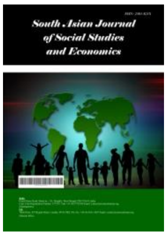

South Asian Journal of Social Studies and Economics

14(1): 75-84, 2022; Article no.SAJSSE.87035
ISSN: 2581-821X

Does Access to Public Drinking Water Services Positively Impact Health in Cameroon?

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Author's contribution

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/SAJSSE/2022/v14i130373

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/87035

Original Research Article

Received 05 March 2022
Accepted 09 May 2022
Published 17 May 2022

ABSTRACT

The objective of this study is to determine the impact of household access to the drinking water distribution network on the state of health of populations in Cameroon. Considering child health (diarrheal morbidity and underweight) and based on data from the Cameroonian Household Survey (ECAM4) of 2014 and the Cameroon Demographic and Health Survey (EDSC-V) of 2018 and adopting probity models with instrumental variable in a dichotomous approach, we obtain the following results. Access to public drinking water services contributes significantly to improving the well-being of populations in Cameroon, significantly reducing the risk of diarrhea and exposure to underweight children. Also, the public authorities will have to develop water production and distribution infrastructures to promote greater access for the population and allow an improvement in the water quality and quantity.

Keywords: Public water services; access; wealth; health; probit model.

1. INTRODUCTION

Access to drinking water is a basic need for good health. However, contaminated water can be an important vector of waterborne diseases considered to be threats to human health [1]. Therefore, the guarantee of safe drinking water is a major public health issue. An adequate supply of good quality running water reduces the risk of contamination (fecal peril) and effectively protects human health [2]. The indisputable role of drinking water on human health has also prompted the United Nations to commit to halving the number of people without access to

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drinking water by 2015 (Millennium Goals for Development).

In Africa, access to quality water in sufficient quantity is becoming more and more difficult with urban growth and a good part of the population often resorts to unsecured and contaminated water sources with serious health risks. Illnesses related to contaminated water represent a heavy burden that affects approximately 2.3 billion people and is responsible for 60% of infant mortality worldwide [3,4]. The proliferation of precarious supply methods and sanitation problems in distribution areas increase the risk of contamination of drinking water.

The global approach to the problem of water in all its dimensions highlights three levels of inequality between households connected to the supply network and those who depend on "off-network" water distribution channels: inequality of access (quantity), price inequality and quality inequality. These causes of inequality are at the origin of a socio-spatial segregation where a section of the population having abundant water rubs shoulders with another in a situation of water stress which pays even more for water that is often of poor quality. Such a situation, which particularly affects populations with a very low socioeconomic level in disadvantaged areas, leads to behaviors and practices likely to alter water quality with an increased risk of contamination [5,6].

Although intuitively obvious, the effect of the water supply on health in general, and on that of children in particular, is the subject of controversy highlighted by many theoretical approaches, and on the contradictory empirical results [7,8, 9]. Analyzes carried out in developing countries have been more successful in illustrating the complexity of the relationships between water supply and health than in providing statistical demonstration of causal links [10]. However, it is clear that access to drinking water and adequate sanitation is vital for a significant reduction in health risks and the establishment of a healthy environment. This is all the more true in the African socio-cultural context.

The purpose of this paper is to assess the effect of different sources of water supply on the health of populations, in particular that of children under the age of 5. The contribution of this study is at three levels. Firstly, this study will fill the information gap related to the scarcity of studies linking the use of water and health. Secondly, it incorporates in its analysis an original methodology combining descriptive and econometric approaches. Thirdly, this study claims to provide an effective instrument for achieving the objective of reducing the death and morbidity rates of the health policy in force.

The paper is divided into three sections. A section that presents in detail the literature review, a section that illustrates the methodological framework of the evaluation and a section that presents and discusses the results.

2. ACCESS TO DRINKING WATER AND POPULATION HEALTH: LITERATURE

Water remains an essential resource for the sustainable well-being of populations. The diversity of water resources makes it possible to exploit surface water or groundwater. However, its availability is continuously declining, both in quantity and quality. The organization of several forums on water and sanitation (Marrakech in 1997, The Hague in 2000, Kyoto in 2003, Mexico City in 2006 and Senegal in 2012) testifies to the scale of the problems of access to water in developing countries, particularly in sub-Saharan Africa (ANSD, 2014). Today, nearly a billion people in the world do not have access to basic water supply and half of the population of developing countries suffers from diseases due to water contamination (Eric, 2004). Risks to human health are arguably the most serious and widespread water-related problem. Because of these health risks, the water sector must meet the challenges of the sometimes poor quality of water supply which continues to deteriorate due to various contaminations from households, industries and agricultural inputs [11].

