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Health shocks and vulnerability to poverty in Congo

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The analysis of the link between poverty and health status in developing countries is a major focus of development policy. However, few studies, particularly in the Congo, focus on a prospective analysis of poverty and consider the variability of future consumption after a health shock. The objective of this study is to estimate vulnerability to poverty and analyse the factors that lead to a loss of well-being after a health shock in Congo. The study uses data from the 2011 Congolese Household Survey (CHS). Estimation of vulnerability to poverty and modelling of the effect of the health shock on expected future consumption are performed using the three-step feasible generalized least squares (FGLS) method. This method is also used to identify the socio-demographic determinants of vulnerability. On average, 26.8% of households are vulnerable to poverty in Congo. Health shocks accentuate this vulnerability. Households living in rural areas are more vulnerable to poverty than those in urban areas. Furthermore, household size and the level of education and marital status of the head of household have an impact on vulnerability. In view of the results obtained, poverty reduction efforts should focus on strategies to develop social safety nets and/or health insurance programmes to stabilize consumption in the event of a health shock in the household.

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Introduction

Poor countries tend to have poorer health outcomes than richer countries, and within countries, the poor do not fare as well as the rich (Wagstaff, 2002). This reflects the reciprocal causality between poverty and health. On the one hand, poverty due to lack of income does not allow for the care of sick people in a household, and on the other hand, the poor health of household members reduces their productivity and consequently their income. The poor thus find themselves trapped in a vicious circle in which poverty breeds ill health, and ill health, in turn, maintains poverty. According to the World Health Organization (1946), health is defined as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". According to this definition, good health is an important component of an individual's well-being, and a health shock to a household can significantly increase the risk of falling into a precarious situation characterized by vulnerability to poverty. Vulnerability to poverty is defined as the probability that a household or individual who is or is not poor at present will be poor in the future. This entry into poverty may be due to a health shock. A health shock is a sudden deterioration in health caused by illness and/or injury (Novignon et al., 2012). These shocks are recognized as being among the most important factors associated with poverty (Leive and Xu, 2008). The issues of vulnerability to poverty and health shocks have been the subject of many studies. Vulnerability research is closely linked to the study of shocks and the risks they generate (Wisner et al., 1994). This line of research highlights different issues and uses various methods. Overall, the studies focus on identifying the elements of a system or the population groups most exposed to the consequences of a major disturbance, such as drought, floods or illness of a family member.

In Vietnam, Vuong et al. (2018) assessed the sensitivity of health care consumers to certain socio-demographic characteristics. The authors showed that uninsured, married, and salaried individuals are less sensitive to costs than their counterparts without these characteristics. Studies analysing health shocks in other developing countries have highlighted the role of household socio-demographic factors. In South Africa, Ataguba et al. (2011) showed that the poor suffer more disease than the rich. The authors associated health inequalities with poverty and certain household socioeconomic characteristics. Similarly, in Tanzania, Somi et al. (2009) found that households reduce their consumption of luxury goods in the face of a health shock. They behave strategically when faced with an illness shock to minimize its impact on basic necessities. The situation of vulnerability to poverty is more pronounced for certain categories of people. This is the case for workers in the informal sector. Ahmad and Aggarwal (2017) showed in India that informal sector workers are more vulnerable to health shocks and the economic burden of high treatment costs and low health insurance coverage. In the same logic, Vuong (2015) also highlighted the relationship between disease and low income, particularly in Vietnam, where 58% of seriously ill low-income patients face high health costs and end up abandoning their treatment. The authors highlighted the precarious status of some households, which exposes them to poverty and difficulties in financing health care. This relationship between socioeconomic status and demand for health insurance was also observed in Ghana by Sarpong et al. (2010), where 21% of households with health insurance have a low socioeconomic status. In response to this vulnerability to poverty associated with health shocks, some authors, such as Wiesmann and Jütting (2000), have suggested the implementation of community-based health insurance as an alternative. According to the authors, this type of health care financing has the advantage of covering the working poor, including those in the informal sector.

Castro-Leal et al. (1999) proved that in developing countries, other things being equal, higher incomes are associated with more frequent and intensive use of health services.

