

ANALYSIS OF THE DETERMINANTS OF PNEUMONIA IN CHILDREN UNDER 5 IN IVORY COAST: CASE OF THE GBEKE REGION

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ABSTRACT: *The objective of this study is to analyze the sociodemographic determinants of pneumonia in Ivory Coast. The data is sourced from a survey conducted on pneumonia and household characteristics by the Ivorian Society of Pediatrics (SIP). The study, carried out in the Gbêkè region, specifically in the health district of Béoumi, focused on 784 patients (children aged zero to five years) representative of both urban and rural areas. To achieve our goal, a dichotomous logit model was estimated. The results show that as household income increases and when mothers of children are educated, the likelihood of pneumonia occurrence decreases. Furthermore, the type of households used also plays a role as a factor in childhood pneumonia. On the other hand, the education level of the head of the household affects the decision to seek healthcare in case of pneumonia. These various findings have implications in terms of economic policy. Economic policy within the framework of the WHO-initiated Sustainable Development Goals (SDGs), aimed at reducing childhood illnesses, should place a particular focus on respiratory issues, especially childhood pneumonia, in the Gbêkè region.*

Keywords: *Pneumonia, Dichotomous logit, Socio-demographic, Childhood illness.*

Introduction

Pneumonia in children under five is a major public health problem. Indeed, among infectious diseases, pneumonia is the leading cause of death in children under 5 years of age. In 2017, 808,694 children under the age of 5 died of pneumonia, representing 15% of deaths in this age group globally¹. According to WHO/UNICEF data analysis reports (2006) the incidence of respiratory diseases, especially pneumonia, in sub-Saharan Africa and Asia scores highest in the world. In 2019, pneumonia accounted for 14% of all deaths of children under 5 (WHO, 2022). Globally, at least one child dies every day every 45 seconds from pneumonia (UNICEF, 2022). Indeed, 37% of mortality was due to death at birth and 20% was caused by acute respiratory infections. The WHO (2019) also notes that the regions of sub-Saharan Africa and Asia (central and southern) account for 80% of the 5.2 million mortality rates in 2019. The causes vary according to the areas, Africa counts, pneumonia (17%) as one of the leading causes of infant mortality.

Despite all the efforts made globally, pneumonia is still responsible for nearly one in five child deaths worldwide (WHO 2014). With the efforts made by governments, these various indicators have improved over time and more specifically in sub-Saharan Africa, but to a lesser extent. However, in countries such as Mali, Côte d'Ivoire and developing countries, acute respiratory infections (ARI) are one of the main causes of infant and child deaths causing 1.3 million deaths in 2012².

Infant health and child well-being have always been a concern for some economists, to this end several works have been carried out for the improvement of health and well-being. Health, as a component of human capital, is one of the fundamental sectors for the development and growth of any economy, and which remains at

¹WHO, 2021

²Training for mothers: strategy to improve the treatment of acute respiratory infections in Mali

the center of the concerns of public authorities³. Health is central to well-being and a prerequisite for successful development. The World Health Organization (WHO), the United Nations agency concerned with global health issues, has defined health as "a state of complete physical, mental and social well-being and not merely the absence of disease and infirmity" (WHO, 1947). Health development induces growth in the sense that a healthy population is more productive and the spillover effects of this productivity have a medium and long-term impact on economic growth and social well-being.

On the other hand, economic development would act on the state of health of the population. Becker (1964), defended the importance of associating the concept of human capital with that of health, because it would be advantageous to acquire more knowledge in a specific domain, in particular health. Thus pneumonia, which takes on qualities of knowledge of certain favoring factors, the contribution of human capital is a fundamental element which would therefore make it possible to considerably reduce this phenomenon. In addition, a number of studies carried out in countries with a high burden of childhood pneumonia have compared the costs of treating these pneumonias at home, in outpatients and in hospitals. The overall conclusion is that hospitalization costs are much higher than home treatment costs⁴. With regard to the determinants of child health, many works have evoked preponderant factors.

According to the study conducted by Dieng et al. (2015), using a multinomial probit model, shows that low-income households forgo health care. These individuals who decide to seek treatment also follow therapeutic itineraries that often differ according to their standard of living. The non-poor compared to the poor practice self-medication much more than recourse to external health services.

In a study by Tiehi (2012) rich households and urban households have a stronger preference for private practitioners than poor households, which therefore reflects the need for income in the demand for health care. On the other hand, Koné et al. (2013), on a study of access to care in the event of fever in an urban environment in the context of drug subsidies, demonstrate through a multilevel approach that the richer the household, the greater the probability of using public health services in case of fever instead of resorting to self-medication is great. In 2018, N'Da and Aka, on a study of therapeutic behavior of households in Côte d'Ivoire with a multinomial probit model, shows that the level of education is not only decisive for the use of quality care but is also linked to the use of traditional treatments.