2.1 Water Pollution: A Significant Phenomenon in Societies

Water is a vital element for the survival of humanity. It is both a food and a raw material. Its uses are multiple, but with regard to human health, they are dominated by water recreation, agriculture and above all, the supply of drinking water that can be used for food (drinking water, cooking), but also for domestic and hygienic purposes. According to Mané [12], the quality of water can mainly be altered by three forms of pollution: thermal pollution, chemical pollution, microbiological pollution.

Good water quality is essential to guarantee a healthy environment and the good health of human beings. In many developing countries, particularly in sub-Saharan Africa, the water needed daily for drinking and sanitation does not have the required quality. Thus, water pollution coupled with lack of water disinfection practices and water quality monitoring and insufficient sewage treatment facilities are the major cause of the prevalence of waterborne diseases and deaths [13]. Indeed, according to Festy et al. [14], water risks can arise directly or indirectly. In the first case, they ensue following contact with the contaminated water itself (wastewater, recreational or drinking water); in the second case, they occur through food contaminated by unsuitable quality water.

In general, two main types of health risks are specifically associated with the domestic water supply: The microbiological risk linked to the contamination of water by pathogenic microorganisms (bacteria, viruses, protozoa, etc.) and the chemical risk linked the presence of undesirable or toxic substances.

To these two main types of risk, we can also add the radiological risk. It is a health risk linked to the presence of radionuclides of natural origin in the water.

2.2 Water Quality and Health Risk: An Empirical Review

Water health risks are dependent on individual factors, but also environmental ones. Very little previous work analyzing the health risks of domestic water quality has been conducted to date. Most of the studies are much more in the field of medicine and hydrology. In recent years, such studies have attracted some interest from economists. However, these studies have highlighted the preventive actions that can have an effect on different aspects of water quality, it is very often to improve the sanitary quality of water and thus reduce the risk of disease that these actions are businesses.

Thus, Arnold and Colford [15] rely on 10 studies carried out in developing countries that measure the impact of water treatment with chlorine on water quality or infant diarrhoea. The authors show that such a treatment makes it possible to improve the quality of water (the reduction in the proportion of water contaminated with Escherichia coli is 80%) as well as the health of children (the reduction of diarrheal diseases is 29%). The work of Clasen et al. [16] is based on articles dealing with the impact of improving water quality on the prevention of diarrhoea. It appears that the supply in better quality sources or the consumption of treated water from questionable sources reduces the occurrence of diarrhea in individuals of all ages. The overall reduction in diarrhea in children under 5, for example, is 24%.

Contrary to what can be observed in developing countries, households in developed countries are almost all connected to the public drinking water distribution network. The domestic use of tap water provides a certain guarantee insofar as this water is subject to strict quality controls which ensure that it meets the standards required by law and regulation. The fact remains that despite all these quality standards, many studies show that even in developed countries, preventive measures to remedy a possible water-related risk are often observed among users. According to a survey carried out, for example, in 2000 by the Water Agencies, the French Institute for the Environment and the Research Center for the Study and Observation of Living Conditions in France, a total of 58% of respondents say they usually drink tap water. Of the total of 42% who say they prefer bottled water, 44.7% cite the bad taste of tap water as the main reasons, 22.8% its hardness, 12.7% cite fear of disease or health risks and 9.9% the fear of toxic products.

Abdallah et al. [17] are interested in the factors that explain the choice of households to consume a certain quality of water and to implement measures to deal with the contamination of water with trichlorethylene. Indeed, these authors conduct a study with a sample of households in the municipality of Perkasie in Pennsylvania (United States) after the discovery of trichlorethylene in the drinking water distributed. The study shows that among the respondents to the questionnaires, only 43.2% were informed of the presence of trichlorethylene in the water. Among them, 133 (43.75%) declared having taken measures to remedy the situation after being informed of the presence of trichlorethylene in the water. The logit estimate carried out shows that this choice of tap water supply is positively explained by the level of information received about the contamination of water with trichlorethylene, the level of cancer risk that the household.

