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Retrospective Analysis of Under-Five Mortality Rate (U5MR), Crude Mortality Rate (CMR), and Estimated Dependency Ratios in Two Local Government Areas of Adamawa State, Nigeria, 2024–2025

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Abstract: *This study examines the Under-five mortality and Crude mortality rates (U5MR and CMR) in two selected Local Government Areas (LGAs) of Adamawa State. The crude mortality and under-5 mortality rates for Hong and Michika were calculated based on location-specific recall periods, as shown in the mortality parameter table. The CMR in Hong is currently 0.15 (95% CI 0.05-0.49) deaths per 10,000 of the population per day in October, 2024. This compares with a 2023 study that reported 0.16 (95% CI 0.06-0.40), indicating a slight departure from the previous Northern Adamawa rate. The CMR in Michika is currently 0.93 (95% CI 0.54-1.59). Meanwhile, the U5MR in Hong is currently 0.24 (95% CI 0.13-1.86) deaths per 10,000 persons per day, while that of Michika is 0.23 (95% CI 0.03-1.77). This indicates that there are relatively more incidences of mortality in Hong than in Michika. The U5MR and CMR above 1 per 10,000 persons per day indicate emergency thresholds. As per SPHERE and WHO standards, the death rates in the two LGAs for under-fives do not fall under an emergency situation. All mortality-related variables were calculated using the number of deaths during the recall period as the numerator and the midpoint population as the denominator. The respective population pyramids for age-specific spread and their different dependency ratios are presented.*

Keyword: *Under-fives (U5), Crude Mortality Rate (CMR), SPHERE (Humanitarian Standards), Retrospective, Recall-period, Mortality rate, midpoint population.*

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1.0 Introduction

Despite global progress, Nigeria's under-five mortality rate remains well above the Sustainable Development Goal 3 target of fewer than 25 deaths per 1,000 live births (UK drops in European child mortality rankings, 2017). In 2018, Nigeria accounted for 13% of global under-five deaths and 26% of such deaths in sub-Saharan Africa. Childhood morbidity is a major contributor to these Fig.s. Globally, pneumonia, diarrhea, and malaria caused about 29% of under-five deaths in 2018. In Nigeria, nearly 90% of under-five deaths are due to malaria, pneumonia, diarrhea, and three vaccine-preventable diseases: measles, pertussis, and meningitis. Infections and hypothermia also contribute to neonatal mortality. Beyond mortality, childhood morbidity significantly impairs physical and cognitive development, mainly during early childhood. Nigeria has implemented strategies aligned with the World Health Organization and other child health agencies, leading to measurable improvements (Lancet, 2017). The under-five mortality rate fell from 193 to 132 deaths per 1,000 live births between 1990 and 2018 (Tondor C. U &, Ishmael D. J.,2022). Still, under-five morbidity remains a major challenge. Factors include inadequate sanitation, unsafe drinking water, low maternal education, poverty, and air pollution. Regional differences in childhood illness prevalence may also hinder effective

Cairns K. et al. (2009) highlight that death rates for children under five are very important to public health workers because young children are often the main focus of special programs. These rates are a key measure of death in emergency situations since young children are more likely to die than older kids or teenagers and so have higher death rates. In some emergencies, rises in under-five death rates may happen before increases in overall death rates, giving an earlier warning of worsening health. The household census method can calculate under-five death rates, but the number of people surveyed is often too small for accurate results. Another method, called the 'indirect' method and created in the 1960s, asks women in certain age groups standard questions about how many children they have had and how many are still alive. This method does not ask for birth or death dates. Instead, models estimate when these events happened and the chances of children surviving to certain ages. These methods usually do not work well in emergencies because they assume death rates stay steady over time and that child and mother survival are not linked, which is unlikely. The previous birth history (PBH) method, often used in development work, collects birth and death dates of children from women of childbearing age to create life tables for the last five years. While this method gives estimates focused on about two and a half years before the survey, recent changes allow more up-to-date estimates in emergencies. The PBH method lowers under-counting and false reporting by not asking directly about deaths. Also, the person answering has a direct connection to the deceased, unlike other methods where any adult in the household might report deaths. However, survivor bias is still a problem because deaths cannot be reported if the mother is missing or dead, especially in places with high death rates for mothers and young children. Few studies have checked how complete early childhood death data collected through PBH really is. Despite these issues, PBH is still the main method used in most large surveys measuring infant and child death rates worldwide.