Basu et al. (2020) focus on the effects of indoor air pollution (IAP) from fuel use on child mortality in India. Within households, Uddin et al. (2013) further explained that children from polluted indoor houses in Bangladesh were 5 times more likely to develop pneumonia than children from relatively clean indoor air. Similarly, a child whose parents used charcoal as the main fuel were more likely to have pneumonia than those who did not as presented by Fekadu et al. (2014). Uddin et al. (2013) all conclude their work by stating that these pollutants negatively affect the airways of children under five. As a result, a mother who had learned how to manage this household smoking had a lower risk of her children developing pneumonia.

Other more general studies have been carried out, and in this context, Capuno et al. (2016) assessed the effect of household air pollution from the use of solid fuels for cooking on health, including acute respiratory infections in children. Therefore, various interventions to reduce household air pollution have been advocated or piloted in many countries.

The place of residence of the parents plays an important role in the prevention as the occurrence of pneumonia very few authors have conducted the studies. However, it can be noted here that the studies carried out by Abdelsafi A et al. (2012) who show, in a study conducted in Sudan, that pneumonia is more common in urban areas than in rural areas. Thus, the extent of pneumonia and these various factors may vary from country to country.

In Côte d'Ivoire, for example, we note that the modal value of the distribution of life expectancy has increased to 57 years in 2020, whereas it was 55 in 2017⁵. Although life expectancy has increased, infant mortality is increasing, according to the French Development Agency (AFD), Côte d'Ivoire recorded 108 deaths per 1000 live births in 2013 while the average infant mortality of the eight countries from tropical Africa was 101 per 1000 live births⁶. As for respiratory diseases in children under 5, the incidence fell from 191.5‰ in 2019 to 167.44‰ in 2020, a decrease of 12.56%. But which is still alarming. Regionally, in Côte d'Ivoire we observe at the regional level: Bélier (252.54‰), Gbêkè (241.89‰) and Marahoué (227.69‰) recorded the highest incidences of IRA for children under 5 years old. The health regions which recorded the lowest incidences are: Béré (85.87‰), Tchologo (96.74‰) and Folon (102.54‰). It is clearly observed that in Côte d'Ivoire, according

³Mohamed Adaskou ., Idriss Houmam & Hassan Onbough . Healthcare demand and supply: advances and theoretical models Volume 2, Issue 3 (May, 2021), pp.66-85.

⁴ Classification and treatment of pneumonia cases in children in health facilities according to WHO

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⁶National Institute of Public Health Research, Bamako, Mali and French Institute of Scientific Research for Development in Cooperation, Paris, France.

to the regional figures presented, ARI pose a real public health problem. Thus the Gbêkè area records the highest incidence rate, hence the interest of a study in this area.

In order to reduce pneumonia, the State of Côte d'Ivoire is leading the fight against preventable diseases in children according to the millennium objective set by the WHO, in particular by supporting communities in raising awareness and by supporting NGOs fighting against pneumonia, ARI is still a concern and is one of the main causes of death.

It is recognized that pneumonia is a real public health problem in that it is the second leading cause of death after malaria (RASS, 2020). To this end, care entails enormous economic effort vis-à-vis households, and especially in community life.

From this fact, it is therefore important to ask the following question:

- What are the socio-demographic determinants of childhood pneumonia in Côte d'Ivoire?
- What is the effect of household charcoal use on child health?

The general objective of our study is to analyze the socio-demographic determinants that can further explain the occurrence of pneumonia in children under 5 years of age in the Gbêkè region, and more specifically in the Béoumi health district. More specifically, it will be a question of studying the effect of socio-economic factors and evaluating the effect of the use of charcoal in households. From this, the following hypotheses result:

-Socio-economic conditions are determining factors in the occurrence of childhood pneumonia.

-The use of charcoal in households is the cause of childhood pneumonia.

The study on the socio-demographic determinants of pneumonia in Côte d'Ivoire is important because it is an integral part of the Sustainable Development Goals (SDGs) in order to put an end to preventable deaths attributable to pneumonia. It will make it possible to relate pneumonia to the child's environment. Thus in families, in particular, mothers or daughters of households who are most often in direct contact with children constitute the pillars for the well-being of children, hence their instruction in certain daily practices must be accentuated, especially in the practices Essential Family Care (EFP). Knowledge of the explanatory factors could not only strengthen the level of education but also allow parents, the State in its health system policy and the organizations in charge of childhood respiratory diseases to considerably reduce respiratory diseases, in particular pneumonia. .

I. Methodological approach

For this work we used the database of the Ministry of Health through the Ivorian pediatric society (SIP). The study involved 784 patients (children from zero to five years old) representative of urban and rural areas. The data used are provided by Béoumi General Hospital in the Gbêkè region. A single individual household questionnaire was used to collect information on pneumonia and household characteristics.

1.1. Model and estimate

Econometric regression is a very commonly used technique to describe the relationship between a variable to be explained and one or more explanatory variables. When the variable to be explained is a qualitative variable, classical linear regression in the sense of least squares must be abandoned in favor of logistic regression. If the variable to be explained has only two modalities, binary logistic regression is used. If it has more than two modalities and if these are not ordered, nominal polychotomous logistic regression must be used. Finally, if the variable to be explained has more than two modalities and these are ordered, the method to be used is ordinal polychotomous regression. In the case of this study, the explained variable pneumonia takes two modalities, namely sick or healthy. From this angle, the explained variable is dichotomous (binary). The appropriate estimation method is binary logistic regression.

