



ORIGINAL ARTICLE

Dietary behaviors, food accessibility, and handling practices during SARS-CoV-2 pandemic in Benin

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Abstract

Background: The COVID-19 pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is already affecting all food systems in sub-Saharan Africa including Benin. **Aim:** The study aimed to determine the dietary behaviors, food accessibility, and handling practices during the SARS-CoV-2 pandemic in Benin and the relationship between these components. **Methods:** A survey was carried out with 600 respondents in Benin. Data collected were analyzed using SAS and R statistical software. A hierarchical cluster analysis based on the characteristics of the households and their food access, utilization, and handling practices on the most significant components of AFC was then performed. **Results:** It comes out from the study that hunger and food security levels from 2000 to 2019 in Benin remain unsatisfying and inadequate. This situation had been exacerbated by the new coronavirus pandemic. About food access during COVID-19, 80% of respondents found that their dietary needs had been challenged by the COVID-19 restriction measures. This challenge affects infants as well as children, pregnant women, breastfeeding women, elderly people, and people with a chronic disease. Overall, the price of the food products had increased on the local market, and this change in the price limit the ability of 80% of households to acquire sufficient and safe food. The factorial correspondence analysis of the dietary behaviors and food handling practices during the SARS-CoV-2 pandemic in Benin discriminated three groups of households corresponding to 3 types of dietary behaviors and food handling practices. **Conclusion:** Preservation of food values chain, improvement of food environment in Benin, and nutritional support of low-resilient populations should be the main way to mitigate impacts of COVID-19 on food security, nutrition, and food safety.

Keywords: Benin, dietary behaviors, food access, hygiene, SARS-CoV-2.

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1 Introduction

The COVID-19 pandemic is a newly emerging viral disease caused by the coronavirus SARS-CoV-2 and threatening the food security and nutrition of millions of people around the world ^{1,2}. Supply chains, food and nutrition security, as well as current and future production functions, have been negatively impacted by a host of factors related to the coronavirus SARS-CoV-2 crisis. Food supply, food security, and nutrition is a basic human need and a basic requirement for survival in difficult times ^{1,3-6}. Several studies of food policies, food security, and nutrition outcomes in Sub-Saharan Africa seem to show that lack of access to sufficient nutritious food leads to health problems including under-nourishment, nutritional pathologies, immune deficiencies, stunting, illnesses, and higher child mortality rates ^{1, 7-9}. The Covid-19 pandemic is already affecting the entire food system. Restrictions on movement within and across countries can hinder food-related logistic services, disrupt entire food supply chains, and affect food availability. The impacts of the movement restriction on agricultural labor and the supply of inputs will soon pose critical challenges to food production, thus favoring food

insecurity worldwide, and especially for people living in the poorest regions of sub-Saharan Africa ¹. Indeed, millions of people were already suffering from hunger and malnutrition in sub-Saharan Africa before the SARS-CoV-2 pandemic. If no immediate action is taken to evaluate and to mitigate the impact of the Covid-19 pandemic on food security and nutrition, a global food emergency in countries of Sub-Saharan Africa including the Republic of Benin could occur. Therefore, the main challenges to achieving “global food security” in Benin are to improve the resilience of all food systems to any perturbations including the Covid-19 pandemic on the one hand and strengthen food security and nutrition governance on the other hand.

Known as Dahomey, the Republic of Benin is a country in West Africa and its capital is Porto-Novo. This country is bordered by Togo to the west, Nigeria to the east, Burkina Faso to the northwest, and Niger to the northeast. The majority of its population lives on the small southern coastline of the Bight of Benin, part of the Gulf of Guinea in the northernmost tropical portion of the Atlantic Ocean ¹⁰. Benin is a tropical nation and covers an area of

114,763 square kilometers and its population in 2018 was estimated to be approximately 11.49 million¹¹. This West-African Country is dependent on subsistence agriculture, cotton production, and regional trade as the basis of its food security as well as economic development¹²⁻¹⁴. Its agricultural development is hindered by factors such as lack of modern farming technology, poor soil, high food prices, and inadequate storage, preservation, and food processing. The country is also highly vulnerable to climate changes and recently Covid-19 pandemic, which contributes further to food insecurity and nutritional instability¹. In Benin, the number of Covid-19 cases was 597 on the 17th of June 2020. A severe pandemic causing more than a 25% reduction in labor availability could lead to great food shortages¹⁵. The quick identification of the most critical threats of the Covid-19 pandemic to the food systems of Benin is necessary to implement sustainable mitigation measures.

The study aimed to determine the dietary behaviors, food accessibility, and handling practices during the SARS-CoV-2 pandemic in Benin and the relationship between these components. Specifically, it is to:

- Describe the status of food security and nutrition in Benin before the Covid-19 pandemic;
- Evaluate the food accessibility of the households during the SARS-CoV-2 pandemic in Benin;
- Characterize the dietary behaviors and the food handling practices in the homes and restaurants during the SARS-CoV-2 pandemic in Benin.

