Full Length Research Paper

Food security analysis: A household perspective of private and public employees in Bukavu in the East of the Democratic Republic of Congo

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This study is related to food security and seeks to identify socioeconomic factors likely to explain the nutritional status of private and public employees from Bukavu's town. The result of our binary logistic model reveals that the level of education in addition to the rate of access to food resources explain the food security of the two groups under this study. Moreover, the ordered multinomial regression computed thanks to the Food Consumption Score, underscores the fact of working in public sector, the share of income devoted on savings, the rate of access to food resources, and the age of the head of the household as decreasing factors of the likelihood of the household to getting sufficient food, whilst the household's income, and the share of income devoted on food increase the likelihood of the household to getting sufficient food.

Keyword: Food security, Food Consumption Score, Household, Private sector, Public sector, Bukavu's town

1. INTRODUCTION

The literature devoted to the private and public sector is rare in the Democratic Republic of Congo (DRC). A study from the African Development Bank Group highlights the public sector's failure to control and sustain the wages of workers in the DRC, due to the budget difficulties that encounter the state. In fact, in the public sector the wage bill management emphasis on the number of workers at the expense of increasing wages; this mainly results in employees' productivity.Further, this social management policy has perverse effects on the efficiency of public employees; affecting the level of effort they are willing to make, their loyalty and, therefore, their probity (African Development Bank Group, 2012).

Unlike the public sector, the private sector in the Democratic Republic of Congo has witnessed a higher distribution of income rather than in national enterprises and public sector. Furthermore, in the private sector, the supply of qualified workforce is reduced, whilst that of unskilled workers is almost infinite. Therefore, the enterprises tend to cut down the wages of unskilled staff by outsourcing work that is not part of their core business. In this vain, they prefer to outsource custodial, gardening and other non-essential service's activities. This policy allows them to reduce wages cost, their long-term contracts with their staff by using fixed-term contracts with subcontractors acting as intermediaries, while the rotation of their employees allows them to circumvent the prohibition to renew their contracts (African Development Bank Group, 2012).

In view of the above, it is clear that the employees' treatment differs according to, whether one is in the

public or private sector. This situation raises the issue of the nutritional status of these two groups of employees by emphasizing on the nutritional value of their consumption basket. Indeed, the promotion of decent employment is essential to achieve the food security and alleviate poverty as highlight the first Sustainable Development Goal (SDG) consisting of alleviating poverty. The later takes into account the lack of income and resources for sustainable livelihoods (including food) (…), in addition to the creation of sustainable jobs (FAO, 2015).

Previous research in food security has focused on the role of agriculture in improving the food security on one hand, and the relationship between the household's socioeconomic characteristics compared to its consumption in terms of calories (Dufumier, 1996; Conway, 1994; Zezza et al, 2010; Deaton et Drèze, 2009 et Haddad, 2009) on the other hand. Nevertheless, we did not find any research looking at the role of the business sector in improving food security.

The current research attempts to fill this gap by answering the question of, whether the fact that the head of a given household works in the public or private sector explains the nutritional status of the households in Bukavu's town. The main objective of this paper is to ascertain whether the business sector in which the head of the household works has an impact on food security of the household.

Therefore, we conduct a comparative study between two business sectors, namely the public and the private sector by emphasizing the socio-economic factors that determine the nutritional status and the nutritional value of the household basket in Bukavu. In this regard, the number of Kilocalories consumed by a household is evaluated using the diet-based approach. Further, we perform the calculation of the Food Consumption Score (FSC) to classify household in three classes according to the nutritional value contained in their consumption baskets.

2. LITERATURE REVIEW

Regarding the previous literature, many authors have examined the relationship between the socioeconomic characteristics of a household and its consumption in terms of calories (Deaton and Drèze, 2009; Haddad, 2009). This study is aligned in the same stream while highlighting the business sector of the head of the household. The literature on food security is wide and diverse. According to Hoddinott (1999), the food security can be defined as « a situation in which a population has a physical, social and economic access to healthy and rich food over a period of time to meet its nutritional needs and preferably to enjoy an active life ». Indeed, the factors that determine the human nutrient levels can be analyzed by using the microeconomic theory of consumer. Following this theory, the food consumption is determined, like that of other goods and services, by three elements: income, relative prices and tastes.