1.2. Presentation of the model

When the variable to be explained has two modalities coded for example $y = 1$ and $y = 0$, the objective is to model, as a function of x , the probability of belonging to one of the two categories, called success or event. We denote this probability $\pi(x_i)$, or more simply π . However, the probabilities $\pi(x_i)$ evolve in a non-linear way as a function of x_i . Moreover, the variance of these probabilities varies with x_i . It follows that the use of a linear model expressing π as a function of x and adjusted by classical least squares is not an adequate solution, the conditions for applying the regression – linearity and constancy of the conditional variance – not being fulfilled. For this reason, we perform a transformation of the probability of success $g(\pi(x_i))$. This transformation is called link function (link function), and thereafter will be denoted simply g . Several link functions exist but the most commonly used is the logit function:

$$g = \text{logit}(\pi) = \log[\pi / (1 - \pi)],$$

Because it leads to a simple interpretation of the results, but also for theoretical reasons (Collett, 1999).

The regression model is then written:

$$g = \alpha + \beta x$$

Where α and β are parameters to be estimated, most often by the maximum likelihood method. The inverse transformation then makes it possible to find the estimated probabilities as a function of x :

$$\pi = \frac{\exp(g)}{1 + \exp(g)}$$

which are always between 0 and 1. For a given value x_i , the ratio between the probability of success π and the probability of failure $1 - \pi$ is called luck or odds, but is most often referred to by the English term odds. It is equal to:

$$\frac{\pi}{(1 - \pi)} = \exp(g)$$

When the probability of success is greater than the probability of failure, the odds is greater than unity. If the two probabilities are equal, the odds is equal to 1. Finally, if the probability of success is smaller than the probability of failure, the odds is less than one. If we now consider the ratio between the odds relative to $x_i + 1$ and to x_i , we define the odds ratio or odds ratio, more often referred to by the English term odds ratio, which is directly linked to the regression coefficient β :

$$\frac{\pi(x_i + 1)/[1 - \pi(x_i + 1)]}{\pi(x_i)/[1 - \pi(x_i)]} = \exp(\beta)$$

The odds ratio is never negative, but has no upper bound. A value equal to unity means that the odds for x_i are equal to the odds for $x_i + 1$. In this situation, the explanatory variable therefore has no effect on the odds and the regression coefficient is zero. An odds ratio lower than unity corresponds to a negative regression coefficient and means that the probability of success decreases when x increases. An odds ratio greater than one corresponds to a positive regression coefficient and means that the probability of success increases when x increases. When the explanatory variable is continuous, the odds ratio is sometimes very close to 1, a difference of one unit of x being insufficient to significantly modify the odds ratios. In this case, it may be preferable to calculate the odds ratio for a modification δ of the explanatory variable. We then have:

$$\frac{\pi(x_i + \delta)/[1 - \pi(x_i + \delta)]}{\pi(x_i)/[1 - \pi(x_i)]} = \exp(\delta\beta)$$

1.3. Specification of the study model

We follow the work of Dieng et al. (2015) to specify our econometric model. Based on the general presentation of the logit model and Dieng et al. (2015), we specify our model as follows: the explained variable pneumonia takes two modalities: 0 or 1

$$y_i = \begin{cases} 1 & \text{if pneumonia} \\ 0 & \text{if no} \end{cases}$$

The econometric model is given by: $y_i = \alpha + \beta x_i + \varepsilon_i$

α : constant

β : coefficient to estimate

ε_i : error terme

Taking our variables into account, the previous specification becomes:

$$Pneumonia_i = \alpha + \beta_1 living\ environment_i + \beta_2 household\ income_i + \beta_3 mothers'\ education_i + \beta_4 marital\ status_i + \beta_5 type\ of\ cuisine_i + \beta_6 ttype\ of\ household_i + \beta_7 head\ of\ household's\ education\ level_i + \varepsilon_i$$

3.1.1. Variable explained.

The phenomenon we seek to explain is the probability of occurrence of pneumonia in the population. It is part of ARI type diseases (Acute Respiratory Infections). It is caused in developing countries by a bacterium (Haemophilus influenzae type b). Pneumonia is the leading cause of consultation among ARI. It is the second leading cause of infant and child mortality after malaria (RASS, 2020). The explained variable pneumonia takes two modalities: 0 or 1; 1 for presence of pneumonia and 0 for absence of pneumonia.

Table 1: Distribution of pneumonia

<i>PNEUMONIA</i>			
	Freq .	Percent	Cum.
<i>healthy</i>	651	83.04	83.04
<i>Sick</i>	133	16.96	100
<i>Total</i>	784	100	

Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

In the sample studied, about 17% are suffering from pneumonia. This implies that 83% of individuals are healthy.

