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Self-Reported Food Poisoning Potentially Associated with Chemical Pesticide Residues in Fruits and Vegetables: Evidence from Major Urban Areas of Cameroon

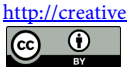
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Abstract

The widespread use of pesticides in African agriculture raises concerns about pesticide residues in food and their potential effects on consumer health. This study examines the socioeconomic, behavioral, and health-seeking factors of self-reported food poisoning among urban consumers of fresh fruits and vegetables in three major cities of Cameroon. Using a retrospective cross-sectional design, 700 consumers were surveyed between March and July 2025. Health problems related to food poisoning and socio-demographic data are the main informations collected during the interview. The results show that 269 consumers (38% of respondents) have reported suffering at least one food poisoning as a result of consuming potentially contaminated fruits or vegetables. The MCA indicated that respondents who claimed to have suffered from food poisoning were more frequently younger than 35 (18 - 30 yrs.), with a relatively modest income level (less than 100 - 150 k/month). They do not make regular medical visits, they consume an average of 300g of fruit and vegetables per day and generally have no idea about the origin of the food they eat. Probit estimates showed that absence of regular medical consultation increased the predicted probability of reported poisoning by 0.27, while lack of knowledge of food origin increased it by approximately 0.10. Among respondents reporting poisoning, traditional medicine and self-medication were associated with approximately 0.18 and 0.21 higher probabilities of recurrent poisoning, respectively, compared with conventional medical treatment. These findings identify socioeconomic, behavioral, and food-traceability factors as-

sociated with reported food poisoning. Because pesticide exposure and clinical diagnoses were not independently confirmed, the findings indicate associations rather than causality. Strengthening pesticide-residue surveillance, food traceability, consumer awareness, and access to appropriate healthcare could improve food safety in Cameroon.

Keywords

Pesticides Residues, Food Consumed, Humans' Health, Cameroon, Probit Regression

1. Introduction

As in most developing countries, human health threats related to food quality in Cameroon are increasingly becoming a major concern among consumers. Chemical residues on fruits and vegetables are at the central concern of these apprehensions. Although synthetic pesticides contribute to supplying diverse classes of foods for household consumption, the presence of their residues represents a source of short- or long-term food poisoning. According to [1], about 2.7 million lives could be saved each year through the consumption of organic foods (fruits, vegetables, and cereals). In the literature, several authors have confirmed a direct relationship between non-organic food production/consumption and the occurrence of food poisoning cases among populations [2]-[6].

However, in Cameroon, main studies on chemical pesticide effects have so far focused on the occupational exposure of agricultural producers and applicators, whereas the clinical effects of pesticide intake are just as significant for urban consumers [7]. Symptoms such as nausea, vomiting, diarrhea, dizziness, and convulsions are frequently reported as recurrent poisoning indicators among consumers [8]. Driven by strong market demand and a widespread lack of awareness regarding chemical toxicity, farmers frequently harvest produce without respecting safety waiting periods. Furthermore, although clear guidelines on proper pesticide use are embedded in Cameroon's regulatory framework and explicitly stated on product labels, enforcement regarding residue levels on crops remains remarkably weak [9] [10]. Constant evolution of the pesticide industry requires closer surveillance and better assessment of factors including bioaccumulation, stability, widespread usage, and food safety [11]. This regulatory gap exacerbates the lack of scientific oversight, leaving empirical data on pesticide residue levels and consumer health impacts in Cameroon remarkably scarce [8] [9].

Empirical evidence across developing countries underscores that pesticide residues constitute a significant driver of food poisoning [12] [13]. For instance, in Uganda, [14] assessed pesticide residues in 160 fruit and vegetable samples from street sellers, restaurants, and homes in Kampala, detecting over 39 harmful active ingredients and highlighting that dietary exposures were highest among the youngest participants. In acute cases, such contamination can be fatal; [15] investigated

the death of five family members in Burkina Faso 24 hours after consuming contaminated vegetables, identifying toxic levels of *Fipronil* and *Lambda-cyhalothrin*. Similarly, in Nigeria, [16] assessed DDT[1] residues in commonly consumed vegetables and found hazard indices exceeding acceptable standards (Hazard Index > 1) for both children and adults. Multi-residue evaluations in Asia and North Africa further demonstrate the ubiquity of contamination: [17] detected *organophosphate* and *carbamate* residues in Dhaka, Bangladesh, while [18] [19] identified elevated pesticide levels in 29% of 506 fruit and vegetable samples in Egyptian wholesale markets. Conversely, studies in Kumasi, Ghana [20] [21] noted that while residues were present in tomatoes, estimated health hazard indices remained below critical threat thresholds.

Despite this global and regional literature, addressable empirical evidence focusing specifically on the socioeconomic determinants and health-seeking behaviors associated with self-reported food poisoning among urban consumers in Cameroon remains practically embryonic. Given that urban consumers suffer daily from chemical food contamination [9], it is essential to bridge this gap by examining consumer profiles within this context.

Hence, the aim of this study is to identify which consumer profiles and behaviors are associated with higher probabilities of self-reported food poisoning in an urban context where chemical pesticide residue contamination is potentially hazardous. Following this introduction, the paper presents the data and methodology, discusses the empirical findings, and concludes with key policy implications.