3. METHODOLOGICAL FRAMEWORK OF THE STUDY

3.1 Data Source and Study Variables

3.1.1 Data source

The data used in this study come from the fifth Cameroon Demographic and Health Survey (EDSC-V) carried out in Cameroon in 2018 by the National Institute of Statistics (INS) in collaboration with several other partner institutions. The survey made it possible to successfully interview 14,695 women aged between 15-64, 6,978 men aged between 15-64 and 11,710 households spread over the entire Cameroonian territory.

3.1.2 Study variables

Our variables, which are summarized in Table 1, include two endogenous variables and several exogenous variables.

3.1.2.1 Dependent variables

The study having for main object the analysis of the effect of the choice of water supply on the state of health of the populations in Cameroon, in particular on the risk of juvenile health (children aged less than 5 years), we let us retain as dependent variables the state of diarrheal morbidity and the nutritional state of the child at the time of the survey. To estimate the occurrence of diarrhoea, mothers were asked if their children under 5 had had a fever or diarrheal illness in the two weeks preceding the interview. This state takes the value 1 if the child had a diarrheal disease during the two weeks preceding the interview and 0 otherwise. Nutritional status is apprehended by being underweight in children under 5 years of age. Thus, the nutritional status variable takes the value 1 if the child's weight is below the WHO reference threshold (WHO/MGRS) and 0 otherwise.

Table 1. Description, measurement and theoretical prediction of the explanatory variables

Variables	Description and measure	Expected effects
Public water service	Measured by the water distribution network	Positive effect on the health of the child
Individual characteristics of the mother		
Mother's age	Represents the number of years the mother was at the time of the survey.	Positive effect
Mother's education	Highest level of education attained by the woman and measured by 4 dummy variables: no level, primary level, secondary level and higher.	Positive effect
Religion of mother	Represents the religious affiliation of the woman and measured by a three variable dummy: muslim religion, religion Christianity and other religions.	-
Individual characteristics of the child		
Sex of child	Measured by a binary variable: =1 if the child is male, and 0 if not.	
Age of the child	Represents the number of years that the child was at the time of the survey and measured by a category taking into account the six age groups: less than 6 months; 6 to 11 months; 12 to 23 months; 24 to 35 months; from 36 to 47 months and from 48 to 59 months	Positive effect
Socio-economic characteristics of the household		
Residence	Measured by three dummy variables: urban environment, semi-urban environment and rural environment.	Positive effect
Household wealth	Represents the standard of living of the household and measured by five binary variables: very poor, poor, average wealth, rich and very rich	Positive effect
Access to health care	Represented by the offer of health care and measured by a binary variable: =1 if the child can access health care, and 0 if not.	Positive effect

Source: author construction

3.1.2.2 Explanatory variables

Variables of interest: Drinking water sources can be grouped into two categories: improved sources (tap water, pumped or drilled wells, protected dug wells, spring waters and protected springs) and unimproved sources (water from unprotected dug wells, any other unprotected source). In the context of our study, only the supply in the distribution network is retained. This source allows us to capture the effect of the public water service. This variable is binary.

Control variables: The control variables are grouped into individual characteristics (the sex of the child, the age of the child, the age of the mother and the level of education of the mother) and socio-economic characteristics of the household (household wealth, place of residence and access to health care). The wealth of the household is measured by the quintile of the standard of living existing in the base, and having the modalities: very poor, poor, average, rich and very rich. The area of residence is a categorical variable that takes the value 1 if the household resides in a rural area, 2 if the household resides in a semi-urban area and 3 if the household resides in an urban area.

3.2 Method of Analysis

3.2.1 The model

The method used in this study is based on the use of descriptive statistics tools and econometrics. To do this, we use the instrumental variable probit model.

Given that the dependent variable of our study is dichotomous (it takes two values 1 and 0), an econometric model with a qualitative dependent variable, and more precisely a probit, seems appropriate.

In the literature, an effective approach to address the possible problem of endogeneity in the presence of cross-sectional data is the use of the method of relevant and exogenous instrumental variables. Also, the instrumental variable that we retain is the basic drinking water supply service noted SEAEP, an improved surrounding source.