3.1.2. Characteristics of explanatory variables

The explanatory variables take into account the socio-demographic variables and the economic variables. Sociodemographic variables include living environment, parental education level and parental marital status and economic variables take into account threat income.

3.1.2.1. Household living environment

For these variables, several authors have used the place of residence to show the importance in decision-making of healthcare recourse. Tiehi (2013) who realizes through a multinomial probit that women from urban households have a strong preference for modern health services (public and private) than women from rural households. This variable is found in the studies conducted by Abdelsafi A et al. (2012) who show, in a study conducted in Sudan, that pneumonia is more common in urban areas than in rural areas.

This variable describes the place of residence of the children. In this study, this variable takes two modalities; 1 for rural and zero urban. Here, we relate living environment and pneumonia. According to the sample analysis, a high concentration of the study population lives in rural areas (455), and there are 94 children with pneumonia.

This analysis shows that children in rural areas are more likely to get pneumonia than children living in urban areas. To this end, the living environment of households represents an important element in the occurrence of pneumonia. And as part of the fight, government actions and non-governmental organizations must more effectively target their awareness in rural areas to reduce pneumonia.

Table 2: Distribution of households according to living environment

LIVING ENVIRONMENT OF HOUSEHOLDS			
PNEUMONIA	Urban	Rural	Total
HEALTHY	196	455	651
SICK	39	94	133
TOTAL	235	549	784

Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

3.1.2.2. Level of education of the head of household

The education of the head of household has been taken into account in certain works, such as that of (Barman et al. 2020) finds that the level of household education, that of the head of the family, is positively and very significantly associated with the use of health services. Audibert et al. (2014) in a study showing that individuals residing in households with a level of education of the head of household equivalent to at least secondary school, have a higher probability of seeking care than of practicing self-medication, unlike individuals living in households that have no level. In this context, we have retained this variable in our study because it captures the level of understanding of the heads of families.

The variable level of education of the head of household takes two modalities; educated (modality 1), uneducated (modality 0). In this analysis children with pneumonia (70) have uneducated parents. Note that in this part we have considered modality 1 as a primary level, and the second modality as no level of instruction. In this study, regardless of the level of education of the household head (no level or primary level), the probability of being ill is substantially equal. We find in the results: sick children (70) with a head of family with no level, and (63) sick children with a head of family with a primary level. Consequently, the slightly higher level of education of the head of the household would make it possible to take the decision more quickly to react to the disease and to seek health care.

Table 3: Distribution of level of education of the head of household

LEVEL OF EDUCATION OF THE HEAD OF HOUSEHOLD			
PNEUMONIA	Uneducated	educated	TOTAL
Healthy	386	265	651
Sick	70	63	133
Total	456	328	784

Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

3.1.2.3. Educational level of mothers

The level of education of the mothers is a selective variable in the case of childhood pneumonia because, the level of education of the mother is high, and the less one has recourse to self-medication. Kone et al. (2013). This variable allows us to capture the level of understanding of mothers in the face of a disease

The mother's level of education variable takes two modalities; educated (modality 1), uneducated (modality 0). Statistical analysis shows that the majority of children with pneumonia with uneducated mother's number 75, on the other hand educated mothers have sick children numbering 58.

The "uneducated" have a positive impact on childhood pneumonia. According to the results, when the level of education increases, it will tend to improve the quality of life of the children living in the household. These results are in line with those obtained by and Perrin (2000)⁷ in Côte d'Ivoire. This reflects the importance of mothers' education in childhood pneumonia.

Indeed, in households, children spend more time with their mother than their father. Thus the education of mothers is closely linked to many behaviors and choices conducive to good health, even taking income into account. Therefore, this level of education of mothers is a determining factor in the use they can make of health services.

Table 4: Distribution of educational level of mothers

LEVEL OF EDUCATION OF MOTHERS			
PNEUMONIA	Uneducated	Educated	Total
HEALTHY	394	257	651
SICK	75	58	133
TOTAL	469	315	784

Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

3.1.2.4. The type of cuisine

The kitchen type variable takes two modalities 1 for open kitchen and zero for closed kitchen. According to the analysis, open kitchens have higher sickness rates (76) than closed ones (57). At this level, children who inhale smoke from firewood inside and outside kitchens are also exposed, and are likely to develop pneumonia. Note also that the quality of ambient air can be associated.

Table 5: Breakdown of cuisine type

TYPE OF CUISINE			
PNEUMONIA	Open	Farm	Total
HEALTHY	394	256	650
SICK	76	57	133
TOTAL	470	313	783

Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

3.1.2.5. The marital status of the parents

This variable was used in particular by Uldbjerg et al. (2019), they find that lack of husband support was perceived to negatively affect health center utilization. Hence in our study we use it in the same context. The marital status variable takes two modalities 1 for married and zero for unmarried. Marital status questions were asked of all eligible women and men in the sample. In the context of the study, all officially married women and men as well as all those living in a consensual union were considered to be in a union. According to this definition, our analysis shows that 67.65% of people are unmarried against 32.35%. Concerning young unmarried women, having children under five years old, and being the head of the family, do not really manage to take charge financially of the states of morbidity of their children, unlike married women who often have recourse to their husbands. . This also explains the use of self-medication. The following table shows the breakdown of marital status by household.