2 Subjects and Methods

2.1 Study area

The survey on the characterization of the dietary behaviors, food accessibility, and handling practices during the SARS-CoV-2 pandemic in Benin was carried out in the Departments of Alibori, Atacora, Atlantic, Borgou, Collines Couffo, Donga, Littoral, Mono, Ouémé, Plateau, and Zou. This study area covered all the 12 Department of the Republic of Benin affected by the SARS-CoV-2 pandemic. With an area of 112622 km² (CountryStat, 2012), the Republic of Benin is limited by the Niger River in the north, in the northwest by Burkina Faso, in the west by Togo, in the east by Nigeria, and in the south by the Atlantic Ocean. The Departments of Borgou, Alibori, Atacora, Donga, and Collines are characterized by one dry season and one rainy season with an average pluviometry ranging from 900 to 1300 mm/year. The Departments of Atlantic, Littoral, Oueme, Plateau, Mono, Zou, and Coufo are characterized by two rainy seasons: the high from April to July and the small from September to November. These two rainy seasons are interspersed with dry seasons. The average pluviometry is about 1200 mm/year¹⁶.

2.2 Methodology

2.2.1 Analysis of food security in Benin before the pandemic of Covid-19

The analysis of food security in Benin before the pandemic of Covid-19 from 2000 to 2019 was made from the data collected and adapted from the database of FAOSTAT¹⁷ on the food security indicators values of Benin (2020) and FAO-WFP¹.

2.2.2 Characterization of dietary behaviors, food accessibility, and handling practices

For the study of the dietary behaviors, food accessibility, and handling practices during the SARS-CoV-2 pandemic in Benin, data collection was carried out among households by using a survey guide. The survey guide gathered the following information: socio-demographic profile of the respondents, government measures observed during COVID-19, food access, dietary changes during the COVID-19, food handling changes during SARS-CoV-2 pandemic, food quality management standards used, and adaptation mechanisms. During the survey, the respondents were invited to remember themselves the different changes in their food environment, food handling practice, and dietary behaviors since the occurrence of the SARS-CoV-2 pandemic and the coping measures used. A sample of 124 households and 600 respondents were surveyed throughout the country. After the interview, the answers obtained from the survey guide were encoded and analyzed.

2.3 Statistical analysis

After examination of the database, the collected data were analyzed using R and SAS software¹⁸. The Proc corresp procedure of SAS was used for factor analysis (CFA). The variables taken into account were the sociodemographic profile of respondents, their occupation, their residence, the dietary changes during Covid-19, adaptation measures used, food preparation practices, food supply point, food quality standards or rules applied, the score of application of the 5 keys for safe food, number of infants (less than 6 months old), number of children (6 months - 5 years old), number of pregnant women, number of breastfeeding women, number of elderly people (65+ years old), number of daily meals, household's monthly income in US Dollars.

A hierarchical cluster analysis based on the characteristics of the households on the most significant components of AFC was then performed. The groups of households were then identified and each group corresponds to one a type of food handling practice and dietary behavior. For quantitative variables, analysis of variance at a single factor was used and the type of food handling practice was the only source of variation. The variables considered were the age, the number of people living by household, the number of infants of less than 6 months old, the number of children of 6 months to 5 years old, the number of pregnant women, the number of daily meals and the household's monthly income in US Dollars. The Proc GLM procedure was used for the

analysis of variance and the F test was used to determine the significance of the effect of the food handling practice type on the variables. The means were calculated and compared by the student t-test. The frequencies were calculated by Proc freq procedure of SAS (2006) and a confidence range (ICP) was calculated for each frequency as follow:

$$ICP = 1,96 \sqrt{\frac{[P(1 - P)]}{N}}$$

P: the relative frequency; N: the sample size.

3 Results

3.1 Sociodemographic profile of the household respondents

Table 1 shows the sociodemographic profile of the respondents. It appears that equal numbers of males and females, 300 each were sampled. The overall sample used herein is relatively young, with 90 percent under the age of 50. Twenty-five percent of the respondents have completed primary school, while 16.67 percent have not attended school or have received informal education only. Sixteen percent of them had completed Secondary graduation and 42 percent of the sample had completed university graduation. A proportion of 49 percent of the sample was employed full time while 51 percent were unemployed. The sample included 62.5 percent of urban respondents and 37.5 of rural. About 23 percent reported their occupations as in agriculture, animal husbandry, forestry, or fishing. Thirty-four percent of them are Professional of food security and nutrition while 19 percent were a student or housewife. The traders represent about 16 percent of the sampled population.

