crime (assaults) while cities with colder climates (Benin City) have higher level and higher seasonal cycle for break-ins. Perceived levels of assaults were highest during the months of long dry seasons (hot weather condition) in the two cities. Precisely, the perceived levels of assault were highest in Benin City during the months of November to March; whereas in Minna, it was between December and April. A number of factors may account for this observed trend, with the most obvious being the increase in temperature during the long dry season months in Nigeria. According to RA theory, individuals are at a higher risk of personal victimization when they are outdoors than when they are at home

(Cohen & Felson, 1979; Rotton & Cohn, 2004). On a hot dry season day in Nigeria, people are more likely to be outdoors for recreational activities (Dibiagu, Kure & Haruna, 2003 and Idachaba, 2004), thus may likely spend more time among strangers. This increases the likelihood that victims and offenders will come into contact with each other in a situation that capable guidance is not present, thus facilitating assault. Similarly, T/A theory states that higher temperatures in long dry season will lead to increased frustration and consequent aggressive behaviour. The fact that aggressive crimes (assaults) increase in hot weather conditions is certainly not new (See Téllez et al., 2006; Breetzke & Cohn, 2012; Uittenbogaard & Ceccato, 2012). The results presented here, however, meaningfully extend and confirm the earlier works on this topic; particularly in Nigeria.

While increased frustration and consequent aggressive behaviour as a result of hot weather conditions was further supported by the perceived levels of occurrence of GBHW in Benin City, it was faulted in Minna as highest perceived level of GBHW occurred during the short rainy season (relatively cold). This likely indicates that other factors other than those of RA or T/A expectations influences seasonal pattern of GBHW in Minna, Nigeria. The fact that the perceived levels of GBHW did not vary seasonally shows that GBHW is a steady crime over the year. Generally, it was perceived that the high density neighbourhood has highest assaults and GBHW rates in dry seasons (dry weather condition), whereas in the raining season (cold weather conditions), assault rates are perceived to be evenly spread over the residential neighbourhoods. Results on neighbourhood patterns revealed that the perceived assaults levels in residential neighbourhoods of Benin were observed to be spatially stratified, regardless of different season types of the year. This neighbourhood pattern was consistent with GBHW in Minna, though the significant of these relationships do, however, vary somewhat by season. Furthermore, findings shows that perceived assault levels by neighbourhoods stratified as low quality is the greatest in hot dry seasons. The implication being that high density neighbourhoods are more likely to experience assault/GBHW in the dry seasons than in any other season of the year.

These findings, at least in a Nigerian context suggests that people from varying geographical areas are not equally prone to the same crime surge and that people living in the low quality parts of Nigerian cities are more likely to react to some acts of frustration or needling through crime. The results presented here are generally in accord with the prevailing global evidences, suggesting that seasonal crime rates are more pronounced in areas with lower socio-economic prosperity (Harries and Stadler, 1983; Harries et al., 1984; Rotton & Cohn, 2004 and Ceccato, 2005).

Results showed that break-ins were perceived to be highest in both Benin City and Minna during the dry season (hot weather condition). However, it was perceived to be at its peak during the long dry season (hot) in Benin City and short dry season (relatively hot) in Minna. A number of factors may account for this seasonal trend. The most obvious one, however, is the increase in temperature during the long dry season months in Nigeria. This is because changing weather conditions can play an important role in changing the routine activities of individuals (particularly discretionary schedules) and can possibly impact the likelihood of the convergence of motivated offender, suitable target, and the absence of a capable guardian against criminal behaviour. For instance, when the weather conditions are hotter, Nigerians are more likely to embark on journey to public/ recreational places (Ojo, 1978). Consequently, homes are left without capable guardians since their occupants are outdoors. This make homes more suitable for targets. Felson and Clark (1998) using this thinking and a variety of data concluded that the routine activity approach still offers the best explanation for rise in criminal activities. The risk of personal and property victimization rises as people spend more time among strangers and away from their own homes.