The choice of spouses is also a strong weapon of the household since there is a tendency for more educated women to marry educated men (Breierova & Duflo, 2004)⁸ where the children from this couple are more likely to have better living conditions. of life and health.

Table: Distribution of marital status

MARITAL STATUS			
	Freq .	Percentage	Cum.
<i>Not married</i>	527	67.65	67.65

⁷PERRIN, H. (2000) Payment for care by users: an equitable care system? Sensitivity analysis of health care demand in Abidjan, CERDI, Clermont-Ferrand, International Colloquium, 30 Nov-1 Dec.

⁸Breierova, L., & Duflo, E. (2004) The Impact of Education on Fertility and Child Mortality: Do Fathers Really Matter Less Than Mothers? National Bureau of Economics Research , Inc.

<i>Married</i>	252	32.35	100.00
<i>Total</i>	779	100.00	

Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

3.1.2.6. The type of fireplace

Smoke produced in the household is the cause of pneumonia. And according to several authors, who have used the variable to explain this phenomenon, we find a study conducted by Roza kumdin Seramo et al. (2022) in public health facilities in Worabe city , Ethiopia. It appears that children with pneumonia were carried on their backs during meal preparation and were more exposed to smoke. This variable is also useful in our framework.

The type of stove in our study is defined according to the use of gas, or firewood to cook food in the household. In this study a binary variable which takes two modalities namely 0: for gas and 1 for firewood. According to the analysis, the proportion of households using charcoal is 50.90%, and those using gas is 49.10%.

Table 6: Breakdown of household type

	TYPE OF FIREPLACES		
	Freq .	%	Cum.
GAS	384	49.10	49.10
CHARCOAL	398	50.90	100.00
TOTAL	782	100.00	

Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

3.1.2.7. Characteristics of the economic variable: household income.

Income occupies a place in all human activity, thus, in the context of health, it causes a real problem for low-income households, and however several authors have looked into this variable. Ngwen (2018) showed by a multinomial logit that income influences the use of care, as well as Dieng et al. (2015), using a multinomial probit model, shows that low-income households forgo health care.

The observation of this table shows that the average income of respondents is 117748.7. There are public and private employees in the informal sector. Household income plays an important role in the decision to seek medical care or not. To this end, low-income households resort to self-medication, unlike those with high incomes, who resort to health care (Dieng et al. (2015)).

Table 7: Distribution of household income

<i>Variable</i>	<i>Effective</i>	<i>Mean</i>	<i>Standard deviation.</i>	<i>Minimum</i>	<i>Max</i>
HOUSEHOLD INCOME	784	117748.7	43239.68	60000	250000

Source : Author, based on data from the Ministry of Health (HG Béoumi , 2021)

II. Results and economic interpretations

Previously we presented the methodology related to our subject. This will present the main results obtained. Once this task has been completed, we will provide an economic interpretation of the results from which we will identify the implications for economic policy.

2.1. Results.

The following table presents the summary of the results obtained after estimation of the logit model.

Table 8: Results of the logit model

PNEUMONIA	coefficient,	Std , Err ,	Z	P> z
REV	-1.379***	0.373	-3.7	0.000
ENVIRONMENT	Ref (urban)			
Rural	-0.311	0.237	-1.31	0.189
EDUCATIONAL LEVEL OF THE HEAD OF H	Ref (not instructed)			
Educated	1.216**	0.476	2.56	0.011
KITCHENTYPE	Ref (open)			
Closed	0.142	0.196	0.73	0.468
EDUCATIONAL LEVEL OF MOTHERS	Ref (not educated)			
Educated	-0.839*	0.466	-1.8	0.072

MARITAL STATUS	Ref (not married)			
Married	-0.051	0.208	-0.25	0.804
TYPE OF FIREPLACES	Ref (gas)			
Charcoal	-0.383*	0.200	-1.91	0.056
_cons	14,588**	4,364	3.34	0.001
OBSERVATIONS	776			
Wald(7)	19.95			
Prob > chi2	0.0057			
Nickname R2	0.0282			

Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

Note: (***) , (**) and (*) , indicate the respective levels of significance of 1% , 5% , 10%

It appears that the income, the level of education of the head of the household, of the mothers and the type of stove used by the households are significant at the respective threshold of 1% , 5% , 10% and 10%. In addition, the income, the level of education of the mothers and the type of stove used by the households reduce the probability of the onset of pneumonia, while the level of education of the head of the household increases this probability. However, it should be emphasized that the coefficients are not directly interpretable. In order to be able to interpret we determine the marginal effects. The following table presents the summary of its results.