The Engel's law reflects better the importance of income in the ability of households to access food. In fact, a household with a high income is less likely to be exposed to under-nourishment, especially in scarcity's periods. This assumption is proved in case the income is stable; otherwise the household remains vulnerable. Therefore, the income defines, to a significant extent, the levels of food consumption, especially for lower income segments of households (Reboud, 2006).

The level of prices plays a fundamental role because of their impact on incomes in addition to the replacement effects they exert. For this reason, the prices of staple cereals represent a crucial indicator of well-being among the poor in low-income countries (Reboud, 2006).

In addition, food tastes and beliefs can hinder a better nutrition since each culture conveys its food tastes and beliefs. Thus, in most human settlements, the existence of a nutritive potential that has remained under exploited can be highlight. For instance, soy products offer a source of protein that is significantly cheaper than animal products while their consumption is important only in Asian countries where they represent an important source of protein. For this reason, Sen (1981) argues that household dietary requirements are likely to pose the under-nourishment problem. In addition to these elements, Alderman and Garcia (1993) show that savings play an important role in coping with seasonal declines and are an important factor in household nutrition, either in a period of fluctuating incomes or in timeof sharp fall in agricultural production. According to Amartya Sen, poverty cannot be defined simply as a lack of resources without taking into account the capacity to transform them into real functioning, such as eating enough (Sen, 1981, Reboud, 2006).

The ability to transform monetary resources into sufficient food depends on a variety of factors, including:

(1)   Type of purchasing food:for a given food expenditure, the amount of consumed calories will depend on the cost of purchasing food.

(2)   The budget breakdown between food and other budget items such as education, health, transportation, etc.

-        High school expenses can lead in sacrificing the household's food;

-        The health expenses, especially when there are patients to be treated, can have a negative impact on the nourishment.

-        For some households living in isolated areas that can explain a high cost of transportation in selling the surplus of their production on the markets and buying other types of goods or non-food items.

(3)	Financial market imperfection and risk behavior: The household environment is uncertain with climatic shocks (droughts, floods) which can lead to economic shocks (lower production and incomes, higher food prices for consumption) and characterized by the insurance and credit imperfection.

(4)	The level of education: a non-poor household is not necessarily safe from food insecurity it its members do not know what appropriate food means.

Since the 1974 World Food Conference, many authors have focused on measuring food security. At the time, food security was conceived as the match between national food supplies and the energy needs by the whole country's population. During the decades following the World Food Conference, and with the contribution from Sen (1981), the food security's debate was enriched by issues of stability, food availability and accessibility for household and individuals before being considered as an integral part of a set of input which is the security of the existence means.

In 1999, the Maxwell's research introduces a new stream of thought in determining food insecurity: the food vulnerability. Therefore, the research has evolved towards a measure of adequacy in terms of quality: nutritional quality, but also cultural acceptability, consistency with eating habits and self-determination. The aforementioned literature review shows that, several studies deal with food security by using different methods of evaluation. In addition, given the specificity of countries and regions, the results of studies are not necessarily generalizable.

In the Democratic Republic of Congo, many studies have been conducted on food security. However, fewer studies have combined the nutritional status of a household and the nutritional value of their consumption basket. Therefore, our study represents an attempt to fill this gap.

3. RESEARCH METHODOLOGY

Data

This study is focused on the households from the city of Bukavu, especially the households working in public and private sector. The private sector encompasses formal and informal activities. The data were gathered using interview and survey of households with a sample of 200 households extracted on a simple random sampling using the relationship proposed by Fellegi (2003).

$$n_0 = \frac{z_\alpha^2 pq}{d^2}$$

Where ;

n_0: original sample size;

z=1.96: Value of the normal distribution corresponding to the 95% level of confidence.

p= Proportion of individuals with the studied trait, in this case the proportion of individuals in food security. The data collected from 30 households during our pre-survey stand this proportion at 43%. However, since q is the proportion of household in food insecurity our pre-surveydata stand this indicator at 57%.

d= margin of error. In our work, we set it at 7%.

The combination of the aforementioned indicators stands the minimum size of our sample at 192 households. For reasons of precision, we take this sample to 200 households.

Econometric models

To identify the factors explaining household food security in Bukavu, we run two econometric models. The first model uses the food ration and runs the Logit model, while the second model uses household Food Consumption Scores (FCS) by applying a multinomial model.