2. Materials and Methods

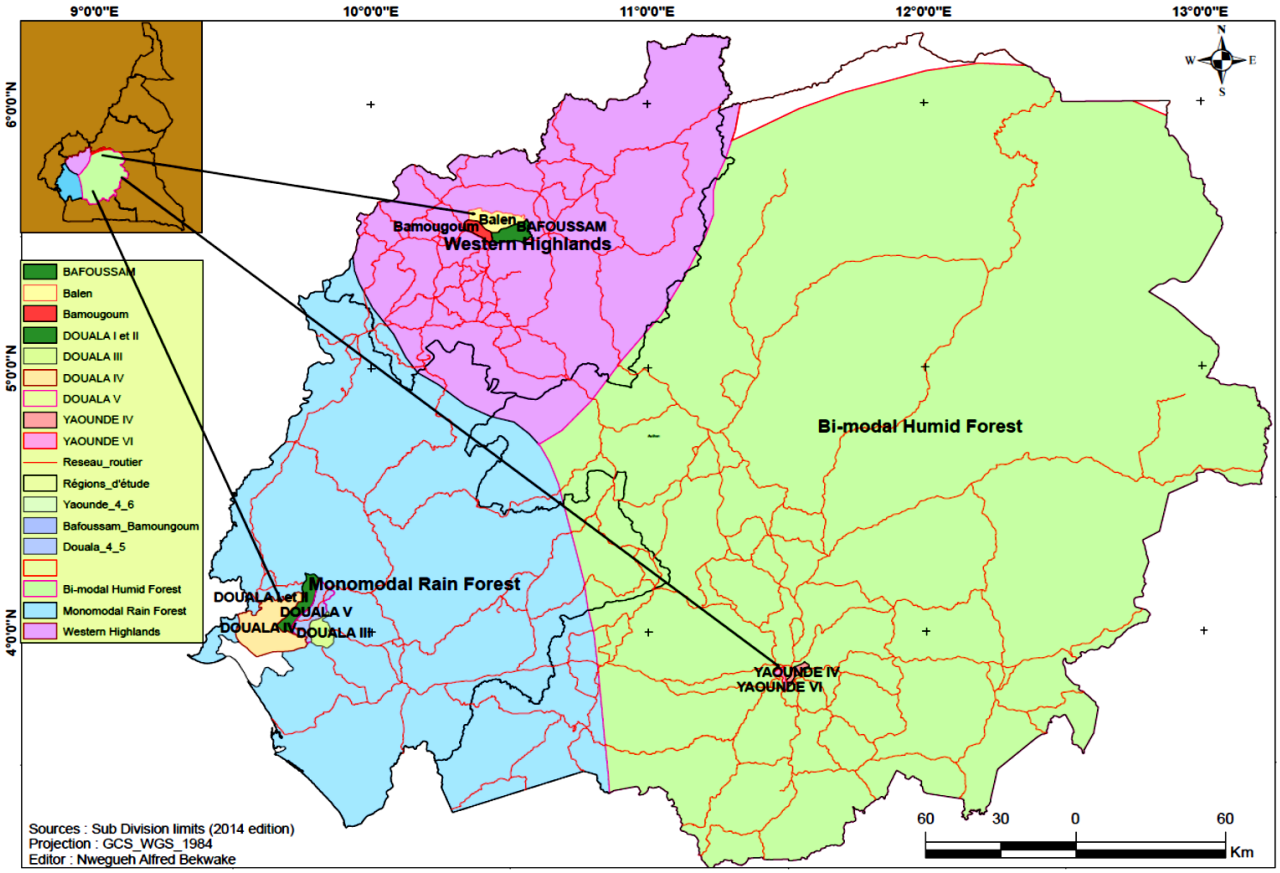
2.1. Study Areas and Sampling Technics

In a socioeconomic context where access to quality food can be complex in some respects, our problematic concerning the consumption of fruit and vegetables led us to work exclusively with consumers in urban areas. The unit of observation here is the consumer of fruit and vegetables residing in one of the intervention cities, namely: Yaounde, Douala or Bafoussam (**Figure 1**).

The map illustrates the geographical distribution of the three study areas within Cameroon.

The map was produced by Bekwake Alfred in ArcGIS from GPS coordinates collected in the field and Open Street Map contributors, (ODbL licence). One group of respondents was targeted in the sample, namely the consumer who had self-reported suffered food poisoning following the consumption of a potentially contaminated fruit and vegetable. However, we also included individuals who had self-reported never been poisoned in order to determine whether they adopted particular strategies to protect themselves from food poisoning. Thus, 700 consumers were interviewed, 269 of whom had self-reported suffered at least one poisoning and 431 indicated that they had never suffered from food poisoning (**Table 1**).

[1]DDT define as Dichlodiphenyltricoloethane.



Source: Alfred Bekwake's design.

Figure 1. Map of the cities surveyed.

Table 1. Distribution of consumers giving cities surveyed.

Region	Survey city	Municipalities	Total number	Percentages of consumers (%)	
				Self-reported poisoned	**Self-reported not poisoned**
Center	Yaounde	Yaounde IV	140	38 (14.12%)	102 (23.66%)
		Yaounde VI	130	34(12.63%)	96 (22.27%)
		270	**(26.76%)**	**198 (45.93%)**	
Littoral	Douala	Douala IV[e]	100	30 (11.15%)	70 (16.24%)
		Douala V[e]	120	45 (16.72%)	75 (17.40%)
		220	**(27.88%)**	**145 (33.64%)**	
West	Bafoussam	Bafoussam III[e]	105	40 (14.86%)	65 (15.08%)
		Bamougoum	105	82(30.48%)	23 (5.33%)
		210	**(45.35%)**	**88 (20.41%)**	
		700	**(38.42%)**	**431 (61.57%)**	

The surveys conducted aimed to characterize the consumption of fruit and vegetables and to identify main factors of food poisoning cases. The cities of Yaounde Douala and Bafoussam were chosen to carry out our surveys. These choices were justified by the fact that they are home to a fairly cosmopolitan population, which

comes from all the other regions of the country and traditionally consumes fresh fruit and vegetables. Our sample of consumers in the intervention cities was chosen to cover a wider range of socioeconomic profiles. A non-probability purposive sampling approach combined with snowball and door-to-door recruitment was used to capture diverse consumer profiles. The population concerned by the survey is therefore heterogeneous without seeking to be representative of the population of each of these towns (no random selection). Around the basic unit "consumer", the aim of study is the self-reported poisoned consumer. From the intoxicated consumer, we are interested in consumption habits and health effects.

2.2. Time Coverage

The survey of consumers in the intervention cities actually started on 12-03-2025 and ended on 29-07-2025. Health problems related to food poisoning and sociodemographic data are those of the last two months in reference to the interview. In this perspective, we adopted a retrospective approach. In addition, the surveys were carried out on an ad hoc basis and not repeated.

2.3. Modelling of Self-Reported Food Poisoning Due to Potential Pesticide Residues

As our variable of interest "self-reported food poisoning" is qualitative, we opt for probabilistic regression, namely the modelling of dichotomous variables. These regression models make it possible to specify the probability that one of the modalities of the variable of interest occurs [22]. The modelling of qualitative variables thus makes it possible to characterize the relationships between a qualitative dependent variable and one or more variables (qualitative or quantitative) taken simultaneously. For this study, we capture the effect of pesticide residues on health through the risk of food poisoning. Therefore, we model the potential risk of food poisoning according to the most relevant variables that we will have selected at the end of the descriptive phase of the data. The objective of this modelling will be to accurately assess the effect and contributions of each of the explanatory variables on the probability of becoming a victim of food poisoning.