As perceived by the residents, robbery follows neither seasonal nor neighbourhood pattern in both Benin City and Minna. However, it was observed to be highest during the months of long rainy seasons (very cold) in both cities. There may be much explanations to this. First, the results of the study support seasonal effect as predicted by RA ideas. On a cold rainy season day in Nigeria, people are more likely to be indoors. Hence, the very few people outdoor increases the likelihood that victims and offenders will come into contact with each other in a situation that capable guidance is not present and thus facilitating robbery. The results supported Landau and Fridman (1993) who explained that the colder weather reduced capable guardians as a result of decrease in the number of people in the streets. Second, it has been established that there is always an increase in cost of living in cold months and increased rate of unemployment is due to drop in seasonal jobs such as construction, transportation, and recreation among others (Cohn, 1990 and Landau & Fridman, 1993). The need to meet up needs and acquire extra goods in order to survive may motivate individual (particularly unemployed people) to engage in robberies. The results supported Cohn, 1990; Landau & Fridman (1993) who found that robberies usually peaked in the cold months and attributed these findings to poverty based on increased unemployment and necessities.

Results on neighbourhood patterns of crime revealed that the perceived levels of break-ins in different residential neighbourhoods of Benin City were significant. This neigbourhood pattern was not consistent with break-ins in Minna, as the perceived levels of break-ins in the different neighbourhoods do not significantly vary. Findings further show that perceived break-ins levels were greatest in the hot dry season in neighbourhoods classified as low quality in Benin City. In Minna, on the other hand, perceived break-ins levels was greatest in hot dry season in neighbourhoods classified as high quality. This perhaps shows some evidence that the high quality areas in Benin City are spared of break-ins, probably because residents utilize sophisticated security devices or security personnel to guide their houses. In Minna, however, the opposite is the cases as conspicuous evidence of wealth as revealed in the socio-economic status of residents in the high quality areas may likely be what put properties in this area at higher risk of break-ins. Both findings supported the work of Weisel (2002) who noted that offenders estimate the potential risk of apprehension and rewards of break-ins by carefully assessing the properties involved.

Another distinguished finding of this study is that perceived levels of assault and GBHW in the low quality residential areas were not vastly different to those obtained in the medium and high quality areas. Several explanations may help to explain this. First, assaults or GBHW are likely to occur with other types of crime such as break-ins or robberies (Breetzke & Cohn, 2012). High quality neighbourhoods and occupied households are also more likely to be targeted by burglars in Nigeria (Badiora, Oluwadare and Dada, 2015). In their research, Badiora et. al (2015) found that residential burglaries in Ile-Ife, Nigeria were more likely to occur when residents are at home. Similar study by Zinn (2008) found that offenders were attracted to occupied residences for a number of reasons: First, offenders felt that the probability of obtaining a larger reward (e.g., acquiring hidden cash) was greater if the home owner/s were present. Second, offenders believed that they were less likely to be surprised during a burglary or robbery if the home owner/s were already present during the time of the crime. Third, offenders stated that any existing security alarm system was more likely to be switched off if the homeowners were present. Offenders burglarizing occupied households must expect to come face to face with occupants and would need to carry some weapon to subdue the residents. The likely result of these confrontations is the probable use of force and violence, including assault, thus leading to the increase in perceived levels of assault recorded in the high quality neighbourhoods of Benin City and Minna.

Table 1: Spatio-temporal analysis of violent crime in Benin City

Crime Type/ Density	Assaults				Grievous harm and wounding				Break-ins				Robbery			
	LRS	SRS	SDS	LDS	LRS	SRS	SDS	LDS	LRS	SRS	SDS	LDS	LRS	SRS	SDS	LDS
High	3.23	3.51	3.91	4.11	3.32	3.44	3.51	3.99	3.23	3.51	3.91	4.44	2.21	4.21	3.44	3.12
Medium	2.89	2.92	3.51	3.09	3.01	3.22	3.52	3.88	2.49	3.24	3.32	4.11	3.22	1.34	3.78	3.99
Low	2.99	3.41	3.19	3.09	3.41	2.88	3.21	3.01	2.11	2.96	3.19	4.01	2.21	4.11	2.96	3.78
Benin City	3.44	3.56	3.78	3.99	2.99	3.39	3.56	3.90	3.23	3.51	3.91	4.44	4.23	3.26	3.01	3.12
Seasonal Variation Statistics	F = 11.55; p=.00*				F = 9.55; p=.02**				F = 16.02; p=.00**				F = 1.05; p=.21			
Spatial Variation Statistics	F = 21.01; p=.01*				F = 0.91; p=.081**				F = 11.01; p=.00**				F = 0.61; p=.41			