This article assesses the vulnerability associated with health shocks in a developing country, in this case, Congo. Congo is a sub-Saharan African country with an average human development index (HDI) ranking 14th in Africa and 138th in the world (PNUD, 2019). However, this indicator hides enormous disparities, particularly in terms of health and morbidity. According to the results of the multiple indicator cluster survey (MICS-2014–2015) carried out in 2015, the country's maternal mortality rate is 436 per 100,000 live births Institut National de la Statistique et UNICEF (2015), one of the highest in Africa; in addition, only 16.8% of the population has complete vaccination coverage, and the malaria diagnosis usage rate, which captures the percentage of children with fever who are tested for malaria, is only 29.7%. Immunization coverage is even lower in some departments, such as Cuvette-Ouest (8.1%), Lékoumou (9.5%), and Plateaux (9.7%). Slightly more than one in five children under 5 years of age (21%) have stunted growth (height/age ratio), 8% of whom have severely stunted growth. There are significant differences in this indicator across departments, with a maximum of 36.9% in Sangha versus 15.9% in Brazzaville. The other most affected departments are Likouala (31.4), Lékoumou (34.2%), and Cuvette-ouest (30.5%) (Institut National de la Statistique et UNICEF, 2015).

In turn, poverty currently affects 40.9% of Congolese households (INS, 2011), down from 50.7% in 2005. Analysis at the department level reveals that there is geographical disparity in poverty. Poverty is essentially a rural issue (69.4%). According to the Congolese Household Survey (CHS) of 2011, poverty is higher in the landlocked departments with predominantly rural areas, such as Cuvette-ouest (79.1%), Lékoumou (76.1%), and Cuvette (70.1%). The departments least affected by poverty are Brazzaville (21.6%) and Pointe-Noire (20.3%), which are also home to the two main cities.

Total public health expenditure has been increasing since 2014 and represented 2.3% of gross domestic product (GDP) in 2018, far below the WHO recommendation of 9.9%. In this context, it is imperative to look at the variability of future household health consumption. The combination of the current high level of poverty and the failure of public health provision justifies research on the subject. This study will make it possible to answer the question, "What factors lead to a loss of well-being after a health shock?" The aim is to measure the vulnerability to poverty associated with health shocks.

- The objective of this study is to estimate vulnerability to poverty in Congo to help public authorities and other development actors better fight against future poverty caused by health shocks.
- The main hypothesis is that health shocks increase households' vulnerability to poverty conditional on their socio-economic characteristics and geographical location.

In addition to this introduction, the article has four sections. The section "Methods" addresses the methodology, and the section "Results" presents the results. The section "Discussion" is devoted to the discussion, and finally, the final section "Conclusion" offers the conclusion.

Methods

Poverty analysis most often takes a monetary approach, which consists of using a poverty line to define who is poor and who is not. This methodological approach provides static indicators,

such as the incidence rate, severity and depth of poverty. For example, using a monetary measure, Banerjee and Duflo (2008) define households in developing countries as middle-class if their daily expenditures are between $2 and $10 purchasing power parity (PPP).

Alongside this relatively static approach, a dynamic approach focused on the need to prevent poverty has emerged. In early 2000, several studies developed methods to measure the mechanisms that lead households to fall into poverty in the future and particularly their present vulnerability to poverty.

This methodology section presents the data sources, variables and estimation techniques.

Data source and variables

Data source. The data used in this study come from the CHS for the Evaluation of Poverty, conducted in 2011 by the National Institute of Statistics (INS, 2011). The CHS is a two-stage stratified sample survey with proportional allocation in the first stage. A total of 10,584 households were drawn from 1035 enumeration areas (EAs), which are the primary units of the survey. The survey covered the entire country (12 departments) and provided data on the following themes: education, health, employment, household assets, household consumption, housing, water, energy, sanitation and perceptions of the economic situation of the household.

Variables. Total household consumption expenditure is used as a dependent variable to measure vulnerability. It refers to all purchases made by the household during a year. It also includes consumption of own production and rent expenditure as well as imputed rent for households that occupy their own homes.

Health shocks are measured by the "serious illness" variable, which measures whether a household member was seriously ill during the twelve (12) months preceding the survey. Since the variable is filled in by the head of household and the reference period is important, there is a risk that the measurement may be slightly biased. For this reason, the variable "death", capturing the decease of a household member in the twelve (12) months preceding the survey, is retained. Given the high prevalence of malaria in the country, a "malaria" indicator variable is inserted in the model. It takes the value of 1 if a household member suffered from malaria in the last 12 months and 0 otherwise.