Multinomial Model

The calculation of Food Consumption Score (FCS) has allowed us to classify the households in three categories: FCS ranges between 0-28 (poor consumption); FCS ranges between 28.5-42 (borderline consumption); FCS > 42 (acceptable consumption). The first category will be used as a reference modality to explain household food security. Thus, the probability for a household to be in a particular situation (poor consumption, borderline consumption, and acceptable consumption) can be written as follows:

$$P_j = \mathrm{Pr}\,ob(y = j/\mathrm{X}) = \frac{\exp(\mathrm{X}\beta_j)}{1 + \sum_{k=1}^{3} \exp(X\beta_k)}$$

Where j is the situation in which the household is located (according to its Food Consumption Score). J= 1, 2,3

$$\sum_{j=0}^{3} P_J = 1$$

X is a vector of explanatory variables that we will present in the following paragraphs.

β is a vector of associated parameters with the explanatory variables;

kis the reference situation ;

The probability of being in a particular situation is estimated in comparison with the probability of being in another situation.

The reference probability is written as follows:

$$P_j = \Pr ob(y = m + 1/X) = \frac{1}{1 + \sum_{k=1}^{3} \exp(X\beta_k)}$$

Logit Model

The evaluation of the number of Kilocalorie consumed per day and per individual has allowed us to categorize our respondents intwo groups: is considered in food security, a household that consumes more than 2400 Kcal/day (code 1: occurrence of the event), otherwise, the household will be attributed the code 0 (absence of the event).

The aim of the model is to predict the probability □ □ that the household has the characteristis associated with the code 1 of the explained variable knowing the values taken by the explanatory variables in the household. In our case, we need to know the probability of being in food security knowing the socio-demographic characteristics of the household.

Assuming that the errors are not normally distributed, the error variance is not constant and that some predictions of the explained variable are outside the range[0; 1], we proceed by the transformation of the logit model which consists of regress explanatory variables not on □ □but on the transformed variable[1]:

$$Log\left[(\pi)/(1-\pi)\right]$$

The factor $[(\pi)/(1-\pi)$ is called odd of probability. The upstream idea of this transformation is quite simple: the relationship between the explained variable and the explanatory variables is not a straight line but rather an S-curve. Therefore, the model is written as follows:

$$Log\left[(\pi)/(1-\pi) = \beta_0 + \beta_i X_i\right] \text{with} X_i \text{ explonatory variables}$$

Table 1: Expected effects of different variables

Definition	Expected sign	Explanation
Dependent variable[2]	------------	
Gender of the head of the household (man)	+	1 : man et 0 woman
Age of the head of the household	Ambiguous	Expressed in years
Level of education of the head of the household	+	
Size of the household	Ambiguous	Number of people in the household
Business sector of the head of the household	+	1 : Public sectorand 0 formal and informal private sector
Secondary activity	+	Existence of an activity ran by a family member
Paid activity of the spouse	+	1 : has an activity et 0 : without activity
Income of the household	+	Monthly income of the entire household
Share of income devoted on food		
The rate of access to food resources		1: Fair (no consumption outside the household for the head of the household); 0: otherwise.
Savings	Ambiguous	Share of income devoted to savings

Source: Authors' confection

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[1]These arguments are inspired by J. Neter, M. Kutner, C. Nachtsheim and W. Wasserman, 1996

[2]Initially, this variable will be measured by the SCA and modeled by the multinomial logit and in a second time, it will be measured by the number of Kcal consumed by a household and modeled by a binomial logit.

4. RESULTS AND DISCUSSION

Descriptive analysis of the variables

Table 2: Descriptive analysis of the variables

Variables	Statistic	Business activity		t-Student	Nutritional status[3]		P-value
		Public	Private		FS	FI	
Age of the head of the household	Mean SD	43 12	37 10	3.954 (0.000)			0.580
Gender of the head of the household (in %)	F M	33.8 66.2	40 60	---------	35.1 64.9	45.5 54.5	0.138
Level of education (in %)	Primary High school University Illiterate	4.2 36.6 56.3 2.8	13.3 41.7 39.2 5.8	---------	7.5 35.8 53 3.7	15.2 47 31.8 6.1	0.030
Size of the household	Mean SD	6 2	6 2	-0.521 (0.603)	------	--------	0.843
Secondary activity (in %)	Oui Non	29.6 70.4	23.3 76.7	---------	24.6 75.4	27.3 72.7	0.852
Income of the household	Mean SD	664 605	542 564	1.421 (0.157)			0.652
Share of income devoted on food in %	Mean SD	28 17	31 18	-1.385 (0.168)			0.363
Share of income devoted on savings in %	Mean SD	18 14	14 14	-1.311 (0.192)			0.407