The population pyramid is a vivid window into the age and gender makeup of a society, capturing its developmental stage at a glance. This striking chart reveals how people are distributed across age groups and between men and women, as shown in Fig.s 1 and 2. More than just numbers, the balance of ages and genders in each group is a key to understanding a population's future. By examining these patterns, we can anticipate the growth of specific groups, such as the elderly or young children, and predict overall population trends. Governments rely on this information to shape policies: a youthful population calls for more schools and, eventually, more jobs and homes, while an older population demands stronger healthcare systems, more caregivers, and reliable pensions. The pyramid's two axes—age and gender—are brought to life through horizontal and vertical bars, usually in five-year steps. Age climbs up the y-axis, gender stretches across the x-axis, and all values are positive, since a population cannot dip below zero. Traditionally, women appear on the right and men on the left, with newborns forming the pyramid's base and the oldest at its peak. Rather than raw numbers, the pyramid shows the share of each age group within the whole, making it easier to spot trends over time or compare different eras

Hong and Michika are in Northern Adamawa, Northeast Nigeria, with estimated populations of about 289,790 and 221,702, respectively, according to the Nutrition Food Security Surveillance (NFSS) December 2023 LGA classification (https://dtm.iom.int/product-series/emergency-tracking-report). Existing community sampling frame in Hong and Michika LGAs showed a total of 9,828 households in the survey area. Hong has 12 political wards, divided into two State constituencies, each with six wards: Bangshika, Daksiri, Hong, Husherizum, Shangui, and Thilbang. The Uba/Gaya Constituency includes Garaha, Gaya, Hildi, Kwarhi, Mayo-lope, and Uba wards. Michika has nine districts: Michika, Nkafa, Madzi, Futu, Garta, Bazza/Yambule/Dakwa, Zah/Ghye, Vi/Bokka, and Sina/Kamale (https://adspc.ad.gov.ng/adamawa-state/).

According to IOM DTM population data for Adamawa State, between 29 July and 4 August 2024, 1,590 new arrivals were recorded in different places across Adamawa and Borno States, including Fufore, Girei, Gombi, Guyuk, Hong, Lamurde, Madagali, Michika, Mubi North, Mubi South, Numan, Song, Yola North, and Yola South LGAs (https://dtm.iom.int/product-series/emergency-tracking-report). These movements may have slightly increased the populations of the two survey LGAs. Population data from the 20 randomly chosen communities were sampled and clustered, ensuring the sampling is with probability propositional to their sizes both in Hong and Michika LGAs.

2.0 Materials and Methods

A retrospective mortality rate (RMR), whether crude or under-five, is an essential epidemiological tool for estimating deaths in a population over a specific recall period. It is particularly important in humanitarian emergencies or where official death records are unavailable, enabling responders to quickly assess the severity of a crisis.

Formula and Calculation

The U5MR and CMR are calculated by dividing the total number of deaths by the total population (adjusted for the length of the recall period), and is typically expressed as deaths per 10,000 people per day. Whereas, the dependency ratios are as calculated using equations 3, 4 and 5.

$$CMR = \frac{(Total\ Number\ of\ Deaths)}{Total\ Population \times Number\ of\ Recall\ Period} \times\ 10{,}000 \quad (1)$$

$$U5MR = \frac{(Total\ Number\ of\ Under\text{-}five\ Deaths)}{Total\ Population \times Number\ of\ Recall\ Period} \times\ 10{,}000 \quad (2)$$

$$Dependency\ Ratio = \frac{Age\ group(0-14) + 64+}{Age\ group(15-64)} \times 100 \quad (3)$$

$$Young\ Age\ Dependency\ Ratio = \frac{Age\ group(0-14)}{Age\ group(15-64)} \times 100 \quad (4)$$

$$Old\ Age\ Dependency\ Ratio = \frac{Age\ group(65+)}{Age\ group(15-64)} \times 100 \quad (5)$$

In many disaster or displacement settings, the absence of official vital statistics necessitates calculating this rate using retrospective household surveys. The recall period, defined as the duration investigated, typically ranges from 30 days to 6 months (Angela M.C Roseet et al., 2006).

2.1 Study area and population

This study was conducted in two Local Government Areas of Hong and Michika located in Northern Adamawa, Northeast Nigeria, with estimated populations of approximately 289,790 and 221,702, respectively, according to the Nutrition Food Security Surveillance (NFSS) December 2023 Local Government Area (LGA) classification (https://dtm.iom.int/product-series/emergency-tracking-report). An existing community sampling frame for Hong and Michika LGAs identified a total of 9,828 households within the survey area.