The other explanatory variables (Table 1) included in the model concern the socio-demographic characteristics of the head of household, such as age, gender (female/male), education level (none, primary, secondary and higher/vocational), and marital status (single, married and widowed). Additional variables included are household location variables, such as place of residence (rural/urban) and the department of residence. Finally, another explanatory variable included in the model is household size, which is the number of members of the household.

Table 1 Variables.

	Effectif
Dependent variable	
Total household consumption expenditure	10,299
Independent variables	
Death	10,408
Serious illness	10,406
Malaria	10,406
Location	10,406
Household size	10,406
Gender of head household	10,406
Marital status of household head	10,299

Econometric method. Methods for analysing vulnerability to poverty have been developed in numerous studies, including those of Chaudhuri (2003), Vuong et al. (2018), Ligon and Schechter (2004), and Dutta et al. (2011), who propose an econometric approach based on consumption data collected from households or individual surveys carried out on a periodic basis. The literature distinguishes three main methods for measuring vulnerability to poverty. These are vulnerability as low expected utility (VEU), vulnerability as uninsured exposure to risk (VER) and vulnerability as expected poverty (VEP). The first two methods, developed by Ligon and Schechter (2004), Hoddinott and Quisumbing (2003) and Skoufias (2002), require panel data for implementation. The last method, VEP, which was developed by Chaudhuri (2003), consists of measuring vulnerability as the probability that a household's consumption falls below a threshold in the near future. For the purposes of this article, the VEP method is used. This method is justified for three main reasons already mentioned in the literature (Atake, 2018; Ligon and Schechter, 2004; Novignon et al., 2012). First, the VEP method, unlike the VER and VEU methods, does not require panel data (which we do not have in the case of Congo); second, it allows us to measure vulnerability ex ante, which is not the case with the other methods; and third, it allows us to identify households that are at risk but are not poor.

The method consists of three steps: (i) estimating the consumption of each household, (ii) calculating the consumption variance of each household, and finally (iii) making assumptions about the distribution of consumption, namely, the poverty line above which the household is considered vulnerable.

According to the Chadhuri method (Chaudhuri, 2003) used by Novignon et al. (2012) and Atake (2018), the vulnerability of household h at time t (V_{ht}) is the probability that the household's consumption level at time $t+1(C_{h,t+j})$ is lower than the consumption poverty line z. It is written as

$$V_{ht} = \Pr\left(\ln C_{h,t+1} < \ln z\right), \quad (1)$$

where z is the poverty line above which a household is considered poor and ln is the natural logarithm.

The method assumes that consumption is determined by the following stochastic process:

$$\ln C_{ht} = X_h\beta + \varepsilon_h \quad (2)$$

where $\ln C_{ht}$ is the logarithm of consumption of household h at time t, X_h is the vector of characteristics of household h (such as place of residence), characteristics of the head of household (such as age, gender, marital status) and health shocks, and ε_h is the error term with a null mean.

For estimation, the model as designed requires assumptions. In particular, the error term must follow a log-normal distribution; therefore, consumption C_{ht} is also assumed to follow a log-normal distribution. This assumption makes it possible to estimate the consumption of households along with their characteristics. The second assumption concerns the stability of the economy under study, such that any structural shocks to the economy are excluded. This assumption facilitates the analysis of health shocks, since it makes it possible to attribute uncertainties of future consumption exclusively to idiosyncratic shocks suffered by the household and not to any instability in the economy.

According to the literature of the last 20 years (Deaton, 1992; Chaudhuri, 2003; Browning and Lusardi, 1996; Vuong et al., 2018; Atake, 2018), consumption, regardless of the period, depends on several factors, such as income, expectations of future income, the uncertainty facing the household, and its capacity to adjust its consumption following various income shocks. The following are some of the factors that have influenced

consumption over the last 20 years. All of these factors in turn influence the observable characteristics of the household and possibly some characteristics that are not observable (Chaudhuri et al., 2002). Formally, this can be summarized by the following expression:

$$C_{ht} = c(X_h, \beta_t, \alpha_h, e_{ht}), \tag{3}$$

where X_h represents a set of observable household characteristics, β_t is a vector of parameters describing the state of the economy at time t, α_h *and* e_{ht} represent an unobserved time-invariant household-level effect and any idiosyncratic factors, respectively.