From a practical point of view, the principle of modelling is presented as follows:

Y_i: The dichotomous variable defined as

$$Y_i = \begin{cases} 1 \text{ if the consumer declare that he has suffered food poisoning} \\ 0 \text{ if not} \end{cases} \quad (1)$$

It is thus assumed that the realization of Y_i (having suffered from food poisoning) is the result of a latent and continuous variable Y_i^* such as:

$$\begin{cases} Y_i^* = X_i'\beta + \varepsilon_i \\ Y_i^* = \begin{cases} 1 \text{ Si } Y_i^* \geq C_0 \\ 0 \text{ Si } Y_i^* \leq C_0 \end{cases} \end{cases} \quad (2)$$

X_i: A vector of explanatory variables selected for the consumer model *i*.

With ε_i the error term and β the vector of regression coefficients.

In order to model the food poisoning event, we opt for Probit models (assuming that the model errors are Gaussian) over Logit models (whose model errors follow the standard logistic distribution). Thus, it is assumed that the errors follow a normal distribution with mean zero and variance $\sigma^2\left(\varepsilon_i \to N\left(0,\sigma^2\right), i=1,....,n\right)$ with the distribution function:

$$F(x)=\frac{1}{\sigma\sqrt{2\pi}}\int_{-\infty}^{x} e^{-\frac{1}{2}\left(\frac{x}{\sigma}\right)^2} dx \tag{3}$$

By posing $b_i=\frac{\varepsilon_i}{\sigma}$, the probability of the consumer i having suffered from food poisoning is given by: $P\left(Y_i=1\right)=1-P\left(\frac{\varepsilon_i}{\sigma}\le -X_i{}^t\frac{\beta}{\sigma}\right)=P\left(\frac{\varepsilon_i}{\sigma}\le X_i{}^t\frac{\beta}{\sigma}\right)$.

$$P\left(Y_i=1\right)=F\left(X_i^t\frac{\beta}{\sigma}\right)=\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{X_i^t\frac{\beta}{\sigma}} e^{-\frac{1}{2}t^2} dt \tag{4}$$

The high sensitivity to extreme values of logistic regression and their requirement of absence of links between independent variables are their main limitations. The analysis of the socio-demographic determinants of fruit and vegetable consumption, health status and the probability of a consumer suffering from food poisoning due to pesticide residues consists of three steps: presentation and comments of uni variate, bivariate and multivariate statistics for the description of the data. A multiple component analysis (MCA) to define the profile of consumers likely to be poisoned and finally an econometric modelling of qualitative variables, particularly dichotomous models, will allow us to identify the factors that explain this effect on health.

3. Results

3.1. Descriptive Statistics

For the first stage of our study, the statistical description of the variables allows us first to familiarize ourselves with the data, then to make a general characterization of the individuals in the sample and finally to identify the variables relevant to the explanation of the potential residual effects of pesticides on consumer health.

From the gender point of view, the results of the analysis reveal that the consumers in the sample are mostly men, with 61% being male and 39% being female. The gender variable is an important determinant in describing food consumption patterns. According to [23], in some Eastern countries and in Saudi Arabia (Riyadh) specifically, fruits and some vegetables are considered to be feminine 'markers', whereas meat is a masculine marker, associated with power and virility. Moreover, in Ireland, a study by [24] even identifies gender as the main determinant of differentiation in fruit and vegetable consumption. However, we suspect in this study that there can be no link between gender and consumer food poisoning due to the consumption of food contaminated with pesticide residues.

In the literature, significant inequalities in access to certain foods can be linked to the level of education and income of consumers. In our study, the results of this variable show that only 1% of the consumers studied had not attended school, while almost half (44%) had attained a higher education level. Finally, just under 35% had attained at least secondary education. It is true that the level of education can explain the importance of the choice of a certain diet for one's health. It is therefore to be expected that the consumer's level of education will influence the probability of suffering from food poisoning or not (Table 2).

Table 2. Descriptive statistics.

Group	Variables	Total number	Proportion
Gender	Men	276	39%
	Women	424	61%
Total		700	100%
Age	Less than 35	216	31%
	35 - 55	205	29%
	55 - 75	167	24%
	75 and more	112	16%
Total		700	100%
Level of instruction	Other	139	20%
	Not in school	9	1%
	Primary	64	9%
	Secondary	180	26%
	Higher school	308	44%
Total		700	100%
Income (XAF)[2]	<100 k XAF	195	28%
	100 k - 200 k XAF	238	34%
	200 k - 300 k XAF	255	36%
	>300 k XAF	12	2%
Total		700	100%
Main activity	Other	84	12%
	retired	104	15%
	Craftsman	118	17%
	Trader	144	21%
	Civil servant	250	36%
Total		700	100%

Thus, of the 700 individuals, the result of the age variable indicates that 31% of the population is made up of young people under 35 years of age, while 29% of

[2]XAF is the actual currency of Cameroon.

the sample is made up of adults aged between 35 and 55 years. Slightly more than 24% of individuals considered old were between 55 and 75 years old. Finally, only 16% of the individuals were over 75 years old. These observations lead us to believe that there is a theoretical link between the age of the consumer and his or her state of health and therefore the possibility of suffering from food poisoning due to pesticides.

Some studies in the literature has confirmed the relationship between income level and fruit and vegetable consumption. For example, [25] found that in Belgium and Poland, young men with low incomes were under-consumers of certified organic fruit and vegetables. Based on this finding, the results of our study reveal that consumers generally have different income levels. Indeed, although 60% of the individuals had a monthly income of at most 200 k XAF, more than 28% had a monthly income of less than 100 k XAF and 34% had a monthly income between 100 k and 200 k XAF. On the other hand, only a small proportion (2%) of the population studied had a monthly income of 300 k XAF or more.

This distribution of income is justified by the distribution of the types of activity. Indeed, this can be explained by the fact that civil servants are the most represented in the sample in terms of main activity (36%), followed by shopkeepers who represent 21%, and finally artisans and pensioners who represent 17% and 15% of the study population respectively. These results suggest a statistical link between the health status variable and the consumer's income level. Finally, we observe that the number of individuals representing the size of the household does not vary considerably from one household to another. The smallest household consists of only one individual, while the largest has up to 14 individuals. On average, households consist of 5 persons.

3.2. Consumption Behaviors and Pesticides' Awareness

A study of [26], based on 2811 consumers revealed that the "routine and pleasure" of purchasing fresh fruit and vegetables are the main determinants influencing their choice of consumption. From our results, all the individuals surveyed reported that they regularly consumed fruit and vegetables. Indeed, based on the results on frequency of consumption, just over half (51%), assumed that they consumed fruit and vegetables every day (**Figure 2**), while 48% consumed them once a week. These results are in line with the outcomes of [27] on affective factors as essential determinants of food preferences. Other factors such as the number of portions consumed daily are also considered by the authors. The analysis of the results in **Figure 3** shows that in terms of quantity consumed, the majority (285), consumes more than 300 - 400 grams of fruit and vegetables, 130 consume between 400 and 500 grams. Only 180 of 700 consume at least 300 grams. This result seems quite relevant because according to [26], information on the number of daily portions of food is the most important indicator to describe consumption patterns.