Table 9: Results of marginal effects

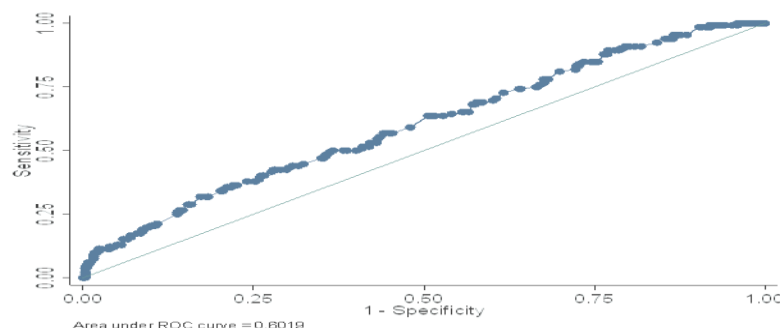
Variable	dy /dx	Std , Err ,	Z	P> z
REV	-0.1864967	0.04875	-3.83	0.000
MIDLIFE *	-0.0439797	0.03484	-1.26	0.207
EDUCATIONAL LEVELTHE HEAD OF H *	0.1770802	0.0734	2.41	0.016
KITCHENTYPE *	0.0195108	0.02713	0.72	0.472
EDUCATIONAL LEVEL OF MOTHERS *	-0.1078185	0.05683	-1.9	0.058
MARITAL STATUS *	-0.0069479	0.02785	-0.25	0.803
TYPE OF FIREPLACES *	-0.0519881	0.02711	-1.92	0.055

Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

Note: (*), indicates that the variables are discrete

An increase in income leads to a decrease in the probability of pneumonia in the population studied in the order of 18.64%. As the level of education of the head of household increases, the probability of occurrence of pneumonia increases. When the educational level of the mother increases the probability of pneumonia occurrence is low. The choice of the type of focus influences the probability of the occurrence of pneumonia. Apart from the analysis of the marginal effects, we also analyzed the sensitivity and specificity of the model. This analysis is made from the ROC curve.

Chart 1: Sensitivity and specificity analysis.



Source: Author, based on data from the Ministry of Health (HG Béoumi , 2021)

The ROC curve shows the sensitivity of the onset of pneumonia. The area under the ROC curve of the model is 0.6019. Therefore the discriminating power of the model is acceptable.

The following section will be devoted to the economic analysis of the results and the implications for economic policies.

4.2. Economic interpretation.

4.2.1. Household income

An increase in income leads to a decrease in the probability of pneumonia in the population studied in the order of 18.64%. This result could be explained by the fact that as family income decreases, children's health becomes increasingly poor. At first, most low-income households do not care about illnesses, in other words there is no way to save in case of illness, since low-income households have always put health in the background. In a second plan, the expenses of the extended family including the unforeseen. However, when the income increases, that positively influences the decision of the households to seek health care. We find this result in the work of Tapé (2006). Also, higher risk factors for childhood pneumonia in Somalia were associated with lack of income, level of education and environment and where firewood is used for cooking (Adawe et al, 2023).

Income has a negative and significant impact on childhood pneumonia. This highlights the fact that as income increases, individuals tend to abandon traditional practices and resort to modern health care in order to obtain quality care. When considering access to economic resources, there is a universal trend that shows that educated mothers are more likely to access quality employment that allows them to have a high income. They can therefore afford better living conditions in the household, adopt health-promoting behaviors such as using health care services.

4.2.2. Level of education of the head of the family

Apart from his economic power in the household, the social position of men and their interest in the welfare of children may vary according to the social and cultural norms of each country. In fact, his education can give him skills to assert in favor or against traditional practices which can have an impact on the health of children (Baya, 1998)⁹, the probability of occurrence of pneumonia is high. This would explain that the children are most of the time in the care of the mothers and according to our traditional sources the phenomenon of matriarchy is present in this area. Most children are left in the care of mothers, mothers most often without income-generating activity, and the head of household has always left in most households.

The level of education of heads of household can represent a constraint in the family health system insofar as they are expected to make the right decision for their family. However, for better consideration of education on the use of care, it would be interesting to take into account the level of education of other family members. Thus the level of education is not only decisive for the use of quality care but is also linked to the use of traditional care (N'Da and Aka, 2018).

4.2.3. Mother's level of education

Maternal education is generally recognized as a powerful determinant of children's chances of survival. When taken into account, the impact of the father's education on child survival is considered to be less important. Therefore when the level of education of the mother increases the probability of occurrence pneumonia is low. Educated mothers are more likely than uneducated mothers to use modern medical services both for prevention and for curative care in the event of illness. This would sometimes explain why mothers with a level of education are more likely to attribute natural causes to illnesses. Mother's education was inversely related to pneumonia, but these associations did not persist in the final model (Fald et al, 2020) . Conversely, uneducated adults overwhelmingly felt that illnesses had rather supernatural causes.

Moreover, if the mother's level of education is high, the probability of recourse to traditional care and self-medication is low Koné et al. (2013) unlike that of the head of household.