Table 1: Percentage of Households sampled and Coverage in the survey

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ocation/Parameter	Sampled Clusters (No.)	Households for Mortality (No.)	Mortality Population (No.)
Hong (Planned)	31	291	1,575
Hong (Achieved)	30	386	1,690
Hong (Percent %)	96.8	132.6	107.3
Michika (Planned)	31	291	1,575
Michika (Achieved)	29	371	1,824
Michika (Percent %)	93.5	127.5	115.8

2.2 Study design, sample size and sampling procedure

This study employed a cross-sectional survey procedure following the SMART methodology, using a two-stage cluster sampling technique based on Probability Proportional to Size (PPS), which is useful Mortality surveys. This technique allowed for more representative sampling units from villages/wards with larger population sizes. The mortality interview included all members of eligible households selected randomly from the clusters unfortunately, Kwatau in Hong and Biang in Michika were inaccessible during the survey due to impassable road as a result of flooding and were consequently not replaced having not met the criteria for cluster replacement. Hence, Hong was left with 30 clusters while Michika was left with 29 clusters.

Table 2: Estimated Parameter for mortality

Parameters for Mortality	**LGAs/Values**		**Assumptions based on contexts**
	Hong	**Michika**	
Estimated Death Rate/10,000/day (%).	0.40	0.40	*Based on estimated rate from NE-NFSS Round 13, June-July, 2023.*
± Desired precision /10,000/day (%)	0.30	*0.30*	*Based on SMART guidelines, where death rates are lower, say, (< 1.0 CMR) as shown in the estimated rate from NE-NFSS Round 13, June-July, in Northern Adamawa.*
Design Effect	1.00	*1.00*	*According to the DEFF of the NE-NFSS Round 13, June-July, in Northern Adamawa.*

Recall Period in days	118 days	*118 days*	*90 days is usually recommended during emergencies but a longer recall period gives more precise mortality rates; especially when the previous study in that specific area is over a year or two ago, hence, this 118 days before the last **Id El Kabir (16th June, 2024**) including days prior to and that actual day of the survey. Also considering the inclusion and exclusion of deadly seasons such as when mosquitoes breeding takes place especially the rainy season and flooding incidents during the period of this survey.*
Average HH Size	5.7	5.7	*Estimate from NE-NFSS Round 13, June-July, 2023.*
% Non-response Households	5.0	5.0	*Anticipated non-response based on contextual information conducting surveys in BAY states and this may adequately account for the Households refusal and exclusion due to flood experience.*
Population to be included	**1575**	**1575**	*This minimum sampled Population is based on the calculations made using ENA Software for SMART*
Household to be included	**291**	**291**	*This minimum household (BSU) to be included is based on the calculations made using ENA Software for SMART.*

2.3 Cluster Selection

Demographic data were collected for all selected household members, irrespective of the presence of children under five years of age. All household members were enumerated according to the established household definition. The survey utilized an estimated crude death rate (CDR) per 10,000 persons per day, specified precision of ± per 10,000 persons per day, and a design effect. It also used a recall period of 118 days. This recall period was set prior to Id El Kabir (16 June 2024) and included both the days preceding and the actual day of the survey in each location.

2.4 Training and supervision

The survey was conducted by trained enumerator teams in two locations: five teams with five supervisors in Hong and another five teams with five supervisors in Michika, supported by community workers serving as guides. Each team consisted of three members, including one team leader and two interviewers, and was supervised by one supervisor. At least one team member was female, and all team members adhered to the culturally appropriate dress code. A total of 60 prospective and experienced enumerators and supervisors from Mubi, Hong, Michika, and Yola were invited to participate in a five-day intensive training session held in Mubi. The training covered an overview of a mortality survey, age estimation, sampling principles, data collection methodologies, and potential sources of bias. On the fifth day, participants completed a pretest, role-play, and standardization test. Team selection was based on these results, with outstanding trainees appointed as supervisors. Most teams collected data over a seven-day period in their respective locations, commencing immediately after the training.