Table 2: Spatio-temporal analysis of violent crime in Minna

Crime Type/ Density	Assaults				Grievous harm and wounding				Break-ins				Robbery			
	LRS	SRS	SDS	LDS	LRS	SRS	SDS	LDS	LRS	SRS	SDS	LDS	LRS	SRS	SDS	LDS
High	3.93	3.61	3.99	4.21	3.01	3.98	3.83	4.04	3.13	3.21	3.51	3.71	3.07	3.76	3.54	3.23
Medium	3.78	3.82	4.11	4.19	3.60	3.66	3.94	3.52	3.28	3.62	4.09	3.91	4.04	2.68	3.44	3.13
Low	3.79	3.91	3.07	4.07	3.29	3.31	3.42	3.01	3.59	2.71	4.05	4.17	3.79	3.64	2.36	3.27
Minna	4.41	4.57	4.61	4.82	2.42	4.17	3.87	2.89	3.13	3.21	3.71	3.91	4.07	3.76	3.54	2.23
Seasonal Variation Statistics	F = 5.01; p=.13*				F = 3.09; p=.11*				F = 9.01; p=.00**				F = 0.19; p=.16			
Spatial Variation Statistics	F = 4.97; p=.07*				F = 11.21; p=.01*				F = 4.07; p=.41*				F = 0.77; p=.32			

Note: **LRS -** (Long Rainy Season), **SRS -** (Short Rainy Season), **SDS -** (Short Dry Season) & **LDS -** (Long Dry Season)
***** Statistically significant difference at $p < 0.05$
****** Statistically significant difference at $p < 0.01$

Conclusion and implications for further study

The study determines whether perceived levels of assault, grievous bodily harm and wounding as well as break-ins and robberies varied across seasons in Nigeria. It also investigates the possible neighbourhood patterns of perceived seasonal rates of these crime types. Although, the present study makes use of residents' perception of crime data, this study through its findings makes some important contributions to the existing literature on spatial-temporal analysis of crime. First, this study demonstrates that assault, grievous bodily harm and wounding (GBHW), break-ins and robberies are seasonal and vary within and between cities in Nigeria. Even though, this may be considered rather petty findings to international crime literature, the fact that this study is the first of its kind in Nigeria, and indeed tropical Africa, makes it very significant. Second, the study has also demonstrated that perceived levels of violent and properties crime in the different residential neighbourhoods in Nigeria may be at time spatially homogeneous and sometimes spatially heterogeneous regardless of the season of the year. This likely indicates that other factors other than those of RA or T/A expectations influences seasonal pattern of crime in the study area. However, this study did not account for other factors (such as socio-economic drive, climate change adaptations among other) that may be causing this variation. Hence, a further study may be required.

Also, we believe that the results presented here, are sufficiently valuable to merit further investigation and that they provide an important spatial–temporal platform for future crime seasonality research in Nigeria and other countries in the tropic region. Exploring the above analyses across police data in Nigeria are vital for understanding of annual crime patterns and the application of environment-specific prevention policies. Furthermore, it is apparent from this study that temporal seasonality analyses in a given city may not translate effectively into another. In this respect, law enforcement agencies in Nigeria should be aware of annual fluctuation in crime to deploy available resources to the most effective place at the right time or season. This is because each city will have its own weather patterns and general routine activities; the monitoring of each city's trends must be conducted regularly. From a situational crime prevention standpoint, knowledge of the frequency of crime surges will assist in applying effectively, crime prevention strategies to forestall continual re-occurrence. As such, research into the seasonal patterns of crime is highly important and should prove useful in the continuing attempts to reduce crime in Nigeria and other countries of the World.

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