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The cause and effect of the nutrition transition in Nigeria: analysis of the value of indigenous knowledge and traditional foods in Enugu State, Igboland

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Abstract

The objective of this study is twofold: one, to analyze the presence of the nutrition transition in Nigeria through assessment of national food consumption trends, obesity, and noncommunicable diseases (NCDs) data over time, and two, to assess the role that indigenous knowledge and foodways can play in promoting healthy diets in the country through the case study of Enugu State, Igboland. A mixed-methods approach was utilized with quantitative data from the Nigerian Living Standards Survey and Demographic Health Survey to measure changes in obesity, diabetes, hypertension, and food consumption across Nigeria from 2003 to 2018 using Natural Language Processing and Trend Analysis. Primary qualitative data in Enugu State were collected through semi-structured interviews in 2021 with a random sampling technique undertaken to analyze the status of indigenous Igbo foods and traditions to curb the negative effects of the nutrition transition, as well as to document the motivations behind using or abandoning traditional foods in the present generation. *The findings of the study depict the nutrition transition in Nigeria in multiple forms*. The combined overweight and obese population in the country has experienced a 29% increase in the 15-years study period, while the NCDs hypertension and diabetes have experienced a combined 21% increase. Consumption patterns have shifted, though not always in the ways predicted from the literature, with statistically significant increases displayed in the consumption of Breads and Pastries, Starchy Roots and Tubers, Legumes, Plant and Animal Fats, Seafoods, Milk and Dairy Products, Beverages, Non-alcoholic Drinks, Vegetables, and Red Meats. *The primary data analysis displayed that the traditional Igbo foodscape is defined by local, nutritious whole foods*. The data depicted significant recent trends toward using ultra-processed seasoning cubes instead of local herbs as spices, with a huge shift from 0% frequency usage identified in the parents' generation to a 35% frequency in the current generation. Eighty-three percent of the community surveyed stated that they believe that the diets of the younger generation are changing, with the majority stating that the change is for the worse. Participants from the community provided recommendations for curbing the nutrition transition and empowering indigenous foodways through policy, investment, and mindset change. Though consumption patterns are changing and Nigeria's obesity and NCD rates are increasing, it is still far behind the rate of obesity in countries farther along in the nutrition transition such as its former colonizer Britain. Interviews conducted around Enugu State show how the indigenous food system is centered on fresh, healthy foods, primarily local tubers, legumes, vegetables, and spices. There is extensive knowledge and pride in the indigenous food system, even though there was a consensus that Igbo food culture

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is currently undergoing immense changes in part due to some of the younger generation's new tastes in processed foods and convenience.

Keywords Nutrition transition, Indigenous knowledge, Nigeria, Natural language processing, Nigerian Living Standard Survey

Introduction

The Igbos are the third-largest ethnic group in Nigeria, and the South-East region of the country including Enugu State is considered 'Igboland' [1]. Igboland or Enugu State specifically has been noted in extensive scholarly literature spanning centuries for its productive agriculture and good nutrition.

A historical account by Olaudah Equiano, an Igbo man captured into slavery and brought to the Americas in the 1700s, suggests that Igboland was, "uncommonly rich and produced all kinds of vegetables in great abundance." He elaborated that pineapples in Igboland are grown without culture; they are finely flavored and have the size about the size of the largest sugar loaf [2]. In addition, according to [2], the Igbos are blessed with various kinds of foods, particularly pepper and a variety of delicious fruits which he never saw while in Europe [2]

Similarly, Hermann Koler, a German doctor living in Bonny, wrote in 1840 that the Igboland great forest reserves and tress—encompassing products such as maize, rice, yams, oil palms, dyewoods, cotton, horses and elephants." He described the Igbo as strong, powerful people who exported their agricultural surplus and were feared by neighboring ethnic groups [3].

In a 2009 FAO publication, 220 food species of multiple varieties were documented as making up the traditional food system of the Igbo people. The study identified many nutritious leafy vegetables endemic to the area as well as important tubers such as yam, cocoyam, cassava, legumes, and wild fruits. The traditional diet is predominantly Produced from simple processing (e.g., fermentation) and cooking methods such as steaming, baking and roasting) [4].

The researchers noted many traditional Igbo foods with significant micronutrient composition, including iron, b-carotene, copper, and zinc. These prepared Igbo meals include egusi, bitter leaf, achicha, moimoi, akara, ukwa, utipiri, okpa, and native salad. Local palm oil is a primary component of Igbo cooking and is referenced as contributing the majority of Vitamin A to local peoples' diets. In the past, over 90% of the energy intake of rural communities in Igboland was from traditional food sources. In addition, over 90% of Igbo mothers breastfeed their children with the majority doing so for 15–18 months. [4] concluded that the Igbo was well-informed about foods that contain all the necessary nutrients for human nutrition."[4]

In his paper on the ontological functions of food in Igboland, Osuji writes that in Igboland food has more functions than just agricultural, nutritional, and economic. For Igbos, food has deep social, communal, and spiritual implications and food fosters human-to-human connections and human-to-spirit relationships, as well as medicinal functions. He writes that in Igboland food functions as a way to "create a symbiosis and cosmological balance between human and nature"[5].

In Igboland, vegetables are very important culturally and nutritionally as they comprise a large portion of local diets because of their vitamins and minerals which are believed to maintain good health and protect the body from diseases. Igbo traditional foods, beyond using many varieties of vegetables, are often minimally processed and utilize local fermentation techniques which are "embedded in the traditional knowledge" of the people. The probiotics and enzymes that fermentation produces are essential to health and aid in increasing the nutritional value of local foods [5].

Because of the multidisciplinary nature of food and the long-esteemed history of local food culture in Igboland, the nutrition transition poses philosophical and sociocultural implications for people in addition to the more obvious and tangible nutritional and economic ones that are more often studied. Osuji, as well as other Igbo scholars including Eneh [6], has called for further comprehensive studies in this area to continue the documentation of Igbo food pathways "in order not to lose them in the wake of global digital practices"[5] which this paper strives to accomplish.

In 1983, Okere wrote an extensive book-length study, largely viewed as one of the first at the time, on the anthropology of food and nutrition in rural Igboland [7]. He concluded that, by the 1980s, the majority of Igboland had become food deficient for multiple reasons including population density, as well as new agricultural policies and practices that were leading to yam fields being replaced by the less nutritious cassava, as well as an overall trend of land being dedicated to cash crops rather than local staple food crops leading to loss of food production. He recommended an increase in protein-rich wild foods as well as the dedication of more land for staple food crops rather than cash crops aimed at

exports. He also called for a "careful examination of the effects of the Green Revolution approaches" as well as the protection of local food crops through the development of national food-focused agricultural development policies [7]. Despite this, 40 years later, Green Revolution approaches are still being used to undermine Igbo foodways and indigenous voices and nutrition continue to be silenced and undermined by predatory investments and industries.

Despite the abundance of food in Igboland throughout the precolonial era, colonial rule forced the neglect of staple food crops and immediately caused food insecurity in the region. Iwuagwu writes that colonial policies in Igboland directly caused the "beginning of persistent food shortages" throughout Igboland and the rest of Africa [8]. Ultimately, multiple researchers point to how the diet of Igbo people can be improved through better utilization and cultivation of the staple fruits, vegetables, grains, tubers, spices, and animal products that were common in precolonial times before colonial policies shifted cultivation and resources away from native crops and into the production of less nutritious, nonnative, and overwhelmingly export-oriented agriculture [9].

The Igbo summarizes this in the proverb "Ndi mba ozo na-azu na-anwu n'aguu" which means that "People who depend on foreign food eventually die of hunger" and is exemplified in the foreign-instigated nutrition transition the region is currently experiencing.

The modern diet is the direct result of the industrial agricultural system and it causes billions of people to be either chronically food insecure or obese, leading to noncommunicable diseases being cited as causing nearly three-quarters of all deaths worldwide [10]. Despite the multiple and interconnected negative externalities of the industrial agri-food system, outsiders including international institutions, foreign governments, and multinational corporations have been attempting to replace the diverse, culturally rich, nutritious, and place-based diets of the indigenous people with high-input, high-waste, and noncommunicable disease-inducing Western ones [11].

Further, policies from the colonial era and preferences entrenched in neocolonial have led to the indigenous food system being sidelined, ridiculed, and marginalized, which has contributed to the younger generation's embracement of the new Westernized system [12]. To illustrate this, the former president of Burkina Faso Thomas Sankara is credited with saying simply "look at your plate" to see the effects of imperialism in Africa [13].