The vulnerability to poverty of household h with its characteristics X_h can be calculated by estimating Eqs. (2) and (3) such that

$$V_{h,t} = \Pr\left(C_{h,t+1}\right) = c\left(X_h, \beta_{t+1}, \alpha_h, e_{h,t+1}\right) \le z/X_h, \beta_{t+1}, \alpha_h, e_{ht}). \tag{4}$$

This expression (4), as stated by Chaudhuri et al. (2002), makes clear that a household's vulnerability stems from the stochastic properties of the intertemporal consumption flow it faces. The consumption flow in turn depends on a number of household characteristics. Using the general framework of Chaudhuri et al. (2002), vulnerability will be estimated with some restrictions imposed by the nature and availability of data.

In general, data from household surveys contain measurement errors on consumption, which can lead to overestimation of the consumption variance and therefore heteroscedasticity of errors. To overcome this problem, it is usually assumed that the variance of the error term is the same for all households. This assumption, as Chaudhuri et al. (2002) have shown, leads to inefficient estimates and disrupts the estimation of vulnerability. The proposed solution is to estimate the equation that links the consumption variance to the characteristics of the household, as follows:

$$\sigma^2_{\varepsilon,h} = X_h\theta + \eta_h. \tag{5}$$

Equation (5) is estimated by the generalized least-squares (GLS) method proposed by Amemiya (1977) in three steps. It involves estimating β and θ.

The first step is to estimate Eq. (2) with ordinary least squares (OLS). The ε_h from Eq. (2) are then used to estimate the next equation, again with OLS.

$$\widehat{\sigma}^2_{(\mathrm{ols},h)} = X_h\widehat{\theta} + \widehat{\eta}_h. \tag{6}$$

The $X_h\widehat{\theta}$ terms, that is, the estimated values of $X_h\theta$, are in turn used to transform Eq. (6), which becomes

$$\frac{\widehat{\sigma}^2_{\mathrm{ols},h}}{X_h\widehat{\theta}} = \frac{X_h}{X_h\widehat{\theta}} + \frac{\widehat{\eta}_h}{X_h\widehat{\theta}}. \tag{7}$$

The estimation of Eq. (7) gives an efficient GLS estimator $\widehat{\theta}_{\mathrm{FGLS}}$. It can be shown that $\widehat{\theta}_{\mathrm{FGLS}}$ is an efficient estimator of $\sigma^2_{\varepsilon,h}$, which is the idiosyncratic component of household consumption. Taking the standard deviation of $\widehat{\theta}_{\mathrm{FGLS}}$, Eq. (2) becomes the following:

$$\widehat{\sigma}_{\varepsilon,h} = \sqrt{X_h\widehat{\theta}_{\mathrm{FGLS}}}(8) \text{ et } \quad \frac{\ln C_{ht}}{\widehat{\sigma}_{\varepsilon,h}} = \left(\frac{X_h}{\widehat{\sigma}_{\varepsilon,h}}\right)\beta + \frac{\varepsilon_h}{\widehat{\sigma}_{\varepsilon,h}}. \tag{8}$$

OLS estimation of Eq. (8) yields an asymptotically efficient estimate of β. The estimated β_{FGLS} and θ_{FGLS} enable a direct estimation of the expected log-consumption (shown in Eq. (9)) and the expected variance of log-consumption (shown in Eq. (10)), respectively.

$$\mathrm{E}\left[\left(\ln \widehat{C}_h/X_h\right)\right] = X_h\widehat{\beta}, \tag{9}$$

$$\mathrm{Var}\left[\left(\ln \widehat{C}_h/X_h\right)\right] = \sigma^2_h = X_h\widehat{\theta} \tag{10}$$

Assuming that consumption is equitably distributed, vulnerability to poverty is estimated as follows:

$$\widehat{V}_h = \widehat{P}_r\left(\ln c_h < \frac{\ln z}{X_h}\right) = \Phi\left(\frac{\ln z - X_h\widehat{\beta}_{\mathrm{FGLS}}}{\sqrt{X_h\widehat{\theta}_{\mathrm{FGLS}}}}\right). \tag{11}$$

Thus, the estimation of vulnerability to poverty depends on elements such as the assumption of the normality of the log-consumption distribution, the choice of the poverty line, and the expected level and variance of log-consumption. The level of vulnerability to poverty decreases as the level and variance of expected consumption increase. Equation (11) will thus be estimated by determining vulnerability to poverty.