Source: authors' analysis

This table shows that the average age of our respondents is 43 years for public sector employees while it is 37 years for private sector employees. The test of student for this variable, which accepts the hypothesis of homogeneity of variances[4], proves that the average ages of our respondents are statistically different. Therefore, we conclude that the public sector's employees are older than the private sector's employees, and that the private sector attracts more young employees. Regarding the level of education, we find that public sector's employees hold a university level while the private sector's employees mainly hold a high school degree. In addition, we observe that this variable is significantly linked to the nutritional status of our respondents. Regarding the household size, we find that the households leaded by the public sector's employees have the same size as the households headed by private sector's employees. These results are confirmed by the student test (0.603) confirming the hypothesis of equality of averages. It is important to highlight that 29.6% of public sector's employees have other secondary activities while only 23.3% of private sector employees have another secondary activity. Regarding the monthly income of the household[5], it is clear that households headed by public sector's employees raise high income (USD 664) than households headed by private sector employees (USD 542). Nevertheless, statistically, we note that the incomes of these two groups of employees are not different.

Therefore we can say that the average monthly incomes gained by the public and private sector employees are not significantly different. However, It should be noted that public sector employees earn more in their work ($ 559) than private sector's employees ($ 432), although the difference is not statistically different (t-student: 1,589). In contrast, private sector'semployees earn more income in their secondary activities ($ 86) than in public sector's

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[3]FS : Food Security, FI : Food Insecurity

[4]The conclusion of the t-student test is based on the result of the Levene test of equality of variances. In our case, the assumption of homogeneity of variances was validated for all the variables except for the variable Age (P-value: 0.038).

[5]The income mentioned here consists of the main's activity income, secondary income or spouse's income, and other occasional income (child financial support or other familiar)

employees (\$ 71), although the difference is not statistically different (t-student: 1,589). The analysis of the percentage of income spent on food shows that private sector employees spend a high percentage of their income on food (31%) than those in the public sector (27%).In addition, public sector employees allocate a significant portion of their income to savings (18%) compare to private sector's employees (14%).

Model validation

The p-value of the Hosmer and Lemeshow test is 0.750 which stands above the significance level of 0.05. Therefore, we accept the null hypothesis of global significance of our model stating that our model is well specified. Regarding the multinomial logistic model, it is clear that the model's fitting information shows that the final model is significant (P-value: 0.000).Moreover, the value of the pseudo R^2 being of 0.366 according to the Nagelkerke statistic shows that 36.6% of the variations of our model are explained by the explanatory variables.

Correlation matrix of the explanatory variables

Table 3: Correlation of the explanatory variable of our model

	SPOUSACTIVITY	GENDER	AGE	EDUCATION	SIZEHOUS	BUSINACT	SECONDACT	INCOME	NUTRITIO	SAVINGS	RESSACC
SPOUSACTIVITY	1										
GENDER	0.169*	1									
AGE	0.213**	0.206**	1								
EDUCATION	-0.113	0.219**	0.00908	1							
SIZEHOUSE	0.236***	0.0179	0.288***	-0.102	1						
BUSINACT	-0.0215	-0.0631	-0.276***	-0.116	0.067	1					
SECONDACT	0.0237	-0.0322	0.169*	-0.0775	-0.0198	-0.124	1				
INCOME	-0.0313	0.119	0.219**	0.0718	0.177*	-0.00956	-0.173*	1			
NUTRITION	-0.0228	-0.0901	0.0532	-0.182**	0.108	0.0254	0.117	-0.266***	1		
SAVINGS	-0.00669	0.117	-0.0189	0.159*	-0.180*	-0.0296	0.0234	0.122	0.406***	1	
RESSACC	-0.178*	0.0214	0.0238	0.0983	-0.0711	-0.132	0.0799	0.0743	-0.0313	0.138	1

* p<0.05, ** p<0.01, *** p<0.001

This correlation matrix gives an idea of the multicollinearity between our explanatory variables.Indeed, we find that the correlation between independent variables is too weak and their square is less than the pseudo R^2(0.366) that we established. This shows that our independent variables are mutually independent.