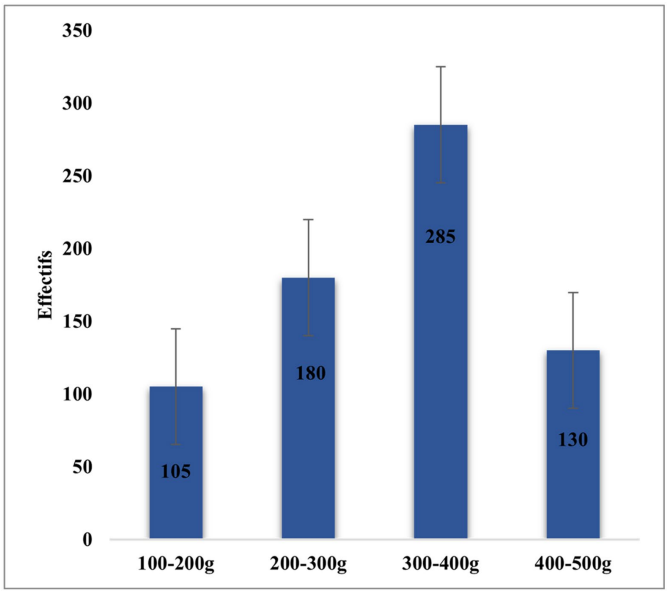


Figure 2. Distribution of consumers according of quantity of fruits and vegetables consumed.

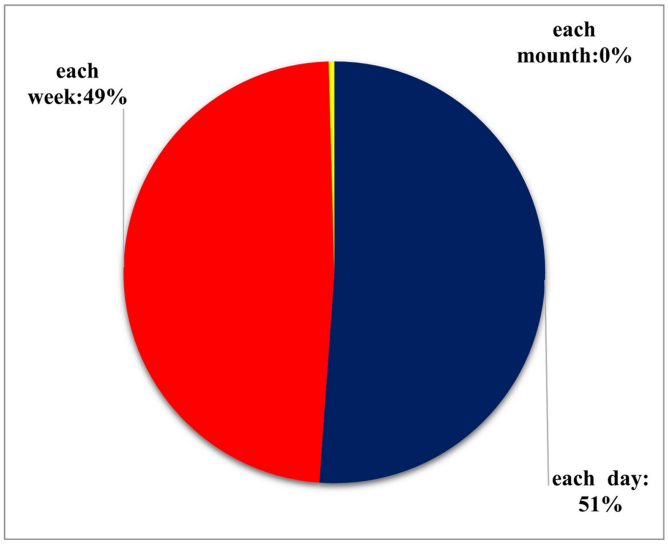


Figure 3. Distribution of consumers based on the frequency of foods consumption.

3.3. Suspected Food Poisoning and Reported Symptoms

The result of Figure 4 indicate that out of the 700 consumers in our sample, 269 respondents (38%) reported having suffered from suspected food poisoning at some point, whereas 62% reported no previous episode.

This result is in the line with observations made by [28] in Nigeria on the effect of Persistent Organic Pollutants (POPs) on the health of consumers in peri-urban areas of Lagos. Among the reported cases, multiple symptoms were commonly experienced. Approximately 61% of affected consumers reported three or four symptoms, while 43% reported four of the five symptoms investigated (Figure 5).

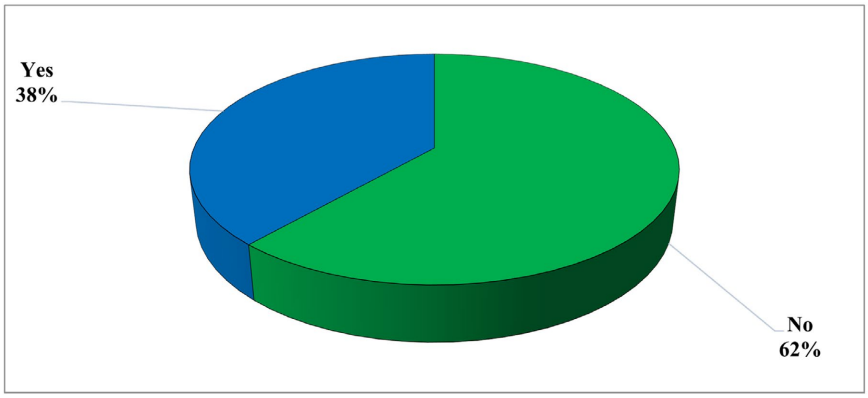


Figure 4. Distribution of consumer giving the self-reported cases of food poisoning.

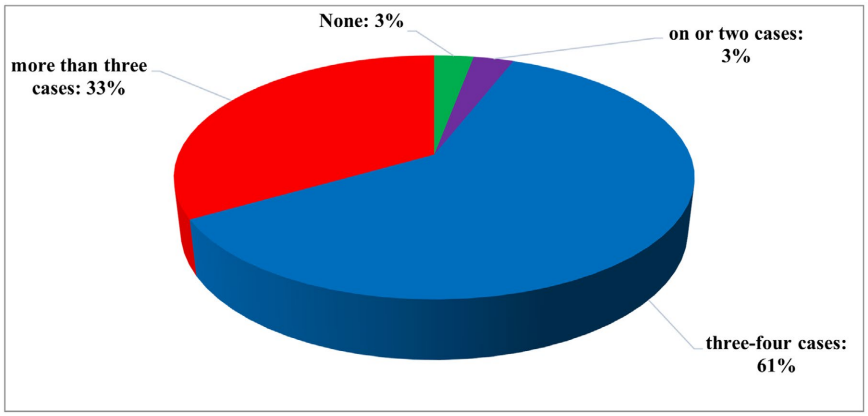


Figure 5. Distribution of consumers according to self-reported cases of food poisoning.

Moreover, 1/3 of the respondents surveyed had all the symptoms, while only 3% had none. Fever and dizziness were among the most frequently reported symptoms, followed by stomach pain.

3.4. Consumers Profiles Associated with Suspected Food Poisoning Cases

Multiple Correspondence Analysis (MCA) was used to explore associations between consumer characteristics and reported food poisoning. This allow us to have a global and simultaneous view of the relationships between the different variables and the probability of food poisoning. Using the elbow method, we retained three (03) axes which group together 47.7% of the total information contained in the data. On a given axis, we are interested in the modalities whose the quality's representation is higher than 10%. Figure 6 represents the projection of the individuals in the factorial plane which allows us to give meaning to the first results.