3.2 Food security status in Benin before the pandemic of Covid-19

The kinetics of Hunger and food insecurity indicators in Benin from 2000 to 2019 is given in figure 1a. It appears that the number of people undernourished decreased from 1.2 million in the year 2000 to 0.8 million in 2019 (3-year average). The prevalence of undernourishment ten years ago of 17.4% decreased to 7.4% in 2019. About food availability, the Average protein supply increased from 55.7 g/capita/day to 66.3 g/capita/day from 2000 to 2019. The average supply of protein of animal origin (g/capita/day) increased from 9 g/capita/day to 16 g/capita/day from 2000 to 2019.

Table 1: Sociodemographic profile of the household respondents

Variables	Absolute frequency (N)	Percent	Confidence range
Gender			
Male	300	50	4.00
Female	300	50	4.00
Education			
No formal or informal schooling	100	16.67	2.98
Primary school completed	150	25	3.46
Secondary /college /graduation	100	16.67	2.98
University graduation	250	41.67	3.94
Religion			
Christian	312	52	4.00
Muslim	208	34.67	3.81
Other	80	13.33	2.72
Employment			
Unemployed or self-employed	120	20	3.20
Employed part time	185	30.83	3.70
Employed full time	295	49.17	4.00
Residence			
Urban	375	62.5	3.9
Rural	225	37.5	3.87
Age			
18 through	225	37.5	3.87
30 through	315	52.5	4.00
50 and over	60	10	2.40
Occupation			
Agriculture	135	22.5	3.34
Professional of food security and nutrition	205	34.17	3.79
Retail Shop	20	3.33	1.44
None/ student/ housewife	115	19.17	3.15
Trader/hawker/vendor	95	15.83	2.92
Unskilled labor	30	5	2.40

Similarly, Average dietary energy supply adequacy increased from 108 to 124 %. The average value of food production passed from 187 constant I\$ per person during the year 2000 to the value of 214 constant I\$ per person in 2019. As for food access, the gross domestic product per capita (constant 2011 international \$) in Benin was on average of 2478.2\$ in 2000. This value increased progressively from 2000 to 2019 and reached 3287.3\$.

Table 2: Food access in households during Covid-19

Variables		N	Percent	Confidence range
Household dietary needs challenged by the COVID-19 restriction measures	Yes	480	80	3.20
	No	120	20	3.20
Evidence of fear of famine in the upcoming months because of the COVID-19	Yes	480	80	3.20
	No	120	20	3.20
Storage of food in a larger quantity than usual during COVID-19	Yes	480	80	3.20
	No	20	3.33	1.44
Food bought in a larger quantity than usual during the COVID-19 pandemic	Grains (Cereal) & starchy foods	120	20	3.20
	Dairy products	40	6.67	2.00
	Meat, poultry, fish	120	20	3.20
	Fruits and vegetables	60	10	2.40
	Legumes	120	20	3.20
	Oils & fats	120	20	3.20
	Sugars	120	20	3.20
Perception of growing inflation in the price of food products during Covid-19	Grains (Cereal) & starchy foods	540	90	2.40
	Dairy products	35	5.83	1.88
	Meat, poultry, fish	56	9.33	2.33
	Fruits and vegetables	600	100	0.00
	Legumes	600	100	0.00
	Oils & fats	60	10	2.40
	Sugars	240	40	3.92
	Drinking	0	0	0.00
Food access problems happened because of COVID-19	Bred	0	0	0.00
	Canned goods	120	20	3.20
	Limited access to water	0	0	0.00
	Access to a less variety of food	420	70	3.67
	Access to food of a lesser quality	325	54.17	3.99
	Limited quantity of food available in the region	120	20	3.20
	Food rationed by the local government in the region	0	0	0.00
Adaptation measures used	Necessity to drive/walk a longer distance to acquire food	60	10	2.40
	Evidence of fear of contamination by the SARS-CoV-2 virus throughout feeding	560	93.33	2.00
	Reduction of food waste	600	100	0.00
	Limitation of portion size at meal times	480	80	3.20
	Limitation of attendance at restaurant	480	80	3.20
	Consumption of seed stock held for next agricultural season	85	14.17	2.79
	Reduce number of meals eaten in a day	30	5	1.74
Rely on less preferred and cheaper foods	18	3	1.36	
Reduction of adult consumption	68	11.33	2.54	

It is important to indicate that the rail lines density (total route in km per 100 square km of land area) of Benin, which was 0.4 during 2003 increase to 0.7 in 2006. Regarding food utilization, the percentage of the population using at least basic drinking water services decreased from 61.5 to 16.5 from 2000 to 2019. The percentage of child malnutrition (under 5 years of age) decreased from 36.2% in 2000 to 32.2% in 2018. Furthermore, the percentage of child malnutrition decreased from 36.2 to 1.9 from 2000 to 2019.