2.5 Data collection

A standardized mortality survey questionnaire, programmed in ODK, was utilized for data collection and electronic entry. Each team's daily data were subjected to plausibility checks. The age of each child was determined by interviewing the mother or another adult household member, primarily by inquiring about the child's age, as the event calendar was unavailable during the survey. When possible, vaccination cards indicating the child's birth date were also used. The questionnaire included items on current household members present at the time of data collection, age and sex of respondents, individuals who joined or left the household within the 118-day recall period, children born during this period, and individuals who died within the recall period.

2.6 Data entry and Statistical Analysis

Data from the mortality questionnaires were entered and analyzed using ENA for SMART software (updated version 2015). Respondent ages were recorded in years for the mortality survey. An age of zero was assigned to respondents younger than one year, while a value of sixty was used in the adult age column (Measuring Mortality, Nutritional Status, and Food Security in Crisis Situations, 2006).

2.7 Data Quality Assurance

To ensure data quality, data collectors received standardized training, and the team included an expert with recent mortality survey experience. The supervisor conducted systematic monitoring and manual checks, using immunization cards and birth certificates for age verification. Reference forms and notes ensured consistency, while cluster control and household selection forms supported triangulation. Enumerators were instructed to work diligently. Before leaving each community, team members confirmed that all identification variables, including codes and dates, were accurately recorded in the electronic questionnaires.

2.8 Ethical Consideration

Multiple measures were implemented to protect confidentiality, secure informed consent, and minimize potential adverse consequences for participants. Confidentiality procedures were explicitly communicated, and permission was obtained from interviewees to record their responses in the survey database. All household interviews were conducted in open spaces to maintain confidentiality and prevent overcrowding. Direct oral interviews with children were strictly avoided due to concerns regarding child consent. The informed consent note, which specifically addressed confidentiality, was thoroughly presented. Survey questions were carefully worded to avoid causing respondents to feel threatened. Ethical approval for the survey was obtained from appropriate quarters.

3.0 Results and Discussion

3.1 Retrospective Mortality

Mortality data collection was successfully completed in all selected clusters in both Hong and Michika LGAs. All available household members were enumerated through a complete household listing based on family hierarchy, thereby ensuring comprehensive capture of mortality events within the specified recall periods. The mortality estimates generated from the survey are summarized in Table 3.

Table 3 presents the crude mortality rate (CMR) and under-five mortality rate (U5MR) for the two LGAs. Hong recorded a CMR of 0.15 deaths per 10,000 persons per day (95% CI: 0.05–0.49), whereas Michika recorded a substantially higher CMR of 0.93 deaths per 10,000 persons per day (95% CI: 0.54–1.59). Although the confidence interval for Michika is wider, reflecting greater variability in mortality occurrence, the point estimate suggests a considerably higher mortality burden compared with Hong. The design effect was also higher in Michika (1.34), indicating greater clustering of mortality events relative to Hong (1.00).

The under-five mortality rates were relatively similar between the two LGAs. Hong recorded a U5MR of 0.24 deaths per 10,000 children per day (95% CI: 0.03–1.86), while Michika recorded 0.23 deaths per 10,000 children per day (95% CI: 0.03–1.77). Although Hong had a slightly higher point estimate, the overlapping confidence intervals indicate that the difference in under-five mortality between the two LGAs is minimal. These findings suggest that mortality among children under five remains a concern in both locations and requires continued monitoring and targeted interventions.

Table 3: Crude Mortality (CMR) and Under-five Mortality Rates (U5MR) for Hong and Michika

Death Rates			
Locations	**Category**	**Rate (95% CI)**	**Design Effect**
Hong	CMR	0.15 (0.05-0.49)	1.00
	U5MR	0.24 (0.03-1.86)	1.01
Michika	CMR	0.93 (0.54-1.59)	1.34
	U5MR	0.23 (0.03-1.77)	1.02

When compared with internationally accepted humanitarian thresholds, both LGAs remained below emergency mortality levels. According to the SPHERE Humanitarian Charter and Minimum Standards in Humanitarian Response (2011) and WHO guidelines, a CMR or U5MR exceeding 1 death per 10,000 persons per day is indicative of a public health emergency. The observed mortality rates therefore do not constitute an emergency situation. Nevertheless, the comparatively higher CMR observed in Michika indicates persistent vulnerabilities that warrant sustained humanitarian support, improved access to healthcare services, disease prevention measures, and strengthened community-based health interventions.

Furthermore, the current CMR observed in Hong is comparable to the previously reported Northern Adamawa mortality estimate of 0.16 deaths per 10,000 persons per day recorded in December 2023, suggesting relative stability in mortality patterns within the area. In contrast, the higher mortality burden in Michika may reflect differences in healthcare accessibility, socioeconomic conditions, population displacement, or residual effects of past insecurity.