Some studies have shown the linearity of the association between mother's education and child health, indicating that even a low level of education has a significant effect on health (Basu and Stephenson, 2005)¹⁰ quality of education in primary education is relatively low and where a significant segment of the population drops out of primary education without knowing how to read properly (World Bank, 2009). This situation is therefore not without consequences for cognitive abilities of learners. As a result, women's ability to access health information, to exercise critical judgment or to communicate effectively may be impaired in those who have had no schooling.

4.2.4 . Choosing the type of fireplace

The type of focus influences the probability of the occurrence of pneumonia. The results show that smoke from homes using mainly wood as fuel inside households or kitchens is the cause of childhood pneumonia. In this savannah area, it is easier to find firewood in the fields and also in or near households, hence Households prefer fuelwood for their cooking, which is easy and cheaper to find, unlike gas. . However, open kitchens, using charcoal as fuel, associated with atmospheric pollutants in the locality would be a convincing

⁹Baya, B. (1998) Parental education and child survival in Burkina Faso: the case of Bobo Dioulasso. 48. CEPED Files. Paris: CEPED.

¹⁰ Basu , AM, & Stephenson, R. (2005). Low levels of maternal education and the proximate determinants of childhood mortality: a little learning is not a dangerous thing. Soc Sci Med, 60(9), 2011-2023

factor. In other words, air quality as a confounding factor (Carreras et al. 2015). On the other hand, the use of gas in households would reduce the occurrence of pneumonia.

Conclusion

The aim of this study was to assess the factors that could explain the risk of pneumonia occurrence in Côte d'Ivoire, specifically in the Gbêkè region, more precisely within the Béoumi health district. The objective was to evaluate the indoor air quality in households, identify the mothers' education level, and assess household income. This study was primarily conducted in the Gbêkè region, where rates of respiratory diseases, particularly pneumonia, are the highest. Using a logistic model, the obtained results reveal that socio-demographic and economic factors influence the probability of pneumonia occurrence. Our results showed that as household income increases, and when mothers of children are educated, the probability of pneumonia occurrence decreases. Additionally, open households reduce the risk of pneumonia even when using charcoal as a cooking fuel. Conversely, an increase in the education level of the head of the household could potentially increase the likelihood of pneumonia occurrence. Ultimately, the mothers' education level, the type of households used, and the education level of the head of the household are the primary determinants of childhood pneumonia in Côte d'Ivoire. However, these socio-demographic and economic factors significantly reduce the risks of pneumonia occurrence in Côte d'Ivoire.

These various findings have implications for economic policy. Economic policy within the framework of the WHO-initiated Sustainable Development Goals (SDGs), aimed at reducing childhood illnesses, should place a particular emphasis on respiratory issues, particularly childhood pneumonia, in the Gbêkè region. Given the low average household income in this locality, economic policy should establish a system to financially support household activities in order to increase their income. In this region with a high incidence of respiratory diseases, policies should support community awareness initiatives targeting mothers about the environmental factors that contribute to pneumonia occurrence. Furthermore, this policy should provide assistance to households, enabling them to acquire improved stoves with the goal of significantly reducing smoke from wood burning. Education is crucial in any society, therefore, it is imperative to prioritize it. The government, through its efforts towards free education, should further encourage the enrollment of all children from a young age, especially girls, as they will become future mothers later on.

References

- [1] Abdelsafi A G , Goaher M A and Mohammed A E (2014) , Childhood Pneumonia at Omdurman Pediatric Hospital, Khartoum, Sudan, *International Journal of Multidisciplinary and Current Research* 2, 1139-1141
- [2] Adawe , Mohamed Osman and Odongo , Alfred Owino and Kariuki , John Gachuki (2023) *Risk factors associated with pneumonia in children under 5 at Banadir Hospital , Mogadishu, Somalia*. *Asian Journal of Medicine and Health*, 21, 8, 1-11.
- [3] Ali, FRM, and Elsayed , M. AA (2017). The effect of parental education on child health: Quasi-experimental evidence from a reduction in the length of primary schooling in Egypt. *Health Economics*, 27, 4, 649–662.
- [4] Arnab K. Basu , Tsenguunjav Byambasuren , Nancy H. Chau, and Neha Khanna, (2020), cooking fuel choice, indoor air quality and child mortality in India.
- [5] Basu , AM, & Stephenson, R. (2005). Low levels of maternal education and the proximate determinants of childhood mortality: a little learning is not a dangerous thing. *Soc Sci Med*, 60, 9, 2011-2023.
- [6] Baya, B. (1998). Parental education and child survival in Burkina Faso: the case of Bobo Dioulasso. 48. CEPED Files. Paris: CEPED.
- [7] Breierova , L., & Duflo, E. (2004): The Impact of Education on Fertility and Child Mortality: Do Fathers Really Matter Less Than Mothers? National Bureau of Economic Research, Inc.
- [8] Capuno , JJ, Tan, CAR, & Javier, X. (2016). Cooking and coughing: Estimating the effects of clean fuel for cooking on the respiratory health of children in the Philippines. *Global Public Health* , 13(1), 20-34.
- [9] Carreras, H., Zanobetti , A., & Koutrakis , P. (2015) . Effect of daily temperature range on respiratory health in Argentina and its modification by impaired socio- economic conditions and PM₁₀ exposures . *Environmental Pollution*, 206, 175-182
- [10] Diallo A., Michalek IM, Bah IK, Diallo IA, Sy T., Roth- Kleiner M. and Desseauve D. (2020), “Maternal mortality risk indicators: Case-control study at a referral hospital in Guinea”, *European Journal of Obstetrics & Gynecology and Reproductive Biology*, 251, 254 -257
- [11] Dieng M, Audibert M, Hesran J. Y, Dial TD, (2015), Determinants of healthcare demand in peri-urban areas in a subsidy context in Pikine, Senegal . Studies and Documents No. 15, CERDI, National Reproductive Health/Family Planning Policy Document, 20, 08.