Considering the recent and ongoing changes in indigenous food systems among Igbos and Nigerian as a whole, the purpose of this paper is to evaluate the status of the nutrition transition in Nigeria while assessing the role that indigenous knowledge and foodways play in promoting healthy diets and mitigating diseases in Igboland. This will be achieved through a literature review of the drivers of the nutrition transition in Nigeria, its associations with colonialism and neocolonialism, and the evidence of the health-promoting effects of indigenous African diets. Analysis of Nigerian Living Standard Survey (NLSS) and Demographic and Health Survey (DHS) data will then be undertaken to determine trends in obesity and noncommunicable disease burden in the country and using NLP to analyze interviews with locals of Igboland to document the pillars of the traditional food system of indigenous Igbo people as well as the process changes that are occurring because of the nutrition transition.

Igbo people were chosen as the focus group of this study because of the ethnic group's established knowledge of native plants as well as Igboland's association with impressive biodiversity, productive agricultural systems, and economic success [14–16].

Literature review

Health benefits of traditional African diets

A 2015 study in the Lancet used self-reported diet information to analyze the consumption of healthy foods like whole grains, fish, fiber, fruits, and vegetables versus unhealthy foods including sugar, salts, saturated fats, and processed meats from 187 countries and concluded that West Africans have one of the healthiest diets in the world [17].

A collection of Western-led empirical studies comparing Africans who are consuming Western diets to those who have not arrived at similar conclusions of the superior health outcomes resulting from indigenous diets. For instance, Dr Weston A. Price's 1939 book "Nutrition and Physical Degeneration" is based on empirical observations on the superior health outcomes of indigenous people worldwide who were not consuming Western foods [18]. His findings state that people eating indigenous diets experienced "superb health," while those eating a "modern"/Westernized diet saw significant negative outcomes, notably in their dental arches, jaw development, and overall immunity to dental infections. In Africa, the people he studied who were eating indigenous diets also had no cases of appendicitis, gallbladder malfunctions, cystitis, ulcers, or malignancy. These findings were directly contrasted with the counter group of African people who had transitioned to more Westernized diets, where negative health outcomes were seen directly within one generation (2). Figure 1 depicts visual evidence of deterioration in tooth and jaw health following some peoples' adoption of the "modern" diet.

Albert Schweitzer a colonial doctor in West Africa also arrived at similar conclusions about the superiority of

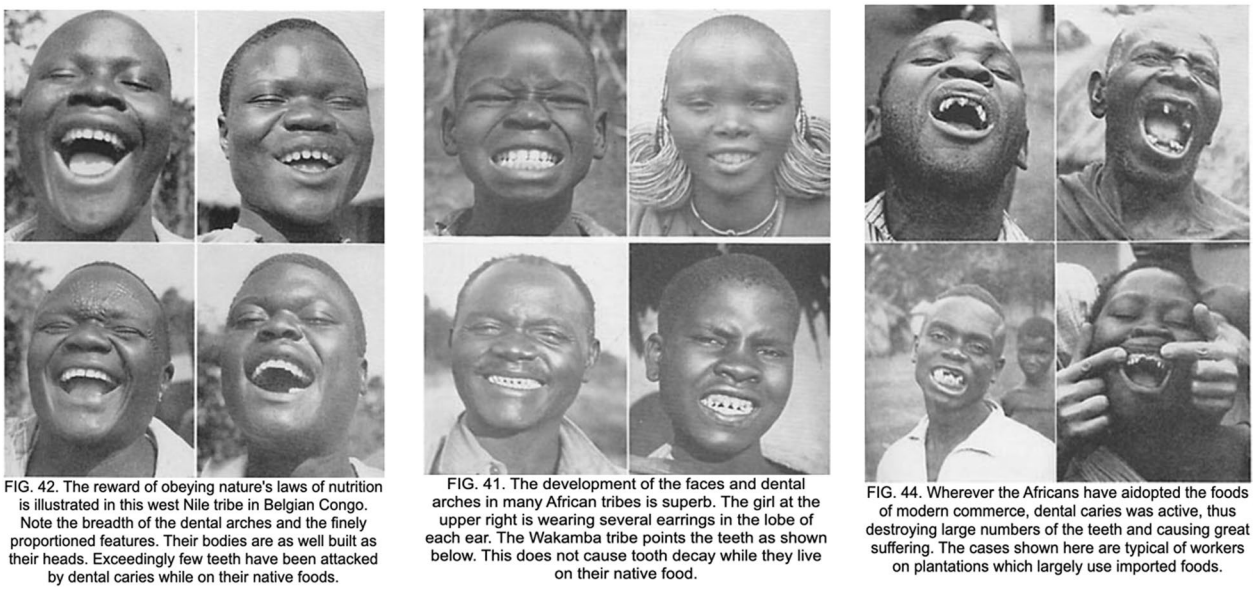

Fig. 1 Differences in tooth and jaw health in Africans eating traditional versus modern diets. Adapted from Price's "Nutrition and Physical Degeneration" (1939)

traditional African diets. According to Schweitzer, cancer incidence was non-existent before Western lifestyle changes. On his arrival in Gabon in 1913, he wrote that he was "astonished to encounter no case of cancer." But by the end of his time in Gabon four decades later, he had unfortunately witnessed a steady incline in cancer incidence in the region. This led him to write that his "observations incline [him] to attribute this to the fact that the natives were living more and more after the manner of the whites" [19].

Similarly, Dr Burkitt studied the effects of the high-carbohydrate, high-sugar Western diet on cancer incidence in 1973. In his research, he used Africa as a control group for the Western world. He found that, in the African control group, 44 hospitals had never seen an instance of colon cancer, appendicitis, or heart disease, and 25 hospitals had fewer than 3 cases of appendicitis annually. Burkitt partially attributed this low burden of chronic disease to the fact that the traditional African diet is extremely high in fiber, with the average person consuming four times the amount of fiber the average American does today [19].

Fruits and vegetables are key sources of fiber, and research shows that many endemic African varieties are both more nutritious and easier to cultivate and simple to harvest and handle than their introduced counterparts on the continent [20]. Additionally, traditional Nigerian spices have been cited numerous times as being functional foods with bio-active properties and medicinal potential, with Ene-Obong et. al, concluding that, "some common Nigerian herbs and spices have been reported to possess pharmacological activities such as anticancer, anti-oxidant" [21, 22]. They list Calabash nutmeg (ehuru in Igbo) and Ashanti pepper or *Piper Guineense* (uziza in Igbo) among others as having significant medicinal potential, while other researchers have also touted the benefits of the three most popular fermented Nigerian spices: ogiri—made out of fermented castor oil bean or melon seeds, okpei from mesquite seeds, and ugba from African oil bean. The fermentation of these spices has been associated with improving microbiome diversity and gut health, as well as providing amino acids, protein, vitamins, and minerals [23].

Drivers of nutrition transition in nigeria

Colonization in Nigeria and the subjugation of indigenous knowledge

One of the main drivers of the nutrition transition in Nigeria is the existing legacy of the colonial suppression of indigenous African foodways. Raschke and Cheema state that the "deleterious influence" of colonial and neo-colonial forces in Africa becomes "glaringly evident" if one is to make any "legitimate inquiry" into the multiple disease epidemics afflicting the continent, including the seemingly new "nutrition transition" [11].

Abukutsa-Onyango adds that a key aspect of European colonialism in Africa centered around suppressing traditional agri-food systems including through the stigmatization of local fruits and vegetables and the introduction of foreign varieties which labeled them as

"out of fashion," "poor man's foods," or fit for a child. Abukutsa-Onyango points out that the lower class began to imitate the higher classes that were rejecting these food sources and accepting new "exotic" foreign alternatives, leading the indigenous species to be abandoned [24].

In addition to this colonial neglect, many indigenous knowledge sources, including those of food, are not written down, and elderly people are the gates to all their information, making it so vulnerable to extinction. Younger generations have been shown, for a variety of factors, to be less receptive to maintaining these traditions as they can seem "outdated and unpopular" due to Western education systematically invalidating indigenous knowledge systems [12].

Neocolonial interventions

The nutrition transition in Africa is propelled by negative attitudes toward indigenous practices and knowledge by international organizations and other foreign parties who possess staggering financial capabilities. As recently as September 2022, the foreign-led Alliance of a Green Revolution in Africa (AGRA) pledged $550 million over the next 4 years toward meddling in African food systems (20). This is in addition to the 1 billion USD that African governments have been encouraged and enabled to spend on subsidies for chemical inputs and hybridized seeds for agriculture *each year* [11], as well as the hundreds of millions that AGRA has received from a combination of billionaire 'philanthropists,' NGOs, and corporations since its inception in the mid-2000s. The Bill and Melinda Gates Foundation, notable for its indoctrination of Africans against their own agricultural capabilities as well as their pressures to utilize GM crops and other biotechnology, contributes two-thirds of the organization's funding [25, 26].