3.2 Household Characteristics and Population Structure

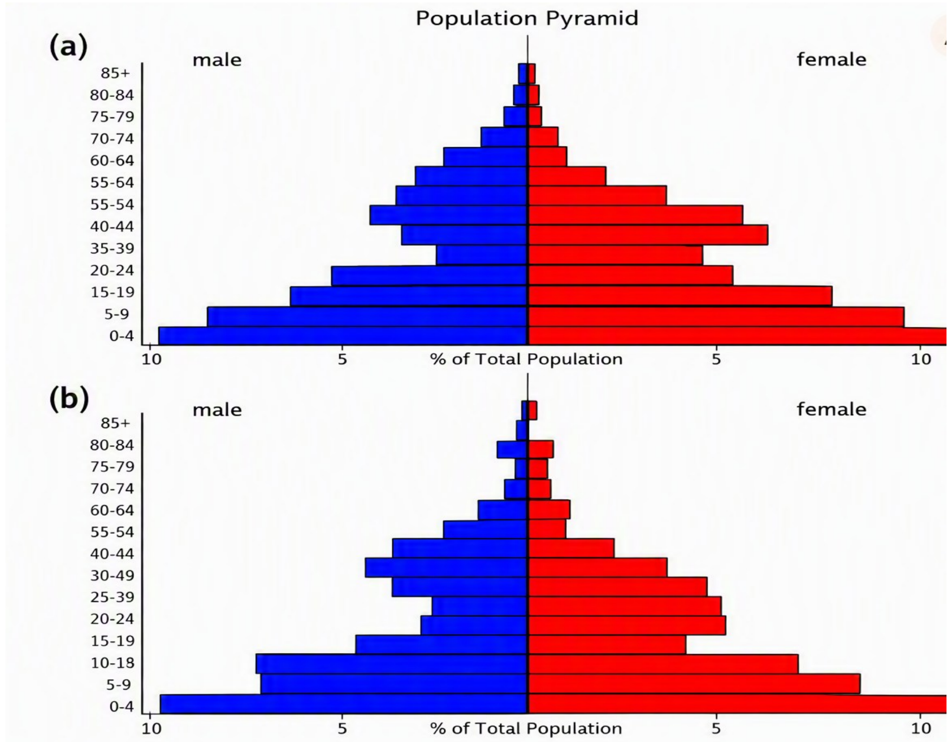
The demographic characteristics of the surveyed population are summarized in Table 4, while the age-sex distributions are illustrated in Figs 1 and 2 through the population pyramids for Hong and Michika LGAs, respectively. A total of 386 households comprising a mid-interval population of 1,691 persons were enumerated in Hong, whereas 371 households with a mid-interval population of 1,825 persons were surveyed in Michika. The average household size was 4.3 persons in Hong and 4.9 persons in Michika, indicating slightly larger household compositions in Michika.

Children under five years accounted for 23.2% of the surveyed population in Hong and 20.0% in Michika, highlighting the substantial proportion of young children within both populations. Such demographic characteristics are important because populations with large numbers of children often require increased investments in maternal, newborn, and child health services, nutrition programmes, immunization coverage, and educational resources.

The population pyramids shown in Figures 1 and 2 reveal expansive age structures characterized by broad bases and progressively narrowing upper age groups. This pattern is typical of rapidly growing populations with high fertility rates and relatively lower proportions of older adults. In Hong, individuals aged 0–14 years constituted 48.2% of the population, those aged 15–64 years accounted for 50.3%, while only 1.5% were aged 65 years and above. Similarly, Michika had 47.1% of its population aged 0–14 years, 49.8% aged 15–64 years, and 3.1% aged 65 years and above.

The predominance of younger age groups in both LGAs indicates a youthful population structure and a high dependency burden. Using Equations 3, 4, and 5, the total dependency ratio was estimated at 98.8% for Hong and 100.5% for Michika, implying that there are approximately as many dependents as economically active individuals in both communities. The young-age dependency ratio was 95.7% in Hong and 94.5% in Michika, confirming that children account for the majority of dependents. Conversely, the old-age dependency ratio was relatively low, at 3.0% in Hong and 5.0% in Michika, indicating a small but comparatively larger elderly population in Michika.