Time horizon and poverty line. The time horizon is understood as the future period in which a household is likely to become vulnerable. The literature does not define the horizon over which a household may become vulnerable to be used for the assessment of vulnerability to poverty. The choice of time horizon is often arbitrary; as Hoddinott and Quisumbing (2010) argue, a household may become poor next year, 10 years from now or in old age. According to Novignon et al. (2012) and Atake (2018), there is a high probability that a household or individual will become poor exactly one period and/or one year after a health shock. Based on these elements, for the purposes of this article, the time horizon is defined by $t + j$, with $j \ge 1$ as in Chaudhuri et al. (2002) and Christiaensen and Subbarao (2005).

With regard to the poverty line, in this article, the poverty line is defined by the CHS for Poverty Assessment conducted by the National Institute of Statistics in 2011. In this survey, the amount of 274,113 FCFA[1] represents the consumption of one household per adult equivalent for one year. A household with consumption below this amount is considered poor. The consumption taken into account includes both food and non-food goods.

Threshold of vulnerability to poverty. Studies on vulnerability most often use a threshold of 0.5, which is justified for two main reasons. First, it is logical to say that a household with a 50% probability of falling into poverty in the next period is vulnerable. Second, when a household whose current consumption level is equal to the poverty line faces a zero-average shock, it has a vulnerability of 0.5 (Atake, 2018).

Similarly, Zhang and Wan (2008) find that a vulnerability threshold of 0.5 provides reliable predictions. Hence, we consider a household whose estimated vulnerability to poverty is ≥0.5 to be vulnerable to poverty.

Ethical approval and consent to participate. The national statistics institute obtained their consent from households before sending them the questionnaire in accordance with the statistical law. The ethics approval component not applicable.

Results

After a summary of the descriptive statistics, the results of the model estimation will be presented.

Descriptive statistics. Table 2 indicates that 75% of heads of household are male and that just over half (52%) live in rural areas. The proportion of heads of household who reported having

Table 2 Summary of descriptive statistics.

Demographic and sanitary characteristics	Number affected	%
Death		
Death in household	1244	11.9
No deaths	9164	88.1
Serious illness		
Serious illness in household	2300	22.1
No serious illness	8106	77.9
Malaria		
Malaria case in household	1638	15.74
No malaria	8768	84.26
Location		
Rural	5433	52.21
Urban	4973	47.79
Household size		
1–3	4247	40.8
4–6	4357	41.8
7–9	1441	13.9
10 or more	361	3.5
Gender of head household		
Male	7795	74.91
Female	2611	25.09
Marital status of household head		
Single	1043	10.13
Married	6813	66.15
Widowed	2443	23.72

Table 3 Mean vulnerability to poverty by household characteristics.

Variable	Mean vulnerability	Vulnerability population ratio
Total	26.8	100
Deaths	32.6	14.7
Serious illness	32.3	27.1
Malaria	24.4	13.6
Administrative region		
Kouilou	38.6	9.7
Niari	35.5	12.9
Lékoumou	35.9	9.5
Bouenza	28.2	10.7
Pool	34.5	11.4
Plateaux	30.6	9.2
Cuvette	30.1	8.3
Cuvette-ouest	26.2	5.7
Sangha	28.4	6.4
Likouala	37.1	11.3
Brazzaville	6.9	3.4
Pointe-Noire	5.9	1.5
Location		
Rural	41.5	83.6
Urban	10,7	16.4
Gender of household head		
Female	23.7	19.9
Male	27.8	80.1

The average vulnerability is calculated from the vulnerability variable (continuous variable), estimated from Eq. (11) and is an average per group of households for each characteristic. For example, for the death variable, out of 10,408 households in the sample, 1244 households (see Table 2) are affected by a case of death, and the average vulnerability of these households is 32.6%. The column 'Vulnerability population ratio' represents the number of vulnerable households by household characteristics in relation to the total number of households surveyed. For the death variable, this weight is 14%.

had a household member suffer from a serious illness is 22.1%, and 12% had experienced a death in the 12 months preceding the survey. Furthermore, 16% had suffered from malaria in the 12 months preceding the survey. Household size varies between 1 and 20. Among all households, those with 4–6 individuals represent 42%, and those with more than 10 individuals represent only 3.5%. The majority of heads of household live as a couple (66%).