Factor Axis n˚1: (Dim 1: 42.05% of inertia)

The first factorial axis is by far the most informative. It is predominantly structured by the health impact variables and treatment behavior, creating a sharp contrast between two poles. On the positive side (right of the plane), all symptoms of

foodborne intoxication cluster strongly: Poisoning_Yes (coord: +1.17), Diarrhea_Yes (+1.23), Nausea_Yes (+1.23), StomachAche_Yes (+1.21), Sweating_Yes (+1.24), as well as all treatment types (Trad_Med: +1.17, Self_Med: +1.21, Modern_Med: +1.08) and treatment durations (2days: +1.27, 3days: +1.18, 5days: +1.22). Consumers who did not seek medical consultation (Consult_No: +0.58) also appear on this side, as do individuals with very good self-perceived health status (Very_Good_Hlth: +0.52) a paradoxical finding suggesting underestimation of health risks by affected consumers. On the negative side (left of the plane), all «No» modalities for symptoms appear: Poisoning_No (−0.74), Diarrhea_No (−0.58), Nausea_No (−0.53), StomachAche_No (−0.72), Sweating_No (−0.56), together with No_Treat (−0.75) and No_Duration (−0.75). Axis 1 is therefore interpreted as a «Health impact and treatment-seeking behavior» gradient, contrasting exposed and symptomatic consumers against unexposed ones.

Factorial Axis n˚2: (Dim 2: 23.19% of inertia)

The second factorial axis structures consumers according to their age profile, socioeconomic status, and frequency of healthcare use. On the positive side (top of the plane), older consumers (>60 yrs: +1.38) and traders (Trader: +1.06) appear, alongside consumers consulting healthcare services biannually (Freq_Biannual: +1.26), those sourcing produce from local markets (Market_Origin: +0.56), and consumers purchasing larger quantities of fruits and vegetables (Qty_ > 500 g: +1.00). On the negative side (bottom of the plane), younger consumers (18 - 30 yrs: −0.79) cluster with lower education (No_schooling: −0.96, Primary: −0.97), lower income profiles (Income_100 - 150 k: −0.61), and lower quantities consumed (Qty_ < 200 g: −0.63). Axis 2 is interpreted as an "Age; socioeconomic status; and healthcare access" gradient.

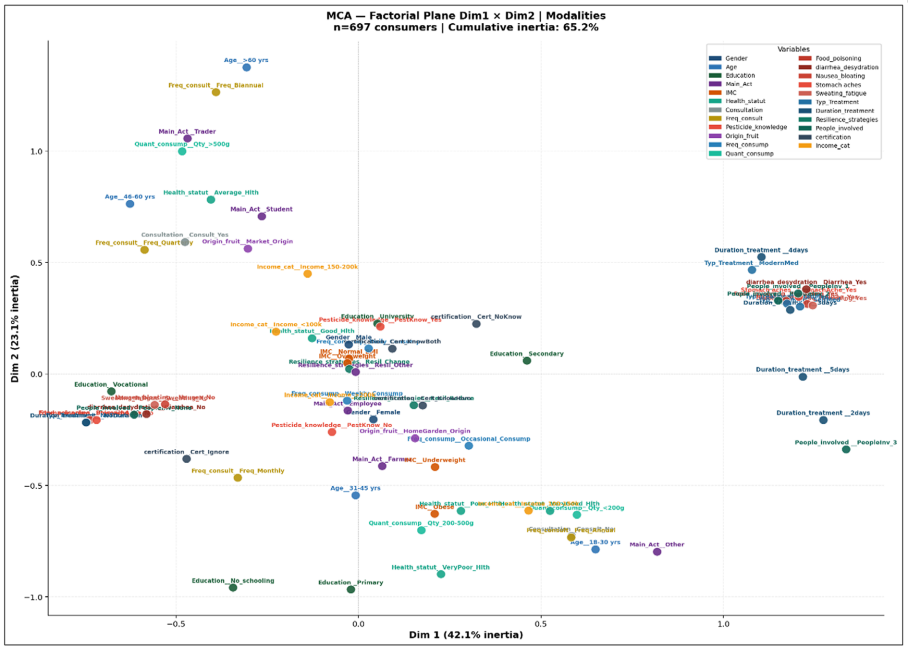


Figure 6. Multiplied correspondence analysis -1st factorial design.

Factorial Axis 3 (Dim 3: 13.55% of inertia)

The third axis adds a complementary reading focused on education and income. On the positive side appear consumers with no schooling (No_schooling: +1.80), obesity (Obese: +1.01), who consult healthcare monthly (Freq_Monthly: +1.21), and who do not know about pesticide homologation (Cert_Ignore: +0.67). On the negative side, younger consumers (18 - 30 yrs: −0.69) with very low income (Income_ < 100 k: −1.00) and university education (University: −0.60) appear. This axis refines the education-income gradient by emphasizing the contrast between poorly educated, low-income consumers with chronic health vulnerabilities versus young, educated, but economically constrained consumers.

Examination of the factorial plane Dim1 × Dim3 reveals several important associations (see Figure 7). The modality Intox_Yes is located on the negative side of both Axis 1 and 2, clustering near the profiles of low-income consumers, low education levels, individuals consuming small quantities of fruits and vegetables, and those sourcing produce less frequently from local markets. Conversely, Intox_No is located on the positive side, associated with more educated profiles, higher income levels, and better knowledge of homologated pesticide products. Furthermore, pesticide awareness clusters near the University-educated and higher-income modalities, suggesting that sensitivity to phytosanitary risks is strongly linked to consumers' human capital.