3.2.2 Model specification

Our model has two equations. The first equation relates the state of child health (ESi) and the supply to the water distribution network (ARDE) of the household. The second equation establishes the link between the supply to the household water distribution network (ARDE) and the instrumental variable. The formalization of the model is then the following.

$$ES_i^* = \beta_0 + \beta_1 ARDE_i + \beta_2 X_i + \varepsilon_{1i} \quad (1)$$

$$ARDE_I = \alpha_0 + \alpha_1 Z_i + \alpha_2 X_i + \varepsilon_{2i} \quad (2)$$

In equation [1], the variable ES_i^* is the latent variable of ESi corresponding to the child health status considered in the household and defined as:

$$ES_i = \begin{cases} 1 \ si \ ES_i^* > 0 & \text{(the individual is in poor health)} \\ 0 \ si \ ES_i^* \le 0 & \text{(the individual is in good health)} \end{cases}$$

The probability for a specific child to be in poor health is written:

$$P(ES_i = 1) = P\,(ES_i^* > 0) = p\,(\varepsilon_{1i} \le \beta_0 + \beta_1 ARDE_i + \beta_2 X_i)$$

$$= \varphi\,(\varepsilon_{1i} \le \beta_0 + \beta_1 ARDE_i + \beta_2 X_i)$$

where φ is the normal distribution function.

Since the child health risks considered are diarrheal morbidity and nutritional status or underweight, equation [2.1] can be written:

$$MD_i^* = \beta_0 + \beta_1 ARDE_i + \beta_2 X_i + \varepsilon_{4i} \quad (3)$$

$$EN_i^* = \beta_0 + \beta_1 ARDE_i + \beta_2 X_i + \varepsilon_{4i} \quad (4)$$

With MD_i^* and EN_i^* respectively representing diarrheal morbidity and nutritional status of children under 5 years of age. $ARDE_i$ is the access to the household water distribution network. X_i represents the matrix of control variables (divided into three groups: the individual characteristics of the mother, the individual characteristics of the child and the socio-economic characteristics of the household. The parameter β_1 associated with $ARDE_i$ makes it possible to measure the effect of the public water service on the risks of child health. As for the parameter β_2, it makes it possible to assess the effect of the control variables.

In equation [2], Z_i is the drinking water supply instrument, namely the average distance to a drinking water supply source at the community level; and α_1 measures the magnitude of its effect on ARDE. As specified above, this instrument must verify the hypotheses $Cov\,(Z_i, \varepsilon_{1i}) = 0$ reflecting the idea that it must not be linked to the unobservable characteristics contained in the error term, and $Cov\ (ES_i\ , Z_i) \neq 0$ indicating that the effect of the supply of drinking water to the distribution network on the state of health of individuals is largely attributable to the instrument. As for ε_1 and ε_2, the error terms of equations [1] and [2] respectively, they are assumed to be independently and identically distributed. We can write $\varepsilon = (\varepsilon_1\ , \varepsilon_2)' \sim N$ (0, Σ), with $N\ (\sigma_{ij}, i, j$ = 1), σ_{11} being normalized to 1.

4. RESULTS AND DISCUSSION

4.1 Statistical Analysis

In Table 2 below, 17.68% of the children suffered from diarrhea during the last two weeks preceding the survey, 87.15% of normal growth and 12.85% of underweight children. For the variable of interest, we observe an average value of the AERD of 0.478, reflecting low access to the distribution network (48%).

Looking at the control variables, women with children under 5 years old are on average 34 years old and 39 years old on average for their spouses.

It also appears that about 35% of households with children under 5 are urban, 49% semi-urban and 17% rural. Finally, the poverty rate is high (43.99%) or 22.63% of households are poor and 21.35% are very poor.

Fig. 1-A illustrates that 24% and 14% of children who have suffered from diarrhea and underweight are from urban households, compared to 30% and 35% for semi-urban households (46% and 51% rural). In addition, 60% and 75% of children with diarrhea and