In a groundbreaking recent report, the Institute for Agriculture and Trade Policy's Senior Advisor Timothy Wise found that the food insecurity situation in Africa has become more dire since AGRA's implementation. He writes that "AGRA has failed to catalyze a productivity revolution in African agriculture. Farmers' yields have not grown significantly, poverty remains endemic, and the number of chronically hungry people in AGRA's 13 focus countries increased by 30 percent" [27]. Specifically in Nigeria, there have been reductions in yields of staple crops since implementing AGRA principles in 2006, and the number of undernourished people in Nigeria doubled [11]. Ultimately, AGRA policies are an economic extension of Western neocolonial rule that undermines African autonomy and power.

Study contribution

The contributions of this paper are threefold. First, though other studies analyze the nutrition transition either more broadly or in other contexts, this is the only study which measures the effects in Enugu State, Nigeria through analyzing by comparing the consumption of indigenous Igbo foods between the older and younger generations, while contextualizing the role that colonialism and predatory investment has played in shaping food systems in the region. Second, the study also relies on nationally representative NLSS and DHS data to compare nutrition transition across four periods in time in Nigeria as well as the prevalence of noncommunicable diseases in Nigeria. Third, this is the first study to rely on Natural Language Processing to elicit nutrition transition and trends in diseases in Nigeria and Enugu State. We believe that results from this study will be important for policymakers and international organizations concerned about malnutrition and nutrition insecurity in Nigeria, as well as elsewhere in Africa.

Methods

Data

The study relied on both secondary and primary data collection and analysis.

Secondary data

The secondary data consists of the 2003 and 2018 NLSS and DHS surveys for 2003, 2008, 2013, and 2018. Both the NLSS and DHS are comprehensive surveys with proportional representation from all 36 of Nigeria's states and federal capital area, with respondents from rural and urban areas, both genders, all ages, and ethnic groups.

The NLSS is conducted over 12 months with the goals to (1) provide critical information for the production of a wide range of socio-economic and demographic indicators; (2) monitor population welfare; and (3) provide statistical evidence to measure the impact of existing and proposed government policies. The most pertinent information to our study is food consumption. A total of 18,770 and 22,122 respondents participated in the data collection in 2003 and 2018, respectively.

The DHS Survey concentrates on generating data to provide basic demographic and health indicators. The main objective for using the DHS is to provide comprehensive evidence on the trends in obesity and noncommunicable diseases in the country and compare it with trends in food consumption in the NLSS datasets. The DHS dataset comprised 7446, 32,462, 7446, and 15,234 for 2003, 2008, 2013, and 2018, respectively. The reason

for the lower sample for 2013 and 2018 is a result of a large number of zero responses.

Primary data

The primary data were collected using a random sampling technique, and semi-structured interviews were conducted based on an open-ended survey by two research assistants who were born and raised in Enugu state. Depending on the fluency of the interviewees, the interviews were either conducted in English or Igbo. The answers were then translated and transcribed by the research assistants into a Google Forms survey.

The interview questions included questions on Most Important Igbo Food Traditions, Foods, and Crops; Spices Used by Parents' Generation versus Current Generation; Igbo Medicinal Foods; Foods Associated with Poverty; Foods Associated with Affluence; Changing Local Foodscapes and Potential Endangerments/Extinctions; Local Perceptions of Nutrition Transition in Enugu State; and Policy Recommendations from Study Participants.

The interviews were concentrated on the provinces surrounding Enugu state that is highly recommended and known for their popular Igbo food including Nsukka Province, Udi Province, Ezeagu Province, Nkanu Province, and Nike province. The interviews took place in July 2021, and each interview took approximately 15 min. Participants were randomly selected, and overall, 54 people were surveyed. Seventy-five percent of the 54 people interviewed were female, while only 25% were male. This was intentional because traditionally Igbo women are traditionally the ones in charge of choosing foods and cooking for their families. Men were still interviewed to see if there were differences or similarities in their opinions and to provide a more representative sample of the overall population. Though a few of the participants had no formal schooling whatsoever, the majority had had some level of formal education, ranging from some primary schooling to graduate degrees. The current professions of the participants were also vast, ranging from current students to petty traders to farmers to housekeepers to businesspeople. Most respondents were fluent in both English and Igbo, while 12 people (22% of the sample) were fluent only in Igbo.

The ages of those surveyed spanned from 20 to 80, 15 respondents were under 40, 9 of whom were under 30, with the remaining 39 respondents being over 40, 11 of whom were over 60. More old people than young were interviewed because of the research which shows that elders often have more knowledge of indigenous food systems and getting an active catalogue of indigenous foods, crops, and preparation methods was one objective of this study. Participants from the younger generations were also sought out to measure changing preferences and ideals between generations.

Method of analysis

Natural language processing

To analyze trends in indigenous knowledge and food consumption, the natural language processing (NLP) technique was used. NLP is a branch of artificial intelligence that gives the computer the ability to analyze and understand human language (Kang et al. 2020). It uses computer programs to transform linguistic knowledge with the assistance of artificial intelligence. NLP has widely been used in many papers to analyze a variety of topics. For instance, Agarwal et al. used NLP to assess hospital readmissions for patients with chronic obstructive pulmonary disease in the United States [28]. Hu et al. also used NLP to determine the prevalence of cannabis, tobacco, and vaping device mentions in online communities [29]. Finally, Kim et al. [30] combined NLP and Machine Learning to identify brain MRI reports with acute ischemic stroke. In nutrition, Choi, Kim, and Kim attempted to use the NLP preprocessing methodologies to extract dietary patterns in Korea using the National Health and Nutrition Examination Survey [31]. Their results indicate a considerable increase in Western dietary patterns. However, there is no known study using natural language processing to understand differences in indigenous knowledge and nutrition patterns in Nigeria.

The NLP method used to process our data involves a series of steps: (1) Converting text data into a corpus by creating a matrix consisting of documents and terms (2) Text cleaning: this involves (i) removing stop words, (ii) removing punctuation, (iii) removing white space and numbers, (iv) removing stop words, and (v) stemming and lemmatization. Clustering and classifying menus using fasttext; 3) Analysis, at this stage, the researcher can perform sentiment analysis, topic modeling, word cloud, etc. In this paper, results from the NLP are presented as frequency tables and bar plots.

The application of the NLP in this paper follows Fig. 2. The text data in the Excel file are loaded into the statistical package as a vector. The vector containing the text document, e.g., frequently consumed Igbo foods is converted into a corpus (giving the number of documents in the vector). The preprocessing stage is the most important in the text analysis. During the preprocessing stage, numbers, punctuation, stop words, white spaces are removed from the documents in the corpus. Also, all text can be changed into lower cases to simplify the analysis. From this stage, a document term matrix is created. This is a mathematical matrix that describes the frequency of terms that occur in a collection of documents. From this stage, the document term matrix can be analyzed using

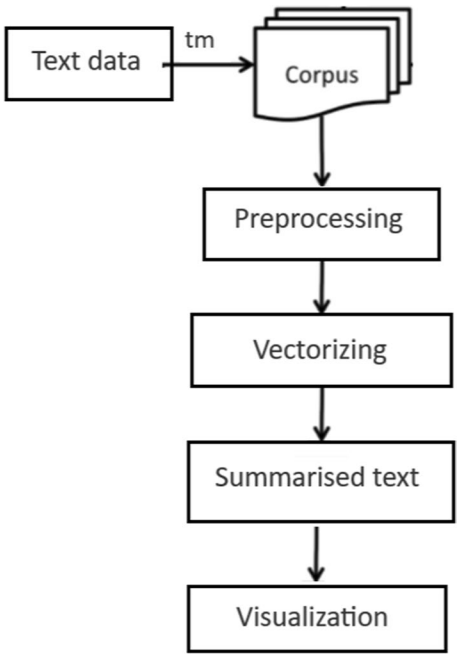

Fig. 2 Flowchart of Natural Language Processing. *Source* Office of National Statistics Learning Hub (2022)

quantitative techniques of the matrix. For this study, we summarize the text using frequency counts by simply summing over all columns in the document term matrix. This is then used to create bar graphs to visualize the results. This procedure was repeated for all questions addressed identifying indigenous knowledge and dietary patterns.

Trend analysis

Trends in the prevalence of obesity, diabetes, and hypertension were analyzed and compared across different periods. In addition, we compared and tested for differences in the consumption of different food categories in Nigeria.

Obesity trends: The Demographic and Health Survey for the years 2003, 2008, 2013, and 2018 measured the weight and height of all respondents, which was used to measure each respondent's Body Mass Index (BMI)—an individual's weight in kilograms divided by their height in meters squared. BMI measurements were chosen to measure the status of the nutrition transition in Nigeria because of the BMI's proven usefulness and simplicity as a tool for measuring noncommunicable disease risk including premature death, cardiovascular diseases, high blood pressure, osteoarthritis, some cancers, and diabetes. Based on BMI estimates, individuals were grouped into underweight (BMI < 18.5 kg/m^2), Normal weight (BMI = 18.5–24.9 kg/m^2), overweight (BMI = 25–29.9 k/m^2) and obese (BMI = > 30 kg/m^2).