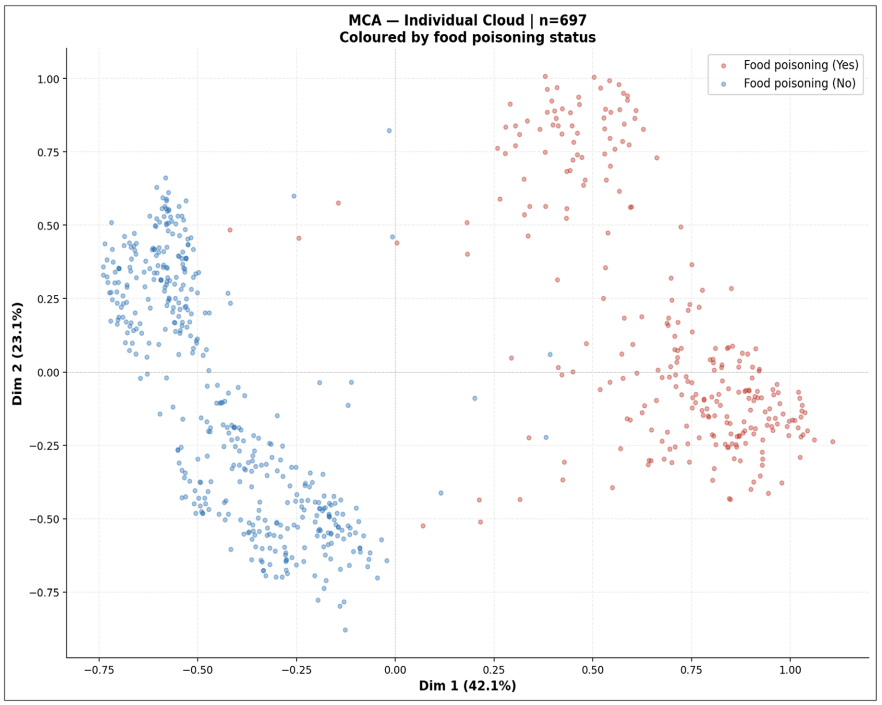


Figure 7. Consumer cloud colored using food poisoning status.

3.5. Link between Food Poisoning Status, Origin and Quantity of Foods Consumed

Figure 8 bellow describe the link between food poisoning cases and knowledge of

the origin of the fruit and vegetables consumed. This link is intuitive. Indeed, consumers who pay particular attention to the origin of the food they eat suffer less from food poisoning than those who pay no attention to the origin of the food they eat. This link is statistically confirmed by the result of independence of the chi-square test, which has a p-value of 0.008 and is significant at 5%.

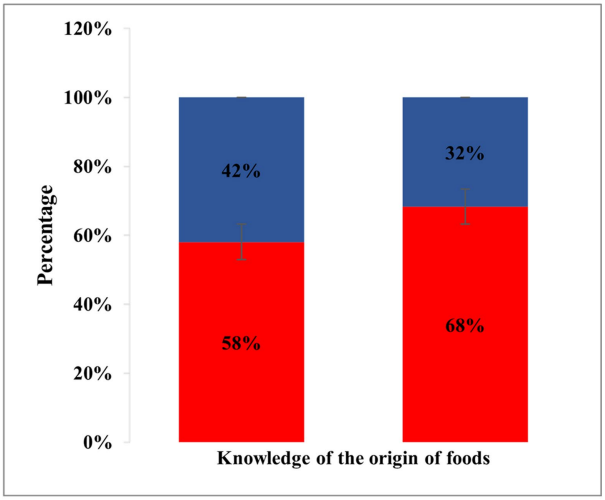


Figure 8. Poisoning status related with knowledge origin of foods.

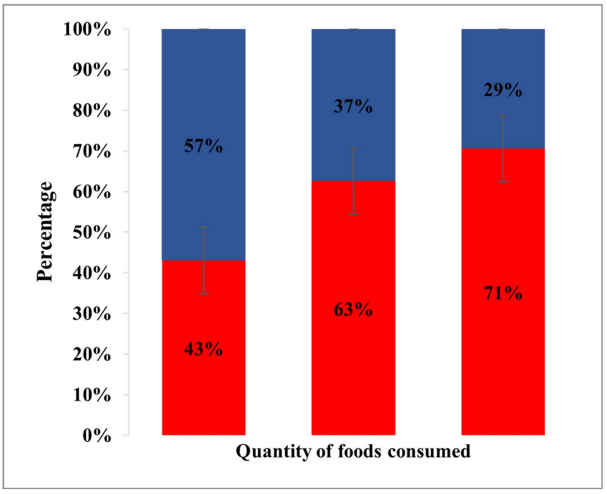


Figure 9. Poisoning status related with quantity of foods consumed.

On the other hand, the risk of food poisoning seems to vary giving the average daily quantity of food consumed (Figure 9). Consequently, a link between these two variables emerges. However, this link does not seem very intuitive insofar as respondent who consume a low daily quantity of foods (fruit and vegetables) are those who have a high probability of potentially suffering from food poisoning. This is confirmed by the chi-square test, which leads to the rejection of the null hypothesis of independence, at the 5% significance level (p-value = 0.000).

3.6. Main Factors Associated with Suspected Food Poisoning

The variable of interest (suspected food poisoning) being binary, we opted for a dichotomous Probit model. By applying Y_i our variable of interest, we assume that it is the result of a latent variable Y_i^* such as:

$$\begin{cases} Y_i^* = X_i^t \beta + \varepsilon_i \\ Y_i = \begin{cases} 1 \text{ if } Y_i^* \geq C_0 \\ 0 \text{ if } Y_i^* \leq C_0 \end{cases} \end{cases}$$

With:

$$Y_i = \begin{cases} 1 \text{ if consumer has reported at least one case of food poisoning} \\ 0 \text{ if not} \end{cases}$$

With:

$$X_i^t = \begin{pmatrix} Sexe_i, householdsize_i, income_i, consult_i, Origin_i, Health_i, Edu_level_i, Freq_conso_i, \\ resilience_strat_i \end{pmatrix}$$

$$\beta = \left(\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8\right)^t ; \quad C_0 \text{ = a constant}$$

Giving to the results of Table 3, the model that explains the probability for a consumer to hypothetically being a victim of food poisoning is globally significant (p-value = 0.000).

Table 3. Probit model estimation.

Probit regression			Number of obs. =		560	
			LR chi2(19) =		121.13	
			Prob > chi2 =		0.0000	
Log likelihood = −313.2989			Pseudo R2 =		0.1620	
Self-reported food poisoning	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]
Gender	Reference: Male					
Female	−0.0888706	0.1239015	−0.72	0.473	−0.331713	0.1539717
Householdsize	−0.0260656	0.0323239	−0.81	0.420	−0.0894192	0.0372881
Income	Reference: Less than 100kXAF/Mounth					
100 k - 200 kXAF	−0.0461348	0.1822414	−0.25	0.800	−0.4033215	0.3110519
200 k - 300 kXAF	−0.2581539	0.1514599	−1.70	0.088	−0.5550098	0.038702
More than 300 KXAF	−0.2274971	0.5769922	−0.39	0.693	−1.358381	0.9033869
Health_condition	Reference: Very bad					
Bad	0.2624568	0.1936032	1.36	0.175	−0.1169984	0.6419121
Good	0.1601987	0.2262224	0.71	0.479	−0.2831889	0.6035864
Very good or perfect	0.0307027	0.1936835	0.16	0.874	−0.3489099	0.4103154
Freq_consult	Reference: 1 time per mounth					
2 - 3 fois per mounth	0.0560368	0.2365157	0.24	0.813	−0.4075254	0.5195991
More than 3 time per mounth	0.2411504	0.265213	0.91	0.363	−0.2786576	0.7609583
None	0.7397106	0.218389	3.39	0.001	0.3116761	1.167745