Table 2. Descriptive statistics of study variables

Variables	Code and description	Mean / percentage	Standard deviation	Min	Max
MD	=1 if child had diarrhea during the two weeks preceding the survey	0,823	0,384	0	1
EN	=1 if the child is not affected by underweight	0,8715	0,654	0	1
AERD	=1 if the household gets its water supply from the distribution network	0,478	0,973	0	1
Mother's age	Number of years the mother was at the time of the survey	33,761	5,726	21	60
Education of the mother	=1 if no level	0,2721	0,498	0	1
	=1 if primary	0,4117	0,499	0	1
	=1 if secondary	0,2896	0,353	0	1
	=1 if University	0,265	0,276	0	1
Religion of the mother	=1 if other mother	0,0702	0,255	0	1
	=1 if Muslim mother	0,2347	0,423	0	1
	=1 if Christian mother	0,695	0,460	0	1
Sex of the child	=1 if male child	0,437	0,421	0	1
	=1 if female child	0,563	0,415	0	1
Child's age	= 1 if age less than 6 months	0,0723	0,207	0	1
	=1 if age between 6 and 11 months	0,1206	0,315	0	1
	=1 if age between 12 and 23 months	0,2352	0,364	0	1
	=1 if age between 24 and 35 months	0,1727	0,401	0	1
	=1 if age between 36 and 47 months	0,2186	0,389	0	1
	=1 if age between 48 and 59 months	0,1806	0,412	0	1
Middle of residence	=1 if urban area	0,3453	0,498	0	1
	=1 if semi-urban area	0,4877	0,499	0	1
	=1 if rural	0,167	0.345	0	1
Household wealth	= 1 if very poor level of wealth	0,2135	0,409	0	1
	=1if poor level of wealth	0,2263	0,418	0	1
	=1 if average level of wealth	0,1977	0,398	0	1
	=1 if wealth level rises	0,1782	0,382	0	1
	=1 if very high wealth level	0,183	0,387	0	1
Access to health care	=1 if the child can access health care	0,7508	0,477	0	1

Source: Based on DHS-MICS data, 2018.

underweight are in very poor or poor households compared to less than 10% and 4% of children in households with a high or very high standard of living (Fig. 1-B).

Access to infrastructure and public drinking water services is strongly correlated with the state of health of populations in Cameroon. The proportion of children with diarrhea or underweight is lower when the household can have access to these facilities.

4.2 Econometric Results

Table 3 highlights the results of the estimation of the instrumental variable probit model. It will therefore be a question of illustrating the effect of access to the public water service on the state of child health by distinguishing between the two measures, in particular diarrheal morbidity and underweight.

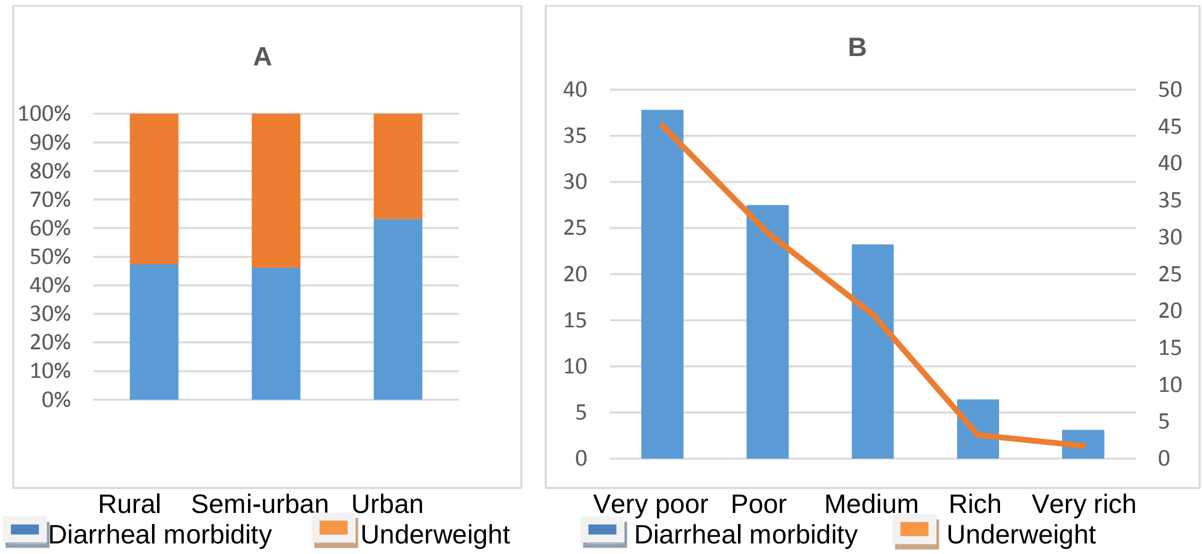

Fig. 1. Distribution of the child's state of health according to place of residence (A) and according to the standard of living of the household