Diabetes and Hypertension Analysis: the 2003 and 2018 Nigeria Living Standards Survey was used to produce and compare tables of illnesses that were self-reported by survey respondents who visited the hospital 30 days before data collection. Noncommunicable diseases were separated from communicable diseases because of the well-established relationship between diet and non-communicable disease risk, whereas there is not the same correlation between diet and communicable diseases. Two important noncommunicable diseases were analyzed: diabetes and hypertension, whose burden has been shown to increase as a country goes through the nutrition transition.

Consumption trends: the raw consumption data from the Nigerian Living Standards survey for the years 2003 and 2018 were used to generate frequency tables for the number of times individual foods were consumed in a week and many respondents consuming the food product. For simplicity, the food products were aggregated into seventeen main food groups. We went further by estimating Asin values for the proportion of individuals consuming each food in the two data sets. This allowed us to test for statistical differences in the number of persons consuming the food in 2003 and 2018.

Results

Increases in overweight and obesity in Nigeria

From 2003 to 2018, the percentage of normal-weight people decreased from 65 to 59%. Concurrently, the combined overweight and obese population increased from 21 to 27%, amounting to nearly 29% increase in the percentage of overweight and obese people in the 15 years (Fig. 3).

Burden of non-communicable diseases

Consistently over the 15 years, the most common first visit to a hospital was for malaria. From 2003 and 2015, malaria has been the cause of over half of all illnesses, only marginally reducing from 54.5% in 2003 to 51.4% in 2018 (Fig. 4).

Concurrently, 0.5% of all first hospital visits in 2003 were for diabetes, while 1.4% were for hypertension. By 2018, the diabetes rate fell slightly to 0.4%, while hypertension had increased to 1.9%. This indicates that the combined noncommunicable disease burden increased from 1.9% to 2.3% over the period, comprising a growth of 21%.

The second hospital visit hypertension rate visits rose from 1.3% to 1.5%, while the second-visit diabetes burden fell from 0.8 to 0.5% during the same period, comprising a

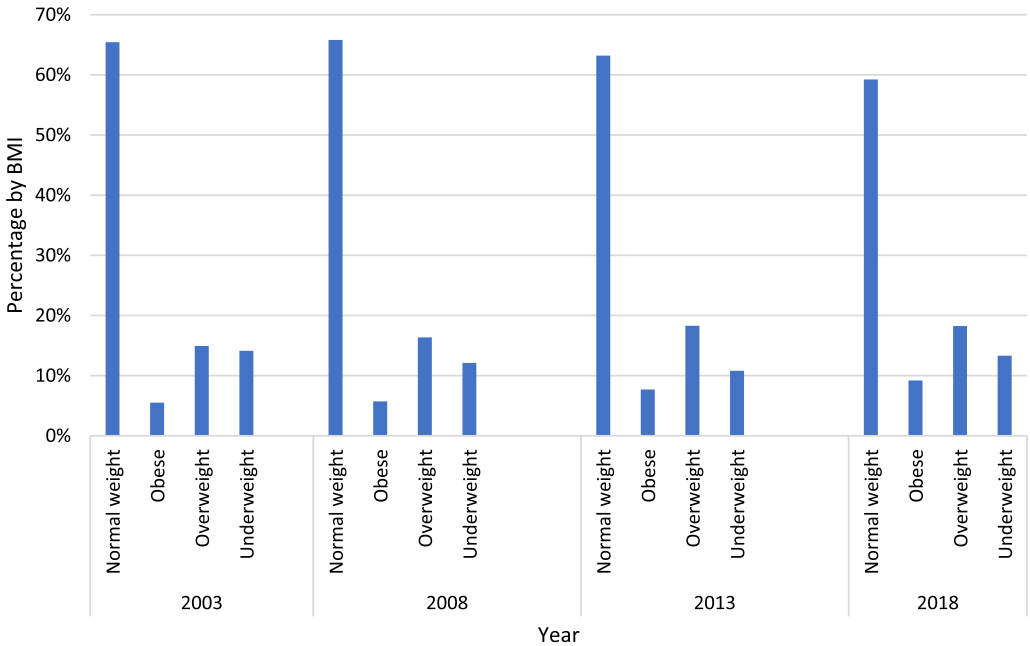

Fig. 3 Distribution of body weight in Nigeria from 2003 to 2018

minor change from 2.1 to 2.0%, amounting to a decrease in 5% (Fig. 5).

Shifts in overall consumption

On the national scale, consumption patterns have shifted in the 15 years, with every category but Grains experiencing an increase in the number of households purchasing them. There was overall higher household consumption in 2018 than in 2003. Table 1 displays how from 2003 to 2018 there were statistically significant increases in the consumption of Breads and Pastries, Starchy Roots and Tubers, Legumes, Plant and Animal Fats, Seafood, Milk and Dairy products, Beverages, Non-alcoholic Drinks, Vegetables, and Red Meats.

In both 2003 and 2018, vegetables were consumed at over 40%, making it the food group that was purchased by the most amount of households, while alcoholic drinks—comprising 2% the share of consumption in 2003 and 3% in 2018—were consistently the least purchased. Oil and Fats and Spices/Condiments were the most used food groups, both consumed 6 times a week in both periods. The frequent intake of oil and fats suggests that most households derive their basic energy from this category. Spices and condiments are used in all cooking as they make food taste better even those with limited amounts of ingredients. Fruits and Milk/milk products were the least frequently consumed food groups in 2003 and 2018. These groups are considered expensive and low in energy as a result they are not frequently consumed. Surprisingly, the frequency of consumption of vegetables increased from 5 times a week in 2003 to 6 times a week in 2018 indicating an improvement in vegetables consumption. The number of times grains and flour was consumed in a week declined from 6 to 5 times a week indicating a marginal shift from energy-dense foods. The number of times animal sources of protein was consumed in a week remained the same, but plant protein sources increased from 3 to 4 times a week. In summary, there has been an improvement in the number of times vegetables and plant sources of protein are consumed per week (Table 2).

Most important igbo foods

When asked which Igbo foods were the most important, thirty-five different foods were identified, with ede (cocoyam), ji (yam), akidi (black beans), fiofio (pigeon peas), and ukwa (breadfruit) being the most common responses. All of the foods mentioned as staple Igbo foods were natural in origin and either completely unprocessed or minimally processed. No packaged foods or ultra-processed spices were considered as most important to the local food landscape or traditions (Fig. 6).

Spices used by parents' generation versus current generation

The most frequently listed spices used by the older generation were reported to be ogiri okpei (fermented castor seeds) followed by nchuanwu (scent leaf), uda (negro pepper), utazi (leaf), and uziza (leaf) (Fig. 7).