Predictive power of the model: confusion matrix and ROC curve

Tableau 4 : Model prediction

Observation		Prediction			
		Nutritional status			
		FI	FS	TOTAL	% Correct
Nutritional status	FI	15	51	66	22.7
	FS	10	124	134	92.5
% Global					69.5

Source: authors' analysis

At the 5% threshold, we find that the model ranks 69.5% of cases correctly. Therefore, we affirm that our model has a good predictive power, the error rate of the model being 30.5%.Since our variable of interest is food security, we find that the model ranks up to 92.5% of food security cases correctly, while food insecure cases are only ranked at 22.7% of correct cases.

Area under ROC curve = 0.6602
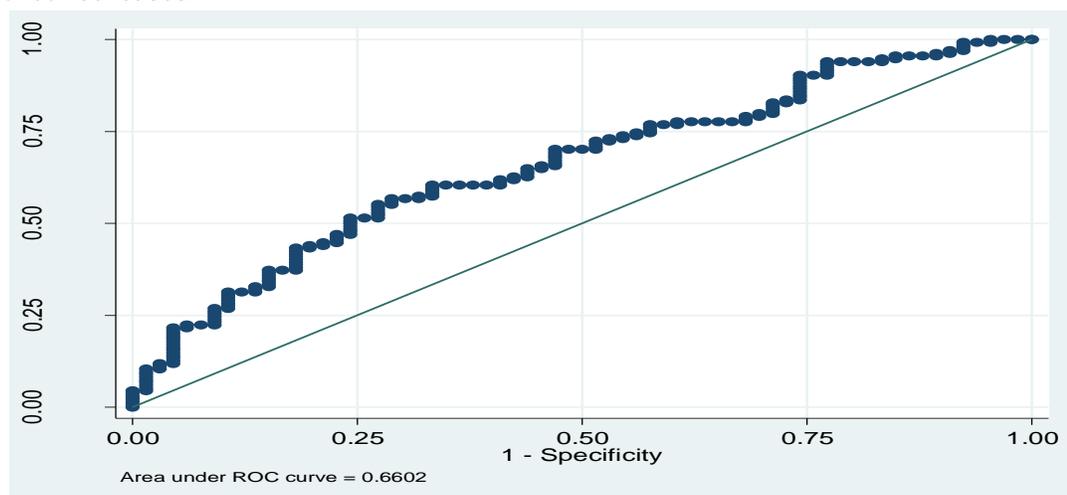
Figure 1: The ROC curve and the AUC test

The area under the ROC curve is 0.66. This result gives information on the performance criterion of our respondents' answers and shows that the curve is not too far from the first bisector. With an AUC (area under the ROC curve) of 66%, we confirm that 66% of our respondents' answers are accurate.

Estimations results

Table 5: Binomial and multinomial estimation results

Variables	Modèle A		Modèle B		Modèle C	
	NS, FCS1, FCS2		NS, **FCS1,** FCS2		NS, FCS1, *FCS2*	
	Coeff	Odds ratio	Coeff	Odds ratio	Coeff	Odds ratio
BUSINACT	.185	1.204	-11.641	8.802	-11.366*	1.159
	(0.593)		(0.196)		(0.038)	
AGE	-.010	.990	-0.446	0.640	-0.458**	0.633
	(0.526)		(0.224)		(0.061)	
SIZEHOUSE	.016	1.016	-1.207	0.299	-1.231	0.292
	(0.824)		(0.176)		(0.165)	
INCOMEHOUSE	.000	1.000	0.046	1.047	0.047*	1.049
	(0.179)		(0.119)		(0.000)	
NUTRITION	.001	1.001	-0.242	0.785	0.240*	0.787
	(0.954)		(0.135)		(0.003)	
SAVINGS	-.005	.995	-0.313	0.731	-0.312**	0.732
	(0.693)		(0.150)		(0.071)	
EDUCATION	.521*	1.683	-1.488	0.226	-1.297	0.273
	(0.026)		(0. 380)		(0.528)	
SPOUSACTIVITY	-.131	.877	3.821	45.638	4.492	89.301
	(0.700)		(0.471)		(0.196)	
GENDER	-.283	.753	3.317	27.567	3.224	25.133
	(0.408)		(0.295)		(0.448)	
SECONDACT	-.174	.840	4.628	102.310	4.421	83.192
	(0.645)		(0.350)		(0.480)	
RESSACC	-.792*	.453	-5.853	0.003	-6.266**	0.002
	(0.016)		(0.191)		(0.071)	
Constant	-.003	.997	59.497		59.860*	
	(0.998)		(0.179)		(0.002)	

Source : Nos analyses. Notes : *, ** indique la significativité des variables au seuil respectifs de 5% et 10%.