Continued

Education	Reference: Not scolarise					
Primary	0.1748323	0.6429069	0.27	0.786	−1.085242	1.434907
Secondary	1.303893	0.6156316	2.12	0.034	0.0972772	2.510509
Higher education	0.8298228	0.6114506	1.36	0.175	−0.3685983	2.028244
Other	−0.067614	0.6224799	−0.11	0.914	−1.287652	1.152424
Origin_fruits	Reference: Yes					
No	0.2735773	0.1387445	1.97	0.049	0.001643	0.5455115
Freq_consumption	Reference: Once a day					
once a month or once a week	−0.1216107	0.1169681	−1.04	0.298	−0.3508639	0.1076425
Resilience_strategies	Reference: Washing food					
Water consumption	0.1822043	0.1788333	1.02	0.308	−0.1683025	0.5327111
Consuming organic food	0.1164494	0.1568577	0.74	0.458	−0.190986	0.4238848
_cons	−1.445727	0.6899237	−2.10	0.036	−2.797952	−0.093501

The variables gender, health_status, size of the consumer's household do not influence the probability for a consumer to in theory being a victim of food poisoning. Indeed, at the level of significance of 10%, the coefficients of the different modalities of these variables are all non-significant (P-value greater than 10%). Resilience strategies against the potential effects of pesticide also do not influence that risk. Also, the frequency of consumption does not influence the probability of being a victim of food poisoning.

On the other hand, the income negatively affects the probability for a consumer to being potentially a victim of food poisoning. Indeed, at the 10% significance level, the coefficient of the 200.000-$ 540 US modality is significant and negative. Thus, compared to consumers with a monthly income of less than 100k XAF, those with an income of between 200k XAF and 300k XAF are less suspected to be victims of food poisoning. The probability of being poisoned does not seem to be identical between consumers who make regular medical visits and those who do not make any. Indeed, medical visits have a negative influence on the probability of being a victim of food poisoning (significant and negative coefficient). In addition, the probability of being a victim of food poisoning does not vary among consumers who make more than two (02) medical visits (non-significant coefficients at the 10% threshold) compared to those who regularly make one medical visit per month. On the other hand, the risk of being a victim of food poisoning increases when the individual does not make medical visits than if he or she makes at least one visit per month (coefficient of the "none" modality significant at 1% and positive).

Knowing the origin of the food (fruits and vegetables consumed) has a negative influence on the probability of getting food poisoning. This simply means that it reduces the risk of being a victim of food poisoning. Indeed, the positive sign of the coefficient of the "no" modality indicates that, compared to those who know

the origin of the fruit and vegetables they consume, individuals who do not take care to check the origin of the fruit and vegetables they eat are more likely to be victims of food poisoning.

Marginal effects

The estimation of the probit model does not quantify the contribution of variables to the suspected food poisoning. It helps us to identify the main determinants expected to influence this probability. Then, to quantify this effect, we calculate the marginal effects of the different modalities.

Table 4. Marginal effects of food poisoning.

Variables	dy/dx	Std. Err.	z	P > z	[95% Conf. Interval]	
Gender	Reference: Male					
Female	−0.033139	0.0459836	−00.72	00.471	−0.123265	0.0569871
Householdsize	−0.009758	0.0120988	−00.81	00.420	−0.033471	0.0139544
Income	Reference: Les than 100k XAF					
100 k - 200 k XAF	−0.017763	0.070179	−0.25	0.800	−0.155312	0.1197846
200 K - 300 K XAF	−0.095872	0.0565911	−1.69	0.090	−0.206788	0.015044
More than 540 US	−0.085003	0.20702	−0.41	0.681	−0.490755	0.320748
Health_condition	Reference: Very bad					
Bad	0.0974227	0.0698782	1.39	0.163	−0.039536	0.2343815
Good	0.0583578	0.0819008	0.71	0.476	−0.102164	0.2188804
Very good or perfect	0.0108679	0.0684058	0.16	0.874	−0.123205	0.1449409
Freq_consult	Reference: 1 time per mounth					
2 - 3 times per mounth	0.0173208	0.0725645	0.24	0.811	−0.124903	0.1595447
More than 3 times/mounth	0.0791802	0.0861871	0.92	0.358	−0.089743	0.2481038
None	0.2700144	0.0715221	3.78	0.000	0.1298336	0.4101951
Education	Reference: Not scolarized					
Primary	0.0446448	0.1540816	0.29	0.772	−0.2573495	0.3466392
Secondary	0.4561289	0.1486237	3.07	0.002	0.1648317	0.747426
Higher school	0.2688708	0.1457725	1.84	0.065	−0.0168381	0.5545797
Others	−0.015287	0.1452668	−0.11	0.916	−0.3000054	0.2694299
Fruits_origin	Reference: Yes					
No	0.1001967	0.0494491	2.03	0.043	0.0032783	0.1971151
Consumption_freq	Reference: Each day					
Once per mounth or per week	−0.0454845	0.0436706	−1.04	0.298	−0.1310773	0.0401083
Resilience_strategies	Reference: Wash foods					
Drink potable water	0.0692328	0.0691256	1.00	0.317	−0.066251	0.2047165
Consumption of organic food	0.043811	0.0596489	0.73	0.463	−0.073098	0.1607207

The results in Table 4 reveal three main insights: First, when an individual's income increases from less than 100 k XAF to between 200 k XAF and 300 k XAF, the probability of suffering from suspected food poisoning decreases by 0.1. Sec-

ondly, medical visits have an impact on the probability of being a victim of food poisoning and when an individual stops making medical visits to health personnel, the probability of being a victim of food poisoning increases by 0.27 point. Finally, when an individual does not bother to check the origin of the fruit and vegetables he or she eats, the probability of being a victim of food poisoning increases by 0.1 point.

Recurrent suspected food poisoning and treatment practice

Figure 10 shows that poisoned consumers who have chosen the "conventional medicine" option for their treatment are less likely to suffer from food poisoning again. There is therefore a link between the type of treatment adopted and the risk of suffering from food poisoning again. This suspicion is confirmed by the results of the chi-square test of independence (p-value = 0.004), which, in view of the evidence of the data and at the significance level of 5%, leads to the rejection of the null hypothesis of independence between the number of intoxications and the type of treatment.