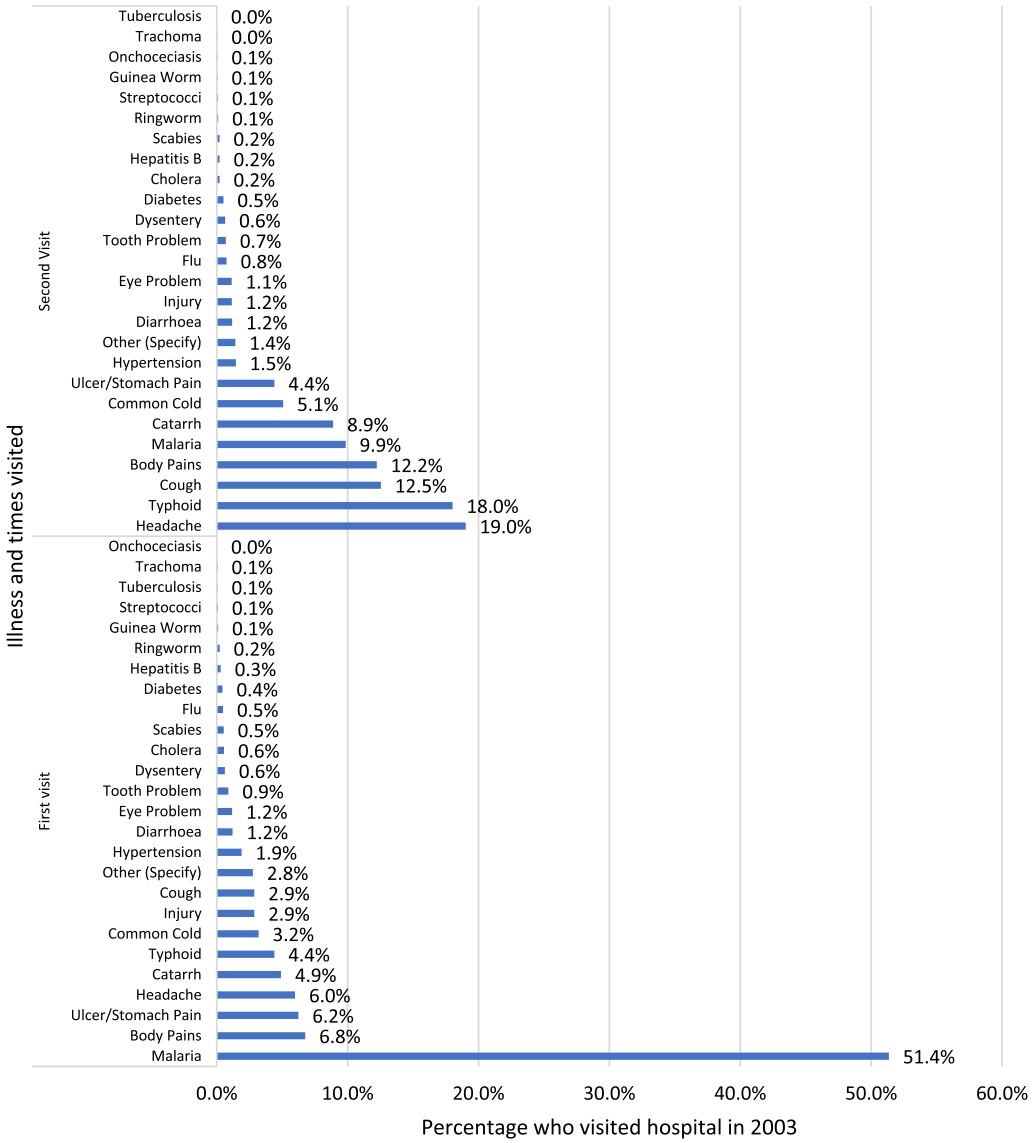

Fig. 4 Percentage of first and second visits to the Hospital in 2003

The results indicate that the younger generation is abandoning these traditional natural spices. The most used spice among them is seasoning cubes, most notably the Maggi, Benny, and Kitchen Glory brands. Although seasoning cubes were not mentioned as being part of their parent generation's cooking, seasoning cubes comprised 35% of all spices the current generation listed as using. Curry, thyme, and ehuru (calabash nutmeg) lagged in second, third, and fourth place. The natural and local ogiri okpei (fermented castor seed), nchuawu (scent leaf), uda (negro pepper), utazi (leaf), and uziza (leaf) ubiquitous in their parents' generation are shown to be becoming thoroughly neglected by the youth.

Many respondents had negative reactions toward the transition from spices that are natural in origin to those that are processed into additive-laden spice cubes. Respondents shared that "The old ingredients that were used to prepare food have been replaced with some modern ingredients which have made the taste of foods too different," and that, "Instead of the local ingredients like ogiri that was being used in soups, it's being replaced with Maggi cube and that ends up changing the taste." One other person shared that, "Before everything was natural and fresh but now, in other things easier people tend to use preserved spices and all this already made ingredients" and another that, "the parents' generation]

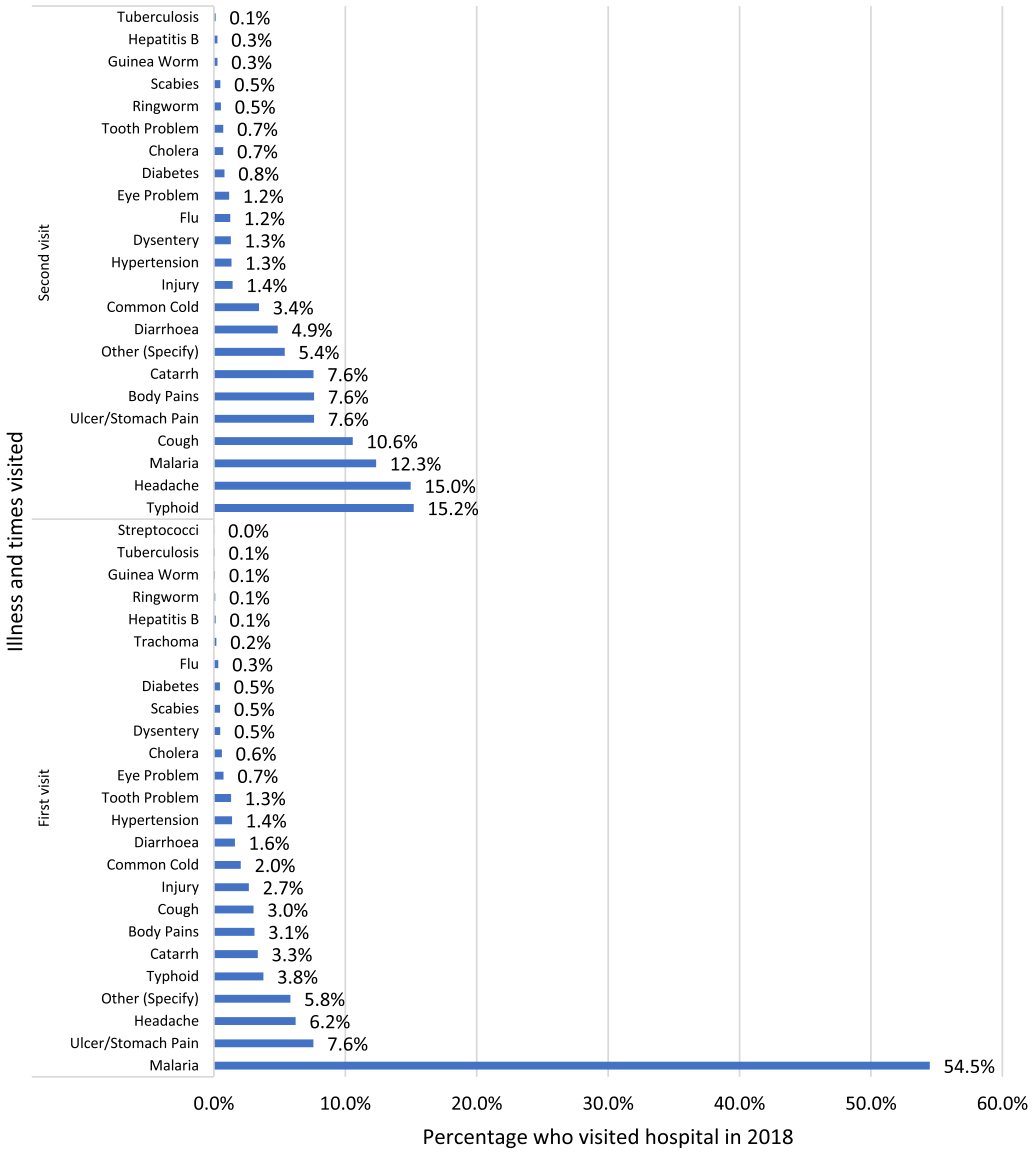

Fig. 5 Percentage of first and second visits to the Hospital in 2018

used natural and fresh stuff, but now it's mostly already preserved ingredients (Fig. 8)."

Igbo medicinal foods

When asked which foods they believed to have medicinal properties, the most common answers were beans including akidi (black beans) and fiofio (pigeon peas), as well as vegetables including garden egg, ugu (fluted pumpkin leaf), onugbu (bitter leaf), fiofio (pigeon pea), utazi (leaf), uziza (leaf), and more.

After beans and vegetables, the next most common response was "all Igbo foods." One respondent stated that they believed the healthiest foods were, "Fresh yams and vegetables just harvested from the farm," while another stated that, "every local food is organic and as such healthier than inorganic foods." One interviewee stated that "all our [Igbo] vegetables" and "all our [Igbo] spices" have health-promoting and medicinal properties with another person g that, "All our local foods are healthy." These responses indicate sizable community pride in local Igbo foods.

There was also some emphasis on the health-promoting effects of proper food preparation, including the acknowledgment of eating foods in the correct proportions, as well as consuming enough protein and vitamins. Some people also indicated that the different foods had

Table 1 Nigerian Consumption in 2003 versus 2018

	Percentage of consuming households	*t*-test for differences	Sig
Food Category	*2003*	*2018*	
Grains	26%	23%	0.17
Bread and pastries	15%	22%	0.01***
Starchy roots and tubers	19%	23%	0.06*
Legumes	21%	26%	0.01***
Nuts	12%	13%	0.32
Plant and animal fats	29%	32%	0.06*
Seafood	12%	17%	0.02**
Milk and dairy products	7%	12%	0.07*
Beverages	8%	17%	0.08*
Confectionary	22%	24%	0.47
Spices	28%	33%	0.01***
Non-alcoholic drinks	9%	14%	0.01***
Alcoholic drinks	2%	3%	0.19
Fruits	10%	16%	0.11
Vegetables	41%	46%	0.06*
Poultry and poultry products	5%	9%	0.11
Red meat	6%	11%	0.05**

***, **, * means significant at 10, 5 and 1 percent, respectively

Table 2 Comparing average number of times food groups was consumed per week in 2003 and 2018

	Average number of times per week		
Food groups	2003	2018	Variance
Fruits	3	3	0
Grains and flours	6	5	−1
Meat, fish and animal products	4	4	0
Meat, fish and animal products used as spices	3	4	+1
Milk/milk products	3	3	0
Oil and fats	6	6	0
Pulses, nuts and seeds	3	4	+1
Spices/condiments	6	6	0
Starchy roots, tubers, and plantains	4	4	0
Sugar/sugar products/honey	4	4	0
Vegetables	5	6	+1

different properties for different conditions, such as recommending uda seed (negro pepper) for pregnant women (Fig. 9).