The main challenges to achieve “global food security” in Benin are to improve the resilience of all food systems and food values chain to any perturbations including the Covid-19 pandemic on the one hand and strengthen food security governance and nutrition leadership on the other hand.

3.3 Food accessibility and handling practices during SARS-CoV-2 pandemic in Benin

The Benin government confirmed its first outbreak of the disease in the country on 16 March 2020. The government measures imposed during the COVID-19 pandemic in Benin are travel ban, supermarkets closed, food and drink outlets closed, social distancing, and home confinement. The government also proposed hygienic measures to prevent the spread of disease, such as isolation, washing hands, quarantine, burning clothes worn by the infected persons, and wearing facemasks to prevent the inhalation of germs.

Table 3: Dietary changes in households during Covid-19

	Variables	N	Percent	Confidence range
Food supply point before COVID-19 pandemic	Respondent own farm/garden	85	14.17	2.79
	Farmers' market	600	100	0
	Open market	600	100	0
	Supermarket	240	40	3.92
	Street vendors	325	54.17	3.99
	Online delivery	0	0	0
	Shops (grocery store, butcher shop...)	540	90	2.40
Food supply point during COVID-19 pandemic	Respondent own farm/garden	85	14.17	2.79
	Farmers' market	600	100	0
	Open market	56	9.33	2.33
	Supermarket	30	5	1.74
	Street vendors	60	10	2.40
	Online delivery	85	14.17	2.79
	Shops (grocery store, butcher shop...)	18	3	1.36
Change in the consumption of the following foods happened because of COVID-19	Grains (Cereal) & starchy foods	0	0	0.00
	Dairy products	420	70	3.67
	Meat and poultry	325	54.17	3.99
	Fish	325	54.17	3.99
	Fruits	325	54.17	3.99
	Vegetables	325	54.17	3.99
	Legumes	60	10	2.40
	Oils & fats	60	10	2.40
	Sugars	60	10	2.40
Food preparation practices affected by COVID-19 related measures	Food preparation (time)	600	100	0.00
	Food shopping (frequency)	600	100	0.00
	Food hygiene	600	100	0.00
	Household eating patterns (time of meals, etc.)	85	14.17	2.79
	Number of meals (Per day)	30	5	1.74
	Quality of diet (use of fresh foods)	18	3	1.36
	Food storage and preservation (time)	325	54.17	3.99
Breakfast, Lunch and Dinner eating point before Covid-19	Home	600	100	0.00
	Take away (or delivery)	600	100	0.00
	At the office (home prepared food)	600	100	0.00
	Office/or work or school canteen	600	100	0.00
	Restaurant	600	100	0.00
	Fast-food outlet	600	100	0.00
Breakfast, Lunch and Dinner eating point during Covid-19	Home	600	100	0.00
	Take away (or delivery)	325	54.17	3.99
	At the office (home prepared food)	85	14.17	2.79
	Office/or work or school canteen	60	10	2.40
	Restaurant	60	10	2.40
	Fast-food outlet	18	3	1.36

N: Absolute frequency

These measures were reported by all respondents (100%). About food access during the COVID-19 pandemic in Benin, 80% of respondents found that their dietary needs had been challenged by the COVID-19 restriction measures (table 2). This challenge affects infants (less than 6 months old) as well as children (6 months - 5 years), pregnant women, breastfeeding women, elderly people (65+ years old), and people with a chronic disease. They were all concerned that their household would not have enough food in the upcoming months because of the COVID-19 crisis. The main difficult situations that happen because of COVID-19 reported by the respondents were their access to a less variety of food, their access to food of lesser quality due to the limited quantity of food available in their region. No water access difficulty was reported during the

COVID-19 pandemic in the current survey (100%). A proportion of 20% of respondents buys food such as meat, poultry, eggs, fish, legumes, beans, cereals, fruits, vegetables, canned goods in a larger quantity than usual during the COVID-19 pandemic. Figure 1b shows the price changes of food products with the number of confirmed cases of covid-19 in Benin. Overall, the price of the food products had increased on the local market, and this change in the price limit the ability of 80% of households to acquire sufficient and safe food. Indeed, the price of the rack of tomatoes increased drastically from 10,000f before Covid-19 to 20,000f during Covid-19. Similarly, the price of the onion rack increase from 14,000f to 21,000f on average. Furthermore, the price of one bag of pepper increased considerably from 18,000f to 80,000f. The same trend

was observed for legume, meat, and in a lesser stand for eggs (figure 1b).

3.4 Dietary changes during the COVID-19

The dietary changes in households during Covid-19 are given in table 3. It appears that the respondents' food supply point before the COVID-19 pandemic were mainly farmers' market, open market, supermarket, street vendors, and shops (40 to 100 percent). During the Covid-19 crisis, the respondents of the sampled households exploit their farm/garden and limit their food supply points to the farmer's market and avoid supermarkets, street vendors, and shops. Online delivery of food

products is more developed during the covid-19 pandemic (14.17% vs 0%). The changes in food consumption happened because COVID-19 are more observed in the utilization of dairy products, meat, poultry, fish, and vegetables because of the increase in their selling price.