The higher old-age dependency ratio observed in Michika suggests a greater proportion of elderly residents requiring social and healthcare support, while the slightly higher young-age dependency ratio in Hong reflects a larger child population requiring sustained investments in nutrition, education, and child health services. Overall, the population pyramids and dependency indicators demonstrate that both LGAs possess youthful populations with substantial dependency burdens, emphasizing the need for long-term planning in healthcare, education, food security, and social protection programmes.



(a) Fig. 1: Hong Population Pyramid and (b) Fig. 2: Michika Population Pyramid

Table 4: Summary Statistics of respondents for the mortality

Individual Results of Death Rates:	Location	
	Hong	Michika
Total number of HHs	386	371
Total number of children under five	392	360
Average household size	4.3	4.9
Mid Interval Population Size	1691	1825
Number of Clusters	30	29
Percentage of children under five	23.2	20

Table 4 and Figs. 1-2 above gives a summary statistics of respondent's enumerated for the mortality component in the survey. For instance, in this study, Hong's population includes 48.2% children aged 0-14, 50.3% people aged 15-64, and 1.5% seniors aged 65 and above. Michika's Fig.s are 47.1, 49.8, and 3.1, respectively. The population pyramid also lets us compare different communities or countries at a single moment, offering a powerful tool for forecasting what lies ahead. Using equations 3, 4 and 5, the Dependency Ratio for Hong is 98.8% while that of Michika is 100.5%, Young-Age dependency Ratio is 95.7% for Hong and 94.5% for Michika and lastly, Old-Age Dependency Ratio is 3.0% in Hong and 5.0% in Michika.

4.0 Conclusion

Crude mortality rates (CMR) and under-5 mortality rates (U5MR) for Hong and Michika Local Government Areas (LGAs) were calculated using location-specific recall periods, as detailed in Table 2. The CMR in Hong was 0.15 (95% CI 0.05-0.49) deaths per 10,000 population per day in October 2024, compared to 0.16 (95% CI 0.06-0.40) in December 2023, reflecting a slight change from the previous Northern Adamawa rate. In contrast, Michika's current CMR is 0.93 (95% CI 0.54-1.59). The U5MR in Hong is 0.24 (95% CI 0.13-1.86) deaths per 10,000 population per day, while Michika's U5MR is 0.23 (95% CI 0.03-1.77), suggesting a marginally higher incidence of mortality in Hong. Mortality rates exceeding 1 per 10,000 persons per day represent emergency thresholds; according to the Humanitarian Charter and Minimum Standards in Humanitarian Response (SPHERE, 2011) Project Handbook and World Health Organization (WHO) standards, the current death rates in both LGAs for under-5s do not constitute an emergency situation. Nevertheless, there remains a need to strengthen the healthcare system in the region at both governmental and humanitarian levels. Table 4 and Fig.s 1-2 present summary statistics for respondents included in the mortality survey component. In Hong, 48.2% of the population are children aged 0-14, 50.3% are individuals aged 15-64, and 1.5% are seniors aged 65 and above. Michika's corresponding Fig.s are 47.1%, 49.8%, and 3.1%. The population pyramid facilitates comparison between communities or countries at a specific point in time and serves as a valuable tool for demographic forecasting. Based on equations 3, 4, and 5, the Dependency Ratio is 98.8% for Hong and 100.5% for Michika; the Young-Age Dependency Ratio is 95.7% for Hong and 94.5% for Michika; and the Old-Age Dependency Ratio is 3.0% in Hong and 5.0% in Michika. This implies that Michika has more elderly people, while the Young-Age dependency ratio is slightly higher in Hong.

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Declarations

Ethical Approval and Consent to Participate

This study did not involve human participants, animals, or human biological materials. Therefore, ethical approval and informed consent were not required.

Consent for Publication

Not applicable.

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Data Availability Statement

The data supporting the findings of this study are included within the article. Additional information may be made available by the corresponding author upon reasonable request.

Authors' Contributions

Anthony Ekpo: Conceived and designed the study, developed the methodology, performed statistical analyses, interpreted the data, prepared the figures and tables, and drafted the manuscript. Adimah Amos Arubi: Coordinated field data collection, supervised survey implementation, validated the data, contributed to interpretation of findings, critically reviewed the manuscript for intellectual content, and approved the final version for publication.

Competing Interests (Conflict of Interest)

The authors declare that they have no competing interests or conflicts of interest regarding the publication of this manuscript.