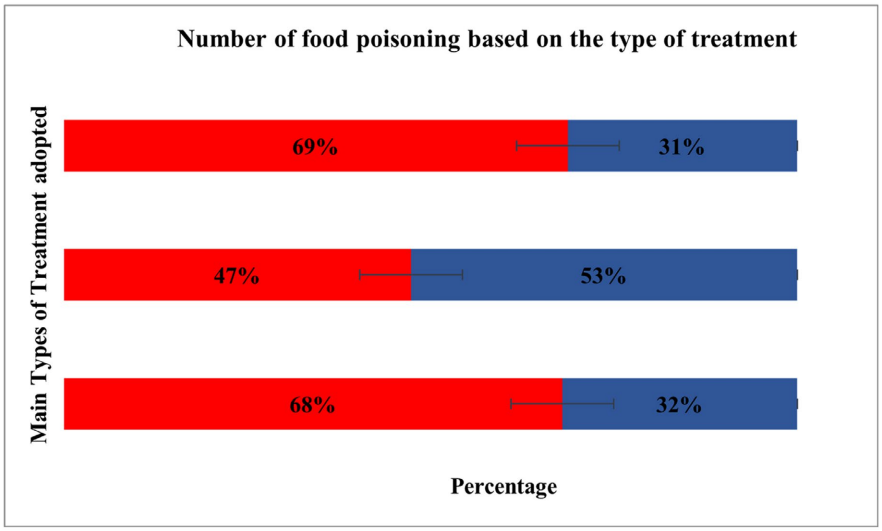


Figure 10. Number of intoxications giving to the type of treatment adopted.

The type of treatment is related to the probability of an individual suffering from suspected food poisoning again (Table 5). We regress the probability of suffering more than one suspected food poisoning according to the type of treatment adopted, in order to capture the contribution of the different types of medical care.

The modelling applied here is not intended to be predictive. It essentially consists of evaluating the contribution of the different types of treatment on the possibility of suffering more than one food poisoning. This model is globally significant (Table 6) and explains 2% of the variability in the probability of suffering from food poisoning again. The results show that the types of treatment are not equivalent. Indeed, compared to conventional medicine, traditional medicine and self-medication have a positive influence on the probability of suffering another suspected food poisoning. In other words, individuals who choose traditional

medicine or self-medication are more likely to suffer from re-poisoning than those who choose conventional medicine.

Table 5. Estimated risk of recurrent suspected food poisoning.

Probit regression						
	Number of obs =			700		
	LR chi2(2) =			9.26		
Log likelihood = −177.44381	Prob > chi2 =			0.0098		
	Pseudo R2 =			0.0254		
Reccurent_poisoning	Coef.	Std. Err.	z	P > z	[95% Conf.	Interval]
Traditional medicine	0.4544735	0.2186277	2.08	0.038	0.0259711	0.8829759
Self-medication	0.5337106	0.2079205	2.57	0.010	0.126194	0.9412272
_cons	−0.0660118	0.0959192	−0.69	0.491	−0.254010	0.1219865

The analysis of marginal effects makes it possible to capture the effect of changing the type of treatment on the risk of suffering more than one food poisoning. The result in Table 6 shows that, compared to poisoned consumers who opt for conventional medicine, those who switch to traditional medicine have a 0.18 point higher risk of suffering a new food poisoning due to food contaminated with pesticide residues.

Table 6. Marginal effects.

Delta-methods						
	dy/dx	Std. Err.	z	P > z	[95% Conf.	Interval]
Treatment						
Traditional medicine	0.1774786	0.0821005	2.16	0.031	0.0165646	0.3383926
Self_medication	0.2063158	0.076223	2.71	0.007	0.0569215	0.35571

Also, those who abandon conventional medicine for self-medication with their own tricks, see the probability of suffering from intoxication increase by 0.20 points.

4. Discussion

The study provides evidence of substantial awareness of pesticide-related food risks among fruit and vegetable consumers in Douala, Yaoundé, and Bafoussam. More than half of participants were aware of potential risks associated with pesticide residues, although reported protective practices varied considerably. Washing fruits and vegetables was the most commonly reported practice, whereas purchasing organic products was uncommon. These findings suggest that awareness does not necessarily translate into the adoption of all available risk-reduction practices.

The finding that 38% of consumers reported at least one episode of suspected

food poisoning highlights an important perceived food-safety concern. However, this result should be interpreted cautiously because poisoning was self-reported and pesticide residues were not directly measured. The observed symptoms may have multiple causes, including microbial contamination, chemical exposure, or other food-related factors. Consequently, the associations identified in the present study should not be interpreted as direct evidence of pesticide toxicity.

The statistical analyses identified several factors associated with reported food poisoning. In particular, knowledge of the origin of fruits and vegetables was associated with a lower probability of reporting food poisoning. This may reflect differences in consumer selection practices, trust in food sources, or access to information about production and handling. Income was also associated with the outcome, suggesting that socioeconomic conditions may influence access to safer food sources, healthcare, or preventive practices.

The association between absence of medical consultations and reported food poisoning may indicate differences in healthcare-seeking behaviour or access to healthcare. Similarly, the association between treatment practices and recurrent reported poisoning suggests that healthcare-seeking behaviour may be relevant to food-safety outcomes. Because these analyses are observational, however, the direction and causality of these relationships cannot be established.

Overall, the findings support the need for better consumer information on pesticide residues, improved traceability of fruits and vegetables, strengthened monitoring of pesticide use and residues, and accessible food-safety education in urban and peri-urban communities. Future studies combining consumer surveys with laboratory analysis of pesticide residues in commonly consumed fruits and vegetables would provide stronger evidence regarding actual dietary exposure and associated health risks.

5. Conclusion

The findings highlight the importance of strengthening food-safety measures along the fruit and vegetable supply chain. Priority actions include improving monitoring of pesticide residues, promoting good agricultural and post-harvest practices, strengthening traceability and consumer information on food origin, and expanding public education on appropriate washing and handling practices. Communication strategies using community outreach and digital tools could further improve consumers' access to reliable information and support informed food-safety decisions. Future interventions should also encourage timely consultation with qualified healthcare professionals following suspected food poisoning.

Study's Limits

Although this study provides significant insights into a diverse urban sample, its conclusions are limited by the use of cross-sectional data, non-probability snowball sampling, and cases of food poisoning reported by consumers themselves without clinical confirmation, thereby precluding any causal inferences or statistical

generalizations.

Data Availability

All data from this study will be made available by the corresponding author (Kaldjob M. Christian) on reasonable request.

Author Contributions

Kaldjob and Enangue conceived the original idea. They supervised and drafted the manuscript. Enangue and Kaldjob has written original draft. Kaldjob proceeded to data curation, methodology, and empiric analysis. Enangue provided critical feedback and helped shape the research, analysis, and manuscript.

Conflicts of Interest

The authors declare no competing interests.

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