Vulnerability to poverty in Congo. The analysis of the distribution of vulnerability is done using a threshold of 0.5 because a household with a level of vulnerability above 0.5 is more likely than not to be poor. The average vulnerability to poverty is 26.8% (Table 3). This national average hides spatial disparities, with the highest average (38.6%) being observed in the department of Kouilou and the lowest (5.9%) in Pointe-Noire. Note that these two departments represent 9.7% and 1.5% of the total population, respectively. Other departments with high average vulnerability are Likouala (37.1%), Niari (35.5%), Lékoumou (35.9%), and Pool (34.5%). On the other hand, the Department of Brazzaville, which is also a commune, has an average vulnerability of nearly 7%. Regarding place of residence, vulnerability to poverty (Table 3) is 41.5% in rural areas compared to 10.7% in urban areas. In terms of gender, male heads of household are more vulnerable (27.8%) than female heads of household (23.7%). Among the sources of vulnerability to poverty, health variables, such as a recent death in the household, serious illness and malaria, make a significant contribution, with an average of 32.6%, 32.3% and 24.4% of households being affected by these factors, respectively, displaying vulnerability to poverty.

Determinants of vulnerability to poverty. Among the variables measuring health shocks, two (2) are significant at the 1% threshold for severe disease and at the 5% threshold for malaria. Table 4 shows that the presence of a seriously ill person in the household increases the vulnerability to poverty. This result is also observed if the household registered a malaria victim in the 12 months preceding the survey. Thus, the effects accompanying disease in a household increase its vulnerability. In addition, certain socio-demographic characteristics of the household are closely related to vulnerability to poverty. This is the case for the level of education of the head of household (significant at 1% for the primary and secondary education levels); as the level of education, especially between the primary and secondary levels, increases, vulnerability decreases. The size of the household also affects vulnerability, with the effect being significant at 1%; the larger the household, the more vulnerable it is to poverty. The same applies to the marital status of the head of household, which is also significant at 1%. Compared to single heads of household, households whose heads live as part of a couple are less vulnerable to poverty. All location variables are significant at the 1% threshold. This link between poverty and location shows the spatial disparity of poverty in Congo. Households living in urban areas are less vulnerable to poverty than those living in rural areas. This result is confirmed by the low average vulnerability to poverty observed in the country's most urbanized departments, namely, Brazzaville and Pointe-Noire (Table 4).

We also study the relationship between poverty and vulnerability. The results show that the two are linked and that a household is not poor at the moment but is still vulnerable to future poverty. Indeed, the chi-squared independence test (Table 5) confirms that there is a relationship between vulnerability and poverty.

Vulnerability affects both poor and non-poor households. Table 5 shows that the proportion of vulnerable non-poor households is 17.6%, compared to 31.2% of poor households.

Table 4 Determinants of vulnerability to poverty.

Variables	Ex ante mean consumption	Ex ante variance of consumption
Health shocks		
Deaths	−0.021 (−0.05 to 0.01)	0.022 (−0.12 to −0.16)
Serious illness	−0.06** (−0.08 to −0.04)	−0.101 (−0.21 to 0.007)
Malaria	−0.034* (−0.06 to −0.01)	0.020 (0.102 to −0.14)
Household characteristics		
Gender head		
Female	−0.037* (−0.07 to −0.004)	0.184 (0.04-0.33)
Household size		
4-6	−0.473** (−0.49 to −0.45)	−0.180 (−0.28 to −0.07)
7-9	−0.736** (−0.77 to −0.70)	−0.249 (−0.39 to −0.10)
10 or more	−0.87′** (−0.93 to −0.81)	−0.487 (−0.74 to −0.23)
Marital status of household head		
Married	−0.123** (−0.16 to −0.08)	−0.023 (−0.19 to −0.15)
Widow	−0.117** (−0.16 to −0.073)	−0.168 (−0.35 to 0.01)
Head education		
None	−0.001 (−0.04 to −0.039)	−0.116 (−0.29 to −0.056)
Primary	0.130** (0.10-0.16)	−0.053 (−0.17 to −0.06)
Secondary	0.465** (0.42-0.51)	0.128 (−0.06 to −0.32)
Department (Administrative region)		
Niari	−0.222** (−0.28 to −0.17)	0.195 (−0.04 to −0.43)
Lékoumou	−0.328** (−0.39 to −0.27)	0.012 (−0.23 to −0.26)
Bouenza	−0.217** (−0.27 to −0.16)	−0.139 (−0.37 to −0.08)
Pool	−0.218** (−0.27 to −0.16)	0.009 (−0.22 to −0.24)
Plateaux	−0.246** (−0.30 to −0.19)	−0.29 (−0.52 to −0.052)
Cuvette	−0.213** (−0.27 to −0.16)	0.068 (−0.171 to −0.31)
Cuvette-ouest	−0.492** (−0.55 to −0.43)	0.219 (−0.031 to −0.47)
Sangha	−0.189** (−0.25 to −0.13)	0.016 (−0.23 to −0.27)
Likouala	−0.196** (−0.25 to −0.14)	0.245 (0.01-0.48)
Brazzaville	0.042** (−0.015 to 0.098)	−0.021 (−0.26 to −0.22)
Pointe-Noire	0 .142** (0.08-0.20)	0.1034704 (−0.14 to −0.35)
Location		
Urban	0.316** (0.29-0.34)	0.034 (−0.14 to −0.08)
Rural	13.3846 (13.27-13.49)	−2.3890 (−2.87 to −1.91)
No. of observations	10,299	10,299
R squared	0.3969	0.0081
Adjusted R-squared	0.3955	0.0056
F-value	270.48	3.34