About food preparation practices, the most affected by COVID-19 related measures are the time of food storage and preservation, the time of food preparation, the frequency of food shopping, the food hygiene, and the time of meals of household eating patterns. Indeed, figure 2a reveals that the score of application of the 5 keys for safe food by the surveyed households had increased during the Covid-19 pandemic.

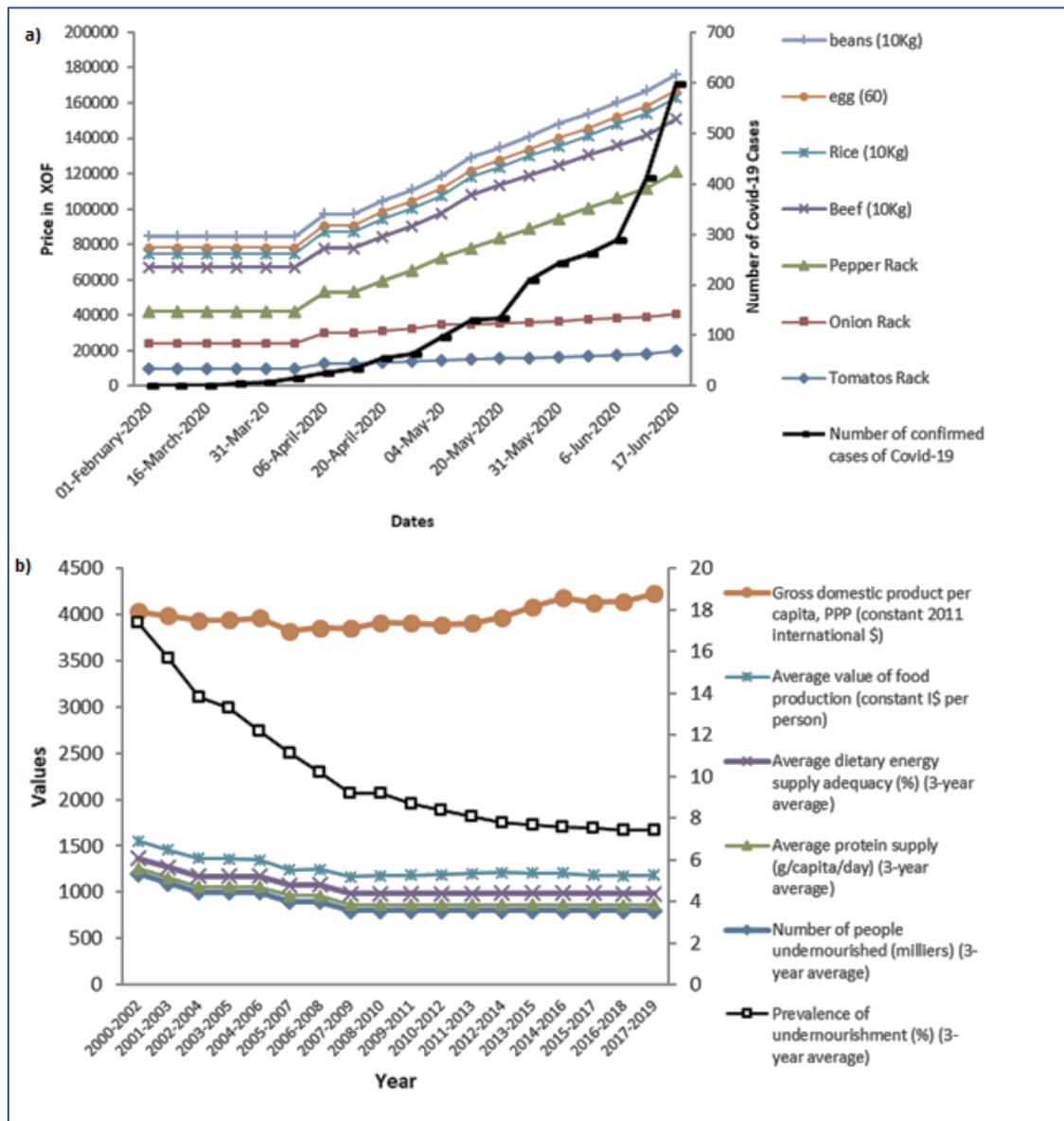


Figure 1: a) kinetics of Hunger and food insecurity indicators in Benin from 2000 to 2019, Source: adapted from FAOSTAT¹⁷ and FAO-WFP¹; b) Price changes of food products with the Number of confirmed cases of covid-19