Foods associated with poverty versus foods associated with affluence

Ji (yam), the historic tuber of the Igbos, was the food most associated with affluence. Ukwa (breadfruit), and rice followed close behind, with meats, beans, and various vegetables also receiving multiple mentions. No explicitly Western or industrialized processed foods were listed as foods associated with affluence, although one respondent did answer, "Chinese food."

Overwhelmingly, the foods that participants identified with poverty were cassava-based. Garri (cassava flour)—a staple food in Nigeria—was most associated with poverty, followed closely by abacha (African salad) which is commonly made of cassava, followed by plain cassava tuber, and akpu (fermented cassava)—a local swallow with a strong sour odor. Overall, no respondents associated cassava-based foods with affluence, while 78% of the foods mentioned that were associated with poverty were made from cassava (Figs. 10, 11).

Changing local foodscapes and potential endangerments/extinctions

Aerial Yam (Adu), Akidi (black bean), Una (bitter yam), Three-leaf yam, Ichipe, and Ihwi were listed as foods that are no longer commonly consumed in the area, while red cassava, Adu (aerial Yam), yellow yam (ji oku), akidi (black bean), abi (flat yellow yam), and various unnamed vegetables and mushrooms were also listed as potentially having gone in extinct in the area in the past few decades. One interviewee also indicated that beyond specific species that are going extinct, "almost all the traditional species of these groups are being replaced by hybrids. Traditionally grown original species are scarce."

Local perceptions of nutrition transition in Enugu State

There was consensus among the participants that the way people eat in Enugu State is changing. When asked to elaborate on how so and in what ways, respondents overwhelmingly indicated that they believe that diets are changing for the worst.

Of the 54 people questioned, only 8% of people surveyed said that they did not believe that diets are changing, 9% did not answer, and a whopping 83% said: yes, they are. When asked "how" they are changing, the answers had similar themes of diets transitioning away from local, whole food sources and toward ultra-processed imports (Fig. 12).

Rationales for how diets are changing ranged from descriptive answers, such as: "The younger generation neglected the Igbo traditional food," "Fast food has taken over," "There is too much reliance on packaged foods," and "There is a lot of sugar in most food now," to more specific, such as, "From Abacha to Indomie" (natural African salad to packaged processed noodles,) "They [the younger generation] do not want to spend time and cook. Noodles and fast foods are their meals of choice," "Children depend on noodles," and "Some youths and

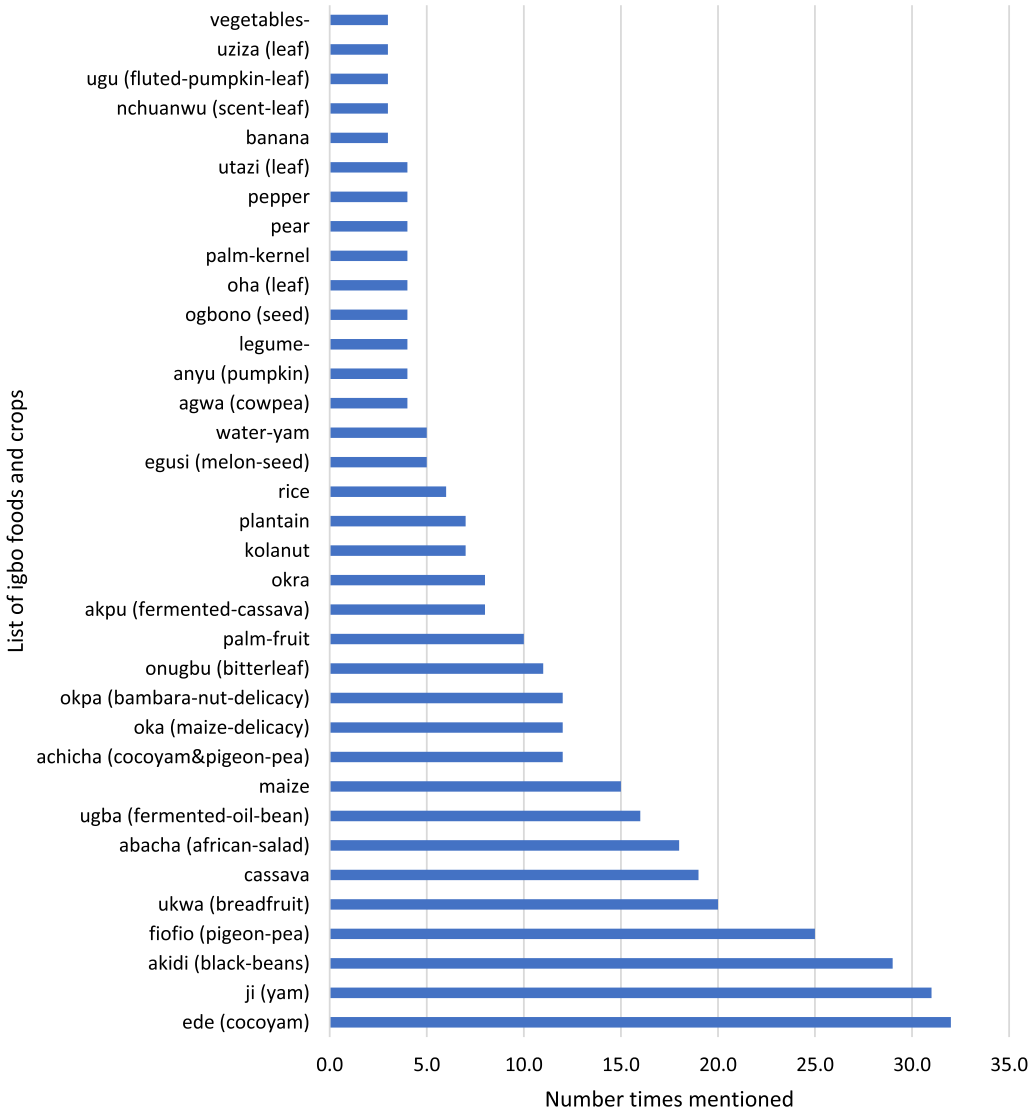

Fig. 6 Most Important Igbo Foods and Crops

children do not like local foods such as cocoyam, Abacha and local beans, many youths and children prefer pizza, shawarma."

Explanatory responses included, "It's changing because of civilization. Most people live in the city so are far away from nature," and "Many are now taking to Western diet coz of their filtration into the market and ease of preparation and refined foods."

Some interviewees even attributed poor health outcomes to the younger generation stating that "Diets have changed in the younger generation because they don't eat a balanced diet and food that will build the body and prevent sickness. They are more into processed foods which has some health implications," and "The younger generation eats more sweets that damage their body system."

A few answers attributed the nutrition transition to the West stating that, "Socialization or Westernization have the greatest impact on the preference of the younger generation. They crave continental dishes more than local foods," with another participant historicizing that, "Because of Western influence and the race to imitate the white man so the new generation ends up loving burgers and French fries."