* and ** indicate significance at the 5% and 1% levels.
Note: These are the results of the model estimation.
1. The dependent variable for the first estimation is the ex ante mean of consumption.
2. The dependent variable for the second estimation is the ex ante variance of consumption.
The categories female (gender), rural (place of residence), Kouilou (department), higher/professional (education), single (marital status) and (Novignon et al., 2012; Wagstaff, 2002; World Health Organization, 1946) (household size) were used as references.

Table 5 Vulnerability and poverty (percent).

	Vulnerable	Not vulnerable	Total
Poor	31.2	68.8	100
Not poor	17.6	82.4	100
Total	26.8	73.2	

Pearson chi-squared (1) = 259.5036, Pr = 0.000.

Discussion

The results in Table 3 show that 26.8% of Congolese households are vulnerable to poverty. Vulnerability is greater in rural areas, where it affects 41.5% of households. According to a World Bank report (Banque Mondiale, 2017), the number of poor people in rural areas increased from 795,000 in 2005 to 951,000 in 2011, thus increasing the contribution of rural areas to poverty. This result corroborates the high vulnerability observed in rural areas with a glaring lack of social infrastructure (PND-2018–2022) (Ministère du Plan De la Statistique et De L'intégration Régionale, 2018). As a result, the use of public health services is low, as concluded by the World Bank (Banque Mondiale, 2017), with "just over half of the sick receiving care in non-governmental health facilities". With poor access to health services, health shocks impact rural households more severely than urban households. This result is similar to that obtained by Chaudhuri et al. (2002) for Indonesia, where vulnerability was greater in rural than in urban areas. The best-equipped hospitals are in urban areas, particularly in Brazzaville and Pointe-Noire. These results imply that public policies to combat poverty should take into account the spatial dimension while placing a particular emphasis on vulnerability to future poverty (Novignon et al., 2012) induced by health shocks. Like the residential environment, the departments are also characterized by disparities in future poverty propensities. The vulnerability of departments can be associated with the lack of health infrastructures and the difficulty of access when they exist. The departments with the best-equipped hospitals have a low level of vulnerability, 5.9% for Pointe-Noire and 6.9% for Brazzaville. According to the results of the MICS (2014–2015) (Institut National de la Statistique et UNICEF, 2015), departments other

than Brazzaville and Pointe-Noire have a high prevalence of diarrhoeal diseases, malaria and acute respiratory infections (ARI). In addition, immunization coverage is low in Pool (1.3%) and Likouala (3.8%) compared to Brazzaville and Pointe-Noire, at 12% and 18%, respectively. Intuitively, this suggests that some departments are more exposed to future poverty than others because of significant health risk factors.

Several studies have shown that the poorest households face economic losses as a result of health shocks (Ataguba et al., 2011; Atake, 2018; Somi et al., 2009; Vuong, 2015). Indeed, poor households cannot buy sufficient quantities of food, pay for quality health care and possibly smooth their consumption after experiencing a health shock. As Vuong et al. (2018) showed in Vietnam, severely ill patients end up abandoning treatment due to lack of income. Similarly, in India, Ahmad and Aggarwal (2017) showed the vulnerability of certain categories of workers with high treatment costs and low health insurance coverage following health shocks. Low income is also an explanation for the low demand for health insurance in developing countries, highlighted by Wiesmann and Jütting (2000) for sub-Saharan African countries. The authors go so far as to propose a less expensive and inclusive alternative health care financing mode.