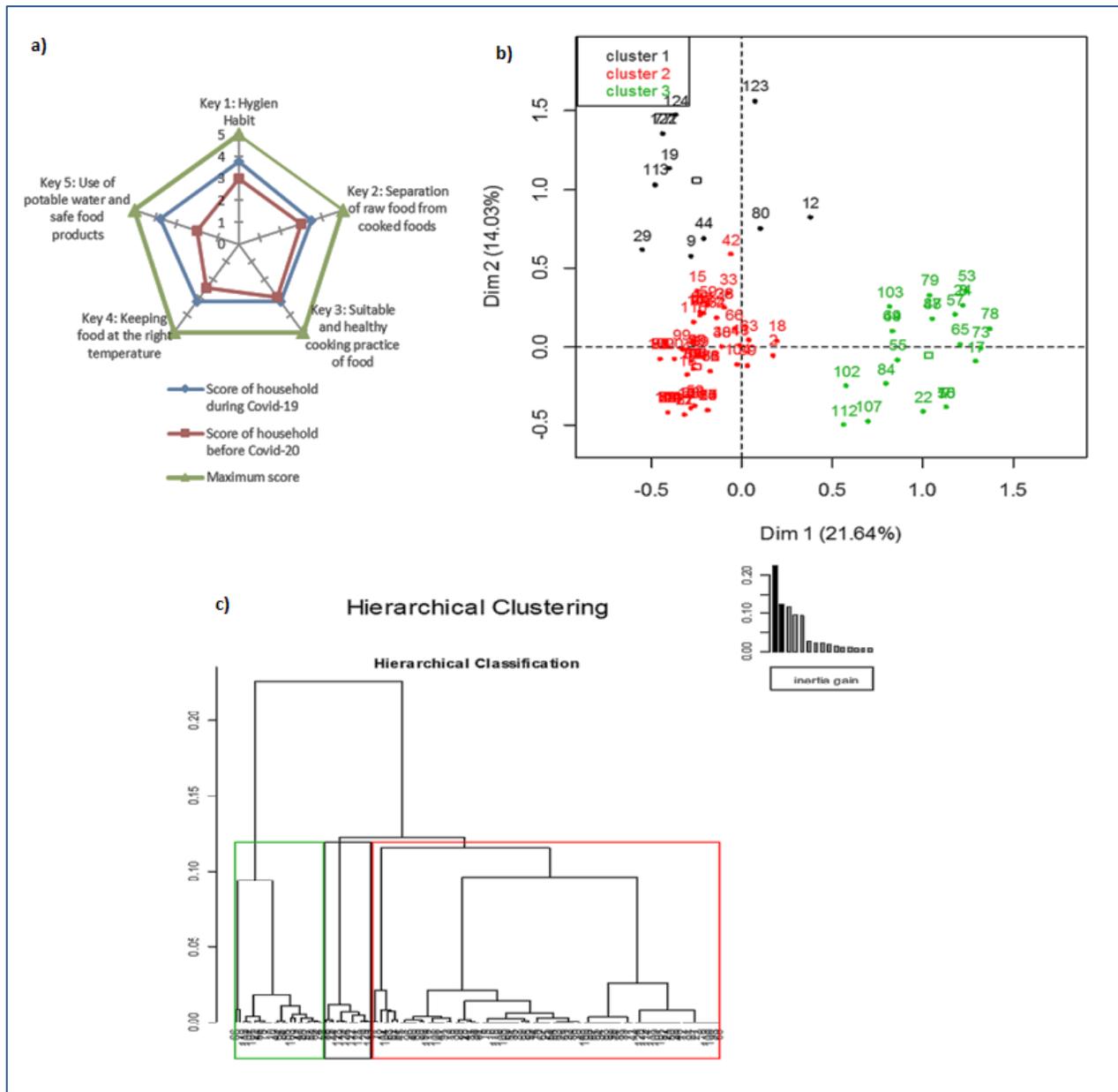


Figure 2: a) Score of application of the 5 keys for safe food before and during Covid-19 pandemic; b) Typology of Dietary behaviors and food handling practices during SARS-CoV-2 pandemic in Benin; c) Dendrogram of the three groups of dietary behaviors and food handling practices

3.5 Typology of Dietary behaviors and food handling practices during SARS-CoV-2 pandemic in Benin

The results of the factorial correspondence analysis of the dietary behaviors and food handling practices during SARS-CoV-2 pandemic in Benin are given by group of households in Figure 2b. Three axes were selected for the interpretation of the correspondence analysis results. Each axis corresponds to a group of households and each group corresponds to a type of dietary behaviors and food handling practices. Group 1 corresponds to the dietary behavior type 1, group 2 to the

dietary behavior type 2 and group 3 to the dietary behavior type 3. Thus, three Types of dietary behavior were identified.