- [12] Elizabeth Washbrook , Paul Gregg , Carol Propper , (2014), A decomposition analysis of the relationship between parental income and multiple child outcomes, *Journal of the Royal Statistical Society*, 177, 4, 757-782.
- [13] Evans RG, Stoddart GL. (1994), Producing Health, Consuming Health Care. In: *Why Are Some People Healthy and Others Not? The Determinants of Health of Populations*.
- [14] Fadl , N., Ashour , A. & Yousry M, Y(2020), Pneumonia in children under five in Alexandria, Egypt: a case-control study. *J. Egypt. Audience. Health. Assoc.* 95, 14.
- [15] Fekadu G., Terefe M., and Alemie G.(2014), "Prevalence of pneumonia among under-five children in Este town and the surrounding rural kebeles , Northwest Ethiopia; A community-based cross-sectional study," *Science Journal of Public Health*, 2, 3, 150.
- [16] Gary s. Becker, (1964), human capital, a theoretical and empirical analysis with special reference to education, *university of Chicago press*, 25.
- [17] Global Health Observatory, 201, Proportions of child deaths by cause.
- [18] Koné Georges, Audibert Martine, Stéphanie Dos Santos, Lalou Richard (2013), Access to care for fever in urban areas in the context of drug subsidies: a multi-level approach.
- [19] Marilys Victoire Razakamanana , Martine Audibert, Voahirana Tantely Andrianantoandro (2022) , Malaria and pneumonia effects on rice , vanilla production and rural household income in Madagascar: case of the Sava region , *a Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 123 , 2, 215–224.
- [20] Mohamed Adaskou ., Idriss Houmam , Hassan Onbough , (2021), Health Care Demand and Supply: Advances and Theoretical Models, 2, 3, 66-85.
- [21] N'Da K. and Aka B. (2018), " Therapeutic Behavior of Households: An Empirical Study for the Ivory Coast ", *Applied Econometrics and International Development* , *Euro-American Association for Economic Development* , 18, 105-120 .
- [22] WHO (2002), Health effects of exposure to indoor air pollution in developing countries.
- [23] WHO (2005), "Rethinking child care: the lens of survival, growth and development",
- [24] WHO (2014), Classification and treatment of childhood pneumonia in health care settings.
- [25] WHO (2021), WHO Management of ARI Programs (Introduction) Edition 1991 WHO. 9 - Consensus Conference.
- [26] WHO, (2008) , *WHO Country Cooperation Strategy: Situation Analysis, National Health Policy* _
- [27] WHO, (2015). Classification and treatment of cases of pneumonia in children in health facilities.
- [28] Rosa K S , Shikur M A , Yasin A W and Musa M A (2022), Determinants of pneumonia among children attending public health facilities in Worabe town , *scientific reports* .
- [29] Sen, A. (2000). A decade of human development. *Journal of human development*, 1, 1, 17-23.
- [30] Study team (1991), Underlying and Proximate Determinants of Child Health *American Journal of Epidemiology* , 133, 185–201
- [31] Tapé Bi Sehi Antoine, (2017), "Access and use of health care in the health structures of Yopougon-Sicogi (Abidjan-Côte d'Ivoire)", Abidjan, Félix Houphouët Boigny University , Unique Doctoral Thesis in Geography.
- [32] Tiehi, TN (2012), Demand of Child healthcare in Côte d' Ivoire: A multinomial probit analysis. *International Rev. Business. Research Paper* , 8, 6, 113-125
- [33] Tiehi, TN (2013). Antenatal care in Ivory Coast: an empirical investigation. *World J Soc Sci* , 3,4, 144-157.
- [34] Uddin K., Jahan N., Mannan M. (2013), "Risk factors determining the outcome of 2–12 Months age group infants hospitalized with severe pneumonia , " *Medicine Today* , vol. 25, no. 1, 9-13 .
- [35] Ulbjerg C, Stine S , Felix O K , Emilio O , (2019) , Perceived barriers to utilization of antenatal care services in northern Uganda: A qualitative study , *Sexual and reproductive healthcare : official journal of the Swedish Association of Midwives*, 23, 100-464
- [36] UNICEF. (2015), Committing to Child Survival: A Promise Renewed. Principle results. *New York, NY USA: United Nations Children's Fund*, 2015.