Policy recommendations from study participants

Throughout the interviews, Enugu locals had many recommendations for policy interventions to curb the negative effects of the nutrition transition. One participant stressed that "More encouragement and mobilization should be given to Igbo farmers to enhance productivity"

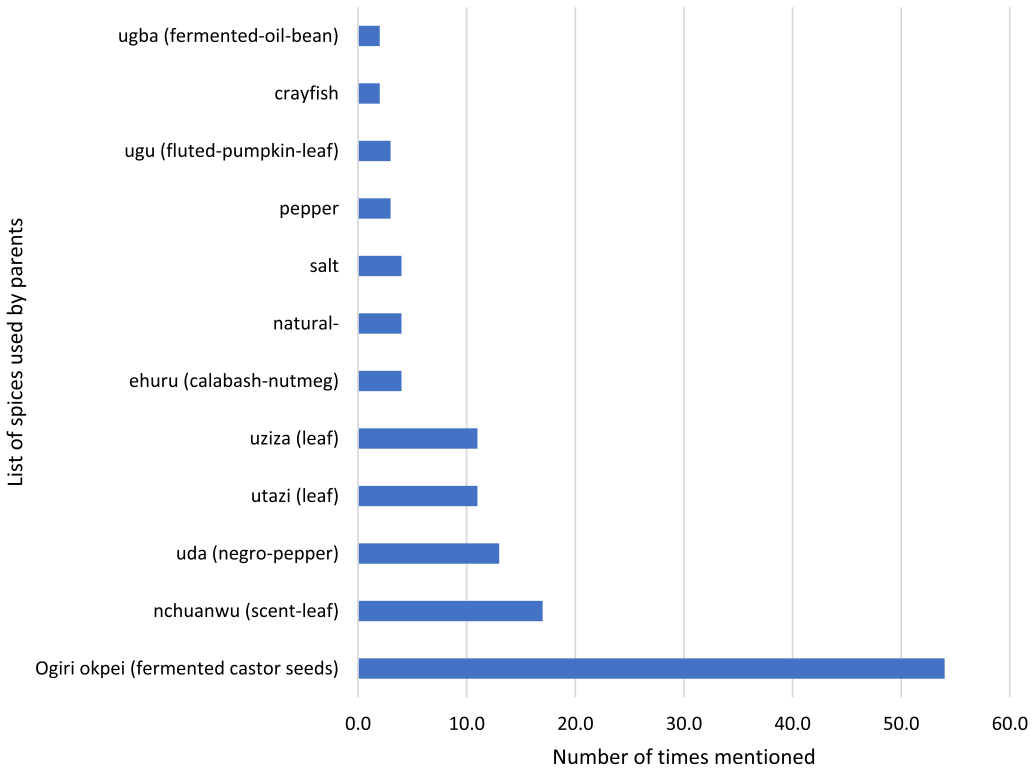

Fig. 7 Top spices frequently used by parents'(older) generation

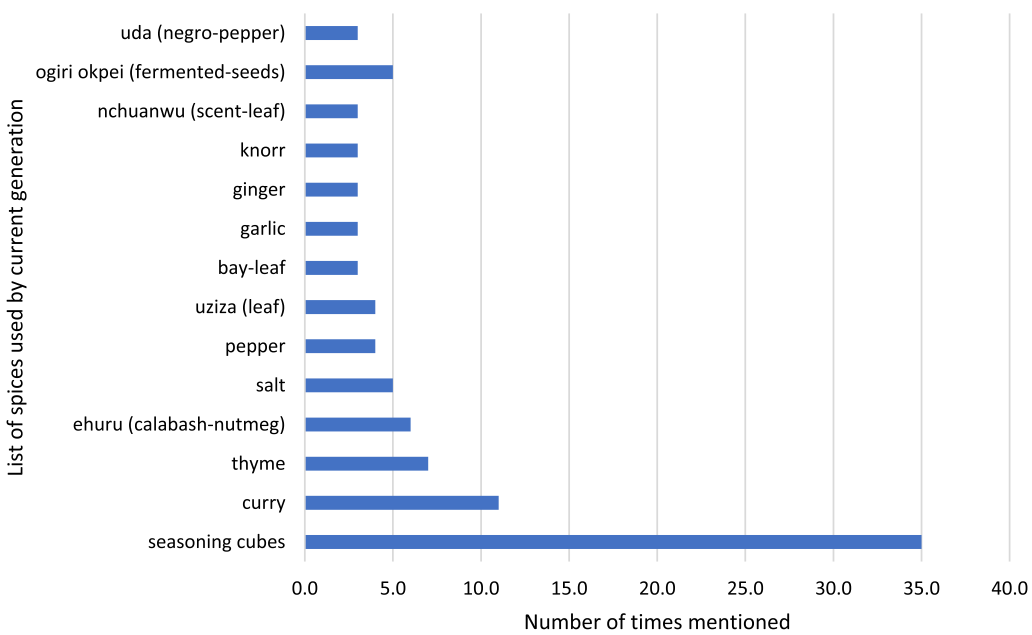

Fig. 8 Top Spices frequently used by the current generation

while another called for the Nigerian government to specifically empower Igbo farmers to produce more Igbo crops.

One participant acknowledged that "The world is now a global village. People access information easily and embrace new ideas." But that, beyond policy

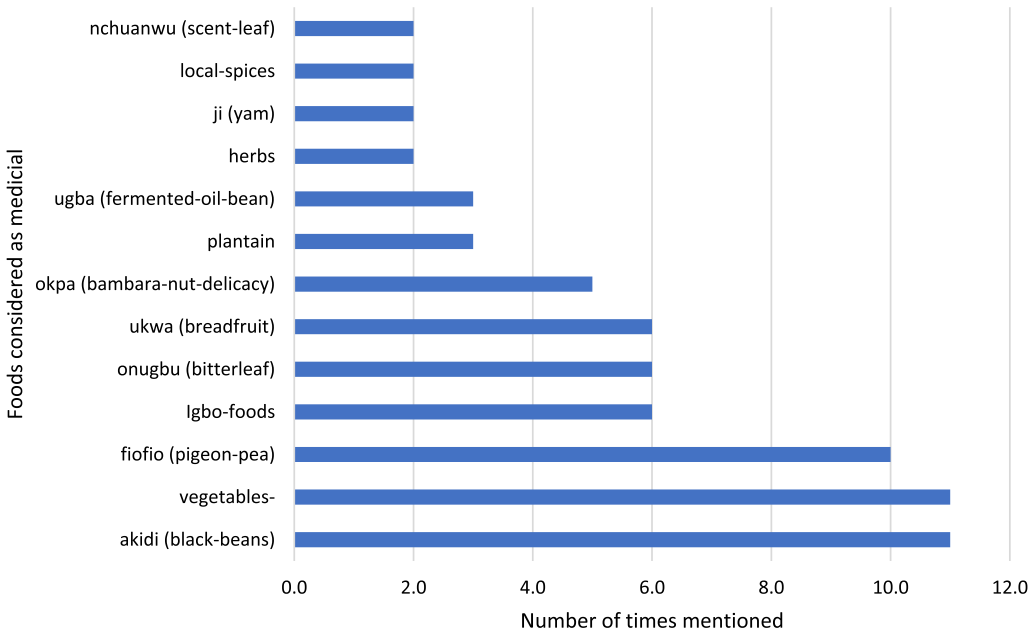

Fig. 9 Frequently listed medicinal foods in Igbo land

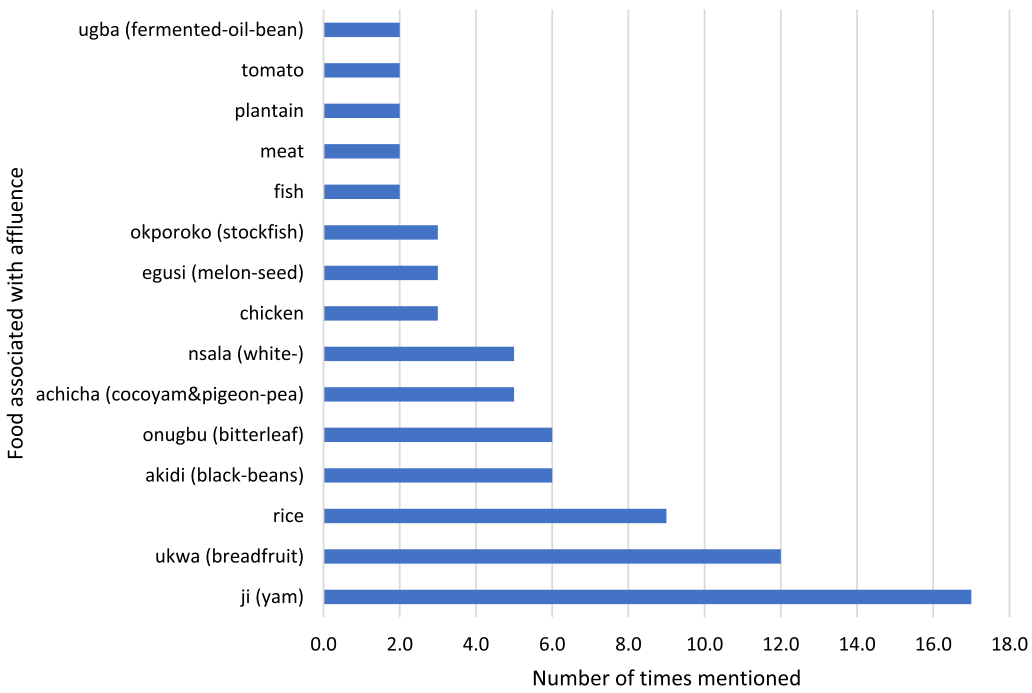

Fig. 10 Foods associated with affluence

interventions, "Parents should advise their kids on the health benefit of local dishes" and "Parents need to educate their kids on the nutrition value of Igbo food and our traditional meal," with another person