Type 1 corresponds to household who have not attended school or have received informal education only and includes farmers, artisans and housewives. They are distributed in almost all departments of Benin and constitute 10% of the surveyed population. They exploit their own farm, garden and livestock products as food and limit their food supply points to the farmer’s market and street food vendors. The average number of people living by household is 8.6 including infants, children, pregnant women and other family members. In this group, the

number of daily meals is 2 (Lunch and Dinner). They do not have material (refrigerator) for food preservation. They have no knowledge of any food quality standards and good hygiene practices. The five keys for safe food and health are not practiced. In this type, the households have reduced considerably their consumption of dairy products, meat, fish, egg, fruits, and legumes during the SARS-CoV-2 pandemic in Benin. The household's monthly income in US Dollars is on average 105.

In Type 2, the households had completed primarily and mostly Secondary or college graduation, and include traders and restorers. They are distributed in almost all urban zones of the study area and constitute 20.2% of the surveyed population. The households exploit farmers' market and open market as food supply point. The average number of people living by household is 6.2 including infants, children, and their parents. The number of daily meals is 3 (Breakfast, Lunch and Dinner). The households own materials (refrigerator and freezer) for food preservation. Hygiene rules and the five keys for safe food and health are known and practiced. In this type, the households have reduced considerably food waste during the SARS-CoV-2 pandemic in Benin. The household's monthly income in US Dollars is on average 318.5.

Finally, in Type 3, the households had completed university graduation, and include professional of food security and nutrition, lecturer-researchers, teachers, and PhD students. They are distributed in urban zones of the departments of Atlantic, Borgou, Collines, Oueme and Littoral. They represent 69.8% of the surveyed population. Their main food supply points are supermarkets, shops, online delivery, and farmers' market. The average number of people living by household is 3.4 including children and their parents. The number of daily meals is 4 (Breakfast, Lunch Tea and Dinner). They own materials (refrigerator and freezer) for food preservation. Food quality and safety concerns as Hygiene rules and the five keys for safe food and health are well known and practiced. In this type, the households have reduced considerably open market frequentation during the SARS-CoV-2 pandemic in Benin. The household's monthly income in US Dollars is on average 1085. The dendrogram of the three groups of dietary behaviors and food handling practices during SARS-CoV-2 pandemic in Benin are given by group of households in Figure 2c.

4 Discussion

4.1 Food security status in Benin before the pandemic of Covid-19

Food insecurity is a worldwide concern, and sub-Saharan Africa is the world region with the highest hungry populations. The republic of Benin is one of the poorest and hungriest sub-Saharan Africa countries. The current research revealed that hunger and food insecurity level, food availability, food access and utilization from 2000 to 2019 in Benin remain unsatisfying

and inadequate despite the progress observed from 2000 to the outbreak of Covid 19 pandemic. According to FAOSTAT ¹⁷, the prevalence of anemia among women of reproductive age (15-49 years) decreased from 65.3 to 46.9% from 2000 to 2019. However, prevalence of obesity in the adult population of Benin (18 years and older) increased from 5 to 9.6% from 2000 to 2019. This description of the food security status of Benin from 2000 to 2019 might be affected by the current worldwide crisis of SARS-CoV-2.

This description of the food security status of Benin from 2000 to 2019 might sadly be affected by the current worldwide crisis of SARS-CoV-2 ¹. The main challenges to achieve global food security in Benin may be to improve the resilience of all food systems to any perturbations including Covid-19 pandemic on the one hand and to strength food security and nutrition governance and functional food value chains on the other hand. This relatively low food security level of Benin is also reported in the literature. According to WHO ¹⁹, malnutrition is the 88th leading cause of death in Benin, and the 10th leading cause of total deaths in the country; the country ranks 23rd in the world in this category. According to the World Food Program ¹³, 16 % of children under 5 years old in Benin suffer from acute malnutrition and 45 percent of that same age group are described as chronically malnourished ⁹. As Clover ⁷ suggested, despite the fact that the right to food is one of the most consistently acclaimed assertions in international human rights law, no other human right has been so frequently and spectacularly violated. Her discussion of food insecurity in Sub-Saharan Africa indicates that hunger is a multi-faceted issue in this part of the continent, and that just growing more food will not eradicate the problem.

The food insecurity indicators highlighted in the current section also confirm the results of Fry ²⁰ that highlight the role of poverty as the root cause of hunger in Benin. Their study found support for the notion that farmers are hungrier than other respondents, but gender and urban-rural differences disappeared in the analysis. Agricultural development and food processing may be promoted. According to the World Food Program ¹³, agricultural development in Benin is hindered by factors such as lack of modern production technology, poor soil, high food prices and inadequate storage, preservation and food processing. This country is also highly vulnerable to natural disasters which contribute further to nutritional instability.