The model A shows the first binary logistic regression model with the Nutritional Status (NS) as the endogenous variable while models B and C indicate the multinomial logistic regression model with the category "borderline consumption" as the modality explained by the model B and the category "acceptable consumption" as the modality explained by model C.

This retrospective study reveals that, the level of education and the rate of access to food resources are considered as discriminating factors between households in food security and those in food insecurity from public and private employees in Bukavu. Indeed, the results show that when the level of study of the head of households increases, it results in the increase of the probability of the household to be in food security.Therefore, when the level of education of the head of the household increases, the probability of the household of being in food secure increases by 68.3%[6]. This result aligns with those obtained by the National Institute of Public Society of Quebec (2011) and (Taondyande, 2009) which show respectively that one of ten households with less educated households is in food insecure.

Moreover, the later study shows that a household with a primary education level is 11.5% at risk of under-nourishment than households headed by an illiterate. In addition to the level of education of the head of the household, the variable rate of access to food resources shows that the households in which the head of the household consumes outside his household are more exposed to food insecurity.Indeed, it can be observed that 96 heads of households record consumption outside their households and spend on average, $ 133 per month. In this regards, it is shown that households headed by public sector's employees are the ones who consume more outside of their households and spend $ 148 per month while households headed by private sector employeesonly spend $ 98 per month.Regarding the multinomial logistic model, we note that the variables like the business sector, the age of the head of the household, the household income, the share of income devoted to foods and savings, and the rate of access to food resources allow to classify the households according to the nutritional value of their diets (poor consumption, borderline consumption, and acceptable consumption).

Indeed, we find that the fact that the head of the household works in the public sector decreases the probability of his household to access an acceptable consumptionby 15.9%.This situation is explained by the fact that the households headed by a public sector employee allocate less percentage of their income to food (27.3%) compare to the households headed by a private sector employee (31.2%). This situation is linked to the fact that these households allocate a high percentage of their income to savings (18.4%) while those in the private sector allocate only 14.8% of their income to savings. Further, we found that the rate of access to food resources was less in households headed by public sector employees (only 31.8% versus 48.8% in households headed by private sector employees), and they are able to consume about $ 148 each month outside of their households. In addition, the fact that a household is headed by an old person decreases the probability of having an acceptable consumptionby 36.7%. Regarding the household income, the model reveals that any increase in household income results in increasing the probability of a household to access an acceptable consumption by 4.9%. Therefore, we notice that when a household increases the share of its income devoted to food consumption, it results in the increase of 21.3% chance of having a sufficient consumption. In contrast, the increase in the share of income allocated to savings reduces the probability of having acceptable consumption by 26.8%. Last but not least, the model reveals that when the rate of access to food resources is not fair in the household, it reduces by 99.8% the chance of the household to access an acceptable consumption.

CONCLUSION

This paper sought to identify the socio-economic characteristics that could explain the food security of employees from the public and private sectors of a city in the Eastern of the Democratic Republic of Congo, in particular the city of Bukavu.35.5% of the 200 households surveyed were led by public sector employees while 64.5% were led by private sector employees. The results of this study reveal that the level of education and the rate of access to food resources explain the food security of households in Bukavu.In addition, the households under this study are mostly in food security and the prevalence of this status is much more observed among private sector employees than the public sector employees (68.2% against 64.8%).Indeed, when the level of education of the head of the household increases by one year, it is translated by the increase of 68,3% chance of the household to be in food security whereas any consumption outside the household exposes the household to food insecurity at a risk of 54.7%.

Using the Food Consumption Score approach, we have witnessed that public sector employees allocate a smaller percentage of their income to food and consume more outside their households, which exposes them to access poor consumption at 84.1%. In addition, any increase in income and the share of income spent on food

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[6](1.683-1)*100

increases the chance of the household to accessing an acceptable consumption. However, the age of the head of the household and the share of his income devoted to saving reduces the chance of the household to accessing an acceptable consumption.

Therefore, the policy arising from this study emphasis on raising the level of education of the population and the equitable redistribution of wealth, that would enable households of private and public sector employees to improve their nutritional status.

Last but not least, we do not pretend to have tackled all the aspects in this paper, other research can investigate the same issue by taking the similar direction or the opposite one.

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