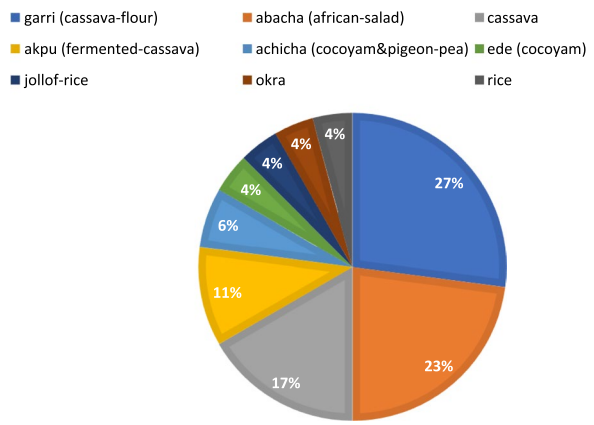

Fig. 11 Foods associated with poverty

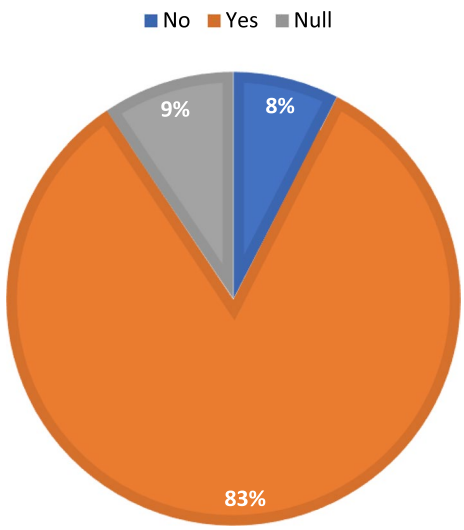

Fig. 12 Local perceptions of changing diets

declaring that: "This present generation needs to be encouraged to go back to traditional food."

Conclusion

Overall, the data analyzed from the Nigerian Demographic and Health Services and World Bank Living Standards Survey depict the Nutrition Transition in Nigeria in multiple forms. First, in the past 15 years, the combined overweight and obesity rate in Nigeria has increased by 29%. The burden of two major noncommunicable diseases—diabetes and hypertension—has similarly increased by 21%.

Concurrently, food consumption in all categories increased. The analysis of national food consumption data also displays that the fruits and vegetables consumed at a national level are primarily of introduced and non-native varieties. Very few are African in origin, likely due to the lack of market for them due to over a century of colonial and neocolonial underinvestment in indigenous fruit varieties leading to their devaluation. The absence of markets for fruits endemic to Africa is a problem that should be addressed given their proven health benefits and the role that they can play in ensuring local food security and economic development [32].

Though Nigeria's current obesity rate of 9% is concerning as it has been steadily increasing for years, it is still far behind the rate of obesity in countries farther along in the nutrition transition, including Western nations. Britain's obesity prevalence, for comparison, is currently 28%, while the USA is staggering at a sizable 42% [33]. This demonstrates that Nigeria is still worlds behind the West in terms of the status of its nutrition transition but is also illuminative that measures must be taken to curb the deterioration of the country's indigenous and healthy agri-food system, while it is still in its early stages.

The burden of diet-related chronic diseases in the Western world is similarly something that Nigeria is not prepared to deal with and should be avoided at all costs. Today, one-third of all deaths in the United States are attributable to heart disease and stroke, which alone costs the health system 214 billion USD each year in direct healthcare costs, in addition to the 138 billion USD in lost economic productivity [34]. According to the United States Centers for Disease Control (CDC), diabetes costs another 327 billion USD in medical costs and lost productivity annually. 90% of the country's nearly 4 trillion USD healthcare expenditure goes toward costs associated with chronic disease [34].

Beyond having the potential for being fiscally costly, Nigeria's rising obesity rate is especially concerning, given the fact that a large portion of the country is still underweight, which increases the country's risk of double and triple burdens of malnutrition and is destructive to national public health (30). One example that Leocádio points out is that "Contaminated environments, early childhood diarrhea and enteric pathogens have been associated with intestinal dysbiosis, increased risk of developing obesity and neurodegenerative diseases." Furthermore, obesity has been proven to contribute additional dangers to an individual who is also experiencing malnourishment or hidden hunger and children who are malnourished early in life are more likely to become obese and have metabolic disease later in life than those who are not [35].

Analysis of the traditional Igbo foodscape depicted that the cataloguing of traditional Igbo foods demonstrated how definitions of "traditional" versus "modern" are occasionally arbitrary. The "traditional" is always evolving and non-static, which is why the current identification of traditional foods and most important foods include

introduced crops [36]. All of the foods identified were natural, fresh from earth and either completely unprocessed or minimally processed through fermentation, pounding, sun-drying, or cooking. Nothing mentioned was factory-made or ultra-processed. Many of the crops listed are endemic to the region, while others are native to other continents. Cassava, for example, is native to South America, though Nigeria is now the world's largest producer of the crop. The tuber has been part of the Igbo food landscape for centuries and is prepared in locally specific ways, for example, fermented into the staple foods garri and akpu. Recently, the Nigerian government has even mandated that all bread produced in the country must contain cassava flour to boost its production.

The literature review showed that the nutrition transition in Africa is mainly displayed through the transition of traditional foods that have been shown to prevent the development of noncommunicable diseases have been replaced with foods that are directly correlated with increased incidence of noncommunicable diseases—including but not limited to processed vegetable oils, sugar, refined flours, and commercial additives [11]. This trend was displayed through the data that was analyzed for this study. Specifically, in the Igboland case study, the transition from natural superfood spices to seasoning cubes laden with artificial colors, flavor enhancers, emulsifiers, and undisclosed flavoring agents was depicted through an increase in 0–35% in perceived use of spice cubes in the parents' generation to their use.

Because of the risk factors of non-nutritional components of industrially processed foods, it is especially important to recognize that no members of the community surveyed in Enugu State listed any ultra-processed foods as being central to Igbo food culture. However, it points to why the marked shift to a reliance on processed spice cubes in Igboland is concerning.

The literature review suggested that indigenous foods are sometimes thought of as being "foods of poverty," specifically by the younger generation, which leads them to be abandoned and is a major driving factor of the nutrition transition. In this study, however, this divide was not as apparent. In contrast to the existing literature, there were not many responses indicating wild foods and indigenous vegetables as foods associated with poverty. Rather, most people when asked, "What foods do you consider the healthiest?" picked a traditional food, or even answered more generally that they believed all local foods were healthy. Additionally, the relationship between fish and meat consumption and wealth is well-documented and was expected. Notably, the significance of yam in the Igbo community is present throughout the data and is reflective of yam's long-held reputation as a wealth indicator, in part due to the difficulty of its cultivation.

Overall, the results of the data analysis demonstrate the nutrition transition in Nigeria through both primary and secondary data analysis. Obesity is rising, noncommunicable disease burdens are increasing, and some food preferences are changing. However, concurrently the interviews conducted around Enugu suggest pride and esteem in indigenous food systems, as well as their health-promoting effects with its emphasis on fresh, whole foods and extensive use of local vegetables and legumes, even though there was a consensus that Igbo food culture is changing because of the younger generation's altered tastes for processed foods and convenience.

The role of indigenous knowledge and foodways promoting health is a narrative left out of most governmental, non-governmental organization (NGO), and corporation-driven initiatives in not only Nigeria but throughout the developing world. To make lasting and impactful progress, these narrative needs to be empowered throughout local and national governments and communities where this knowledge still exists and is cherished. Further research is needed in the field to analyze the effectiveness of implementing specific changes on a grander scale, but the potential embedded in this knowledge is invaluable in the magnitude of resourcefulness alone.

As the participants made clear in their responses, illuminating the findings of the literature review, there needs to be something said about the status of investment currently in African foodways. Currently, the landscape of investment in cash crops, genetic, and biofortification in African foodways from organizations that directly threaten these peoples' livelihoods, their food traditions, and their risk for chronic disease and their economic exclusion. The billions of dollars going toward the Westernized expansion of industrial agriculture in Africa are in direct contradiction to indigenous African ways of growing and consuming healthy foods that have developed over millennia.

Indigenous people around the world already have the answers to how to live a life free from the burden of chronic diseases through their health-promoting diets and lifestyles. It is time for policy, investors, and academics to acknowledge, celebrate, and support these people in protecting their immense indigenous nutritional knowledge bases, natural resources, and food sources, to protect and promote human health, environmental sustainability, and economic independence.

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EC was contributed to conceptualization, writing, original draft preparation, reviewing and editing; WD was contributed to data curation, methodology, reviewing and editing.

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Declarations

Ethics approval and consent to participate
Ethical approval was given by the Committee of Ethical Approval in the School of Geosciences, University of Edinburgh. Informed consent was given to and signed by the participants before the data collection.

Competing interests
The authors declare no conflict of interest.

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