4.2 Food accessibility and handling practices during SARS-CoV-2 pandemic in Benin

The sociodemographic profile of the household respondents of the current study is consistent with the finding of Fry ²⁰. About food access and handling practice, it comes out from the current study that COVID-19 pandemic has affected various aspects of everyday life, including food availability and access. Indeed, the survey shows that the COVID-19 pandemic has affected food security, food handling practices and food supply in different households of Benin. These findings confirms the

previsions of FAO-WFP ¹ who had indicated that the essential protective measures recommended by the WHO ²¹ to limit the spread of Coronavirus (Covid-19) will reduce drastically household productivity and incomes. They add that disruptions in trade and in local food supply chains are already affecting the well-being of the households, food security and nutrition among importing countries and food prices will increase, especially nutritious food. These authors had also prevented that hunger and malnutrition will increase as the livelihoods of the poor will be affected during Covid-19 pandemic ¹. This vulnerability of food systems in Benin is partially due to the weak performance of its agricultural system. According to the World Food Program ¹³, Benin relies on agriculture as the basis of its food security as well as economic development. Agricultural development is hindered by factors such as lack of modern farming technology, poor soil, high food prices and inadequate storage, preservation and food processing. The country is also highly vulnerable to natural disasters and viral diseases, like flooding and drought and recently Covid-19, which contribute further to nutritional instability.

In the current study, it appears that some households have reduced their number of meals per day. The basis of a balanced diet is also the number of meals per day ¹. In relation to the frequency of food intake, FAO ¹² recommended to take 4 meals per day: breakfast, lunch, afternoon tea and dinner. This finding confirms the report of FAO ² which indicated that the negative impact of the COVID-19 crisis on household well-being will be significant. It estimates that welfare losses in 2020 are already at 7% compared to a COVID-19-free scenario and could exceed 10% if the crisis continues. The deterioration of the terms of trade (following the collapse of commodity prices) combined with a decline in employment has resulted in a significant loss of well-being for households. Strategies resulting in sub-regional trade blockages will increase transaction costs and lead to even greater welfare losses.

Therefore, nutritional support for households is needed. The importance of nutrition in the body's response to bacterial and viral infections is widely documented ²²⁻²⁷. Nutrition is a fundamental element in the functioning and maintaining of our immune system integrity and remains closely associated with immunity and host resistance against any infectious agent especially among vulnerable individuals (elderly, pregnant, and infant groups) ³. Furthermore, it would be healthy to promote good cooking practices during Covid-19 crisis as a key to achieving an acceptable meal quality in households. Therefore, it is important to cook food thoroughly in order to kill any microbes present. But households must avoid overcooking vegetables. Cooking food improves digestion and increases the absorption of many nutrients ²⁸⁻³². For example, cooked egg protein is 180% more digestible than raw egg protein ^{1, 29}. However, some cooking methods reduce several key nutrients in the food. Nutrients content such as water soluble vitamins (vitamin C and vitamins B - thiamine (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), folic acid

(B9) and cobalamine (B12)); fat-soluble vitamins (vitamins A, D, E and K) and minerals in this case potassium, magnesium, sodium and calcium) are often reduced during cooking ²⁸. To fry food, households must avoid a long frying time at a high temperature and use the healthiest oils for frying. Overall, cooking for a short time without water prevents the loss of vitamin B and the addition of fat improves the absorption of plant compounds and antioxidants ^{1,26,27,33,34}.

During the current study, households' willingness and efforts to improve their food handling practice and mainly their food hygiene is related to their fear to be contaminated by the SARS-CoV-2. Food safety and food hygiene are both very important for household health. According to several authors, inadequate consumer hygiene habits are responsible for survival, microbial growth, and cross-contamination ^{1,35-38}. Cross-contamination (generally from raw foods to ready-to-eat foods) is a major cause of food-borne disease outbreaks and poisoning ^{1,35-38}. Poor food handling behaviors are associated with acute foodborne gastroenteritis ³⁵⁻³⁸.

5 Conclusion

The results of the current survey reveal that hunger and food security level from 2000 to 2019 in Benin, remain unsatisfying and inadequate. This situation had been exacerbated by the new coronavirus pandemic. About food access during COVID-19, 80% of households found that their dietary needs had been challenged by the COVID-19 restriction measures. This challenge affects infants as well as children, pregnant women, breastfeeding women, elderly people and people with a chronic disease. Overall, the price of the food products had increased on the local market and this change in the price limit the ability of 80% of household to acquire sufficient and safe food. The factorial correspondence analysis of the dietary behaviors and food handling practices during SARS-CoV-2 pandemic in Benin discriminated three groups of households corresponding to 3 types of dietary behaviors and food handling practices.

Benin's governments must develop new strategies to improve food and nutrition security governance, supply the food needs of their low-resilient populations, preserving food value chains and ensuring the fluidity of food supply chains to effectively mitigate the impacts of COVID-19 on food security and nutrition in the country.

The limitation of the current study is the relatively weak size of the surveyed population.

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