Health shocks, as measured by the presence of a sick member in the household, are a major factor in vulnerability. The same is true for a household member who suffered from malaria in the 12 months preceding the survey. Similar results were obtained by Atake (2018) for Togo and Niger, as well as Ataguba et al. (2011). The fragile Congolese health system, which has been put to the test by the COVID-19 pandemic, requires strong measures to meet the challenge of public health care provision and reduce household vulnerability to poverty.

Another important factor associated with vulnerability is household size. The result in Table 3 shows that vulnerability increases with the size of the household. The average size of a Congolese household is 4.3. It is clear that a health shock is more likely to occur in a larger household and in turn increase the household's vulnerability to poverty. Similar results regarding the effect of household size on increasing vulnerability have been obtained for Ghana, Togo and Burkina Faso (Atake, 2018; Novignon et al., 2012). Moreover, this result confirms the hypothesis put forward by Atake (2018) that in sub-Saharan African countries, large households contribute significantly to overall vulnerability through health shocks. Table 3 also shows that the education of the household head is an important factor in vulnerability. A high level of education of the household head reduces the vulnerability of his or her household to poverty. As Novignon et al. (2012) has found for Ghana, education directly or indirectly influences household consumption. In this regard, it is recommended that the education component be taken into account in poverty alleviation policies by facilitating education access through cost reduction, for example. Moreover, the World Bank (Banque mondiale, 2018) rightly affirms that education must equip the educated with the skills they need to lead a healthy, productive and meaningful life. Male-headed households are more vulnerable than female-headed households. Male-headed households are likely to be larger because most male heads of household are part of a couple (66%) (Table 4). All these factors highlighted are likely to tip a household, whether it is poor or not, into vulnerability, as shown in Table 4. Thus, the formulation of policies and programmes to combat poverty must take this aspect into account.

Conclusion

The objective of the study was to estimate vulnerability to poverty and analyse the factors that lead to a loss of well-being after a health shock. The results obtained highlight the importance of considering future poverty and confirm its link with health variables. Indeed, the occurrence of a serious illness in a household reduces its future consumption. In addition to health shocks, other drivers of vulnerability highlighted by the study are the size and location of the household and the socio-demographic characteristics of the household head, such as the level of education and marital status. The results also highlight the importance of future poverty and confirm its link with health variables. Consequently, poverty reduction efforts must focus on strategies and programmes aimed at improving household health and human capital in general. Specifically, this may involve developing social security programmes (social safety nets) and/or health insurance programmes to stabilize consumption in the event of a health shock in the household.

The importance of the rural environment in vulnerability to poverty recommends that development actors also encourage the construction of health infrastructures in rural areas. It is recommended to set up alternative, less expensive health insurance based on community participation.

The study identified the main source of vulnerability as low average future consumption. All poverty-reduction policy measures must aim to stabilize this consumption in the future, especially in the context of the COVID-19 pandemic.

Some limitations of this study should be noted. The main limitation is the lack of panel data to study vulnerability. Indeed, panel data would have made it possible to follow the evolution of household consumption expenditure over time and to better discern shocks. Another limitation is the simultaneous effects of the variables. The sense of causality is that a health shock acts on consumption expenditure, but consumption in turn can also act on the health variables. The fact that only one direction was considered is also a limitation. It would be possible for future studies to go further with panel data (if available), taking into account the limitations mentioned. Another limitation relates to the use of consumption expenditure as a measure of poverty. This is a choice dictated by the availability of data; however, several other variables, such as household income, assets and housing amenities, could also be used to measure poverty. The availability of data also justified the use of data from 2011. The ideal would be to have a current database on household consumption; unfortunately, no other consumption survey has been conducted since 2011.

One of the contributions of this study is the estimation of vulnerability following a health shock in Congo, given the scarcity of work on these issues in developing countries and particularly in Congo.

Data availability

The data are accessible by simple request to the National Institute of Statistics and can be obtained by request addressed to its Director General www.ins-congo.org.

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Note

1 1 EURO = 657 FCFA

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Author contributions

The author read and approved the final manuscript.

Competing interests

The author declares no competing interests.

Additional information

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