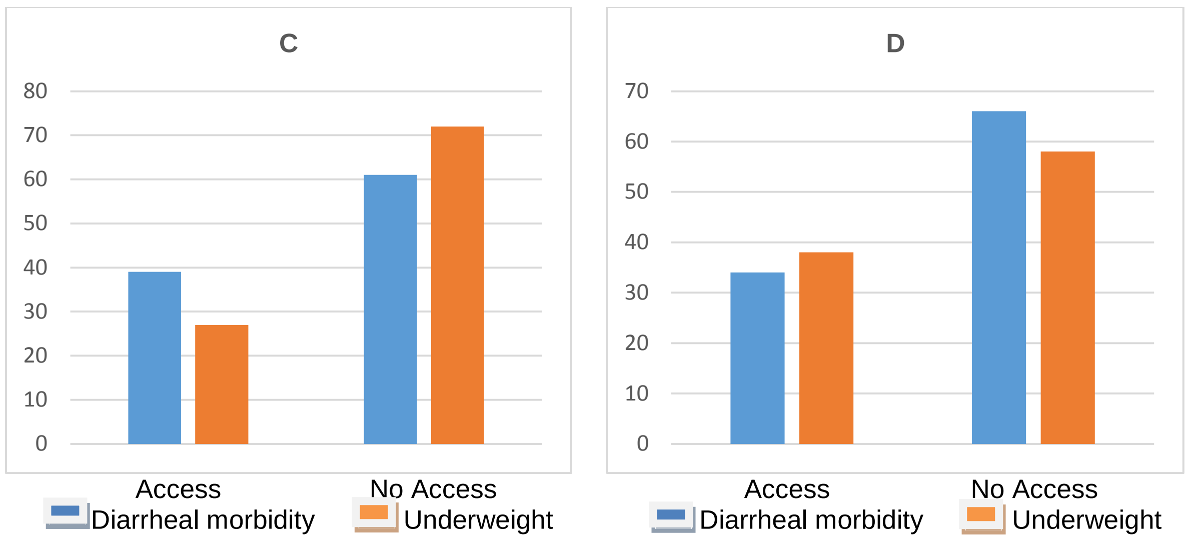

Fig. 2. Distribution of child health according to access to public water service (C) and according to access to health care (D)

Source: Based on DHS-MICS data, 2018.

Table 3. Effect of AERD on the health status of children: IV-probit results

Variables	Diarrheal Morbidity	Underweight
AERD	-0,772***	-0,534
(Ref=alternative sources)	(0,172)	(0,312)
Age	-0,107	-0,199**
	(0,349)	(0,145)
Education : Primary		-0,196*
(Ref=without level)	-0,296***	(0,0318)
Secondary	(0,488)	-0,545*
	-0,402***	(0,198)
Superior	(0,390)	-0,606***
	-0,506***	(0,124)
	(0,249)	
Religion : Christian	-0,535**	-0,833**
(Ref=others)	(0,271)	(0,373)
Muslim	0,694**	0,221***
	(0,294)	(0,438)
Child gender: Female	0,890	0,923
(Ref= Male)	(0,231)	(0,342)
Child's age: < 6 months	-0,342	-0,628
(Ref=6-11 months)	(0,251)	(0,154)
12-23 months	-0,591***	0,498*
	(0,175)	(0,241)
24-35 months	-0,852***	0,914
	(0,406)	(0,231)
36-47 months	-0,526***	-0,641
	(0,627)	(0,715)
48-59 months	-0,791***	-0,920
	(0,416)	(0,342)
Wealth level: Poor	0,149	-0,173
(Ref=very poor)	(0,188)	(0,394)
Medium	-0,259	0,128
	(0,216)	(0,410)
Rich	-0,414***	-0,298***
	(0,313)	(0,464)
Very rich	-0,654***	-0,412***
	(0,433)	(0,478)
Place of residence: urban	-0,928***	-0,709**
(rural)	(0,186)	(0,253)
Semi-urban environment	-0,622***	-0,822*
	(0,157)	(0,554)
Child's access to health care	-0,399***	-0,541**
	(0,145)	(0,220)
Comments		
Log-likelihood	*2042*	*2042*
Prob > chi2	*-1314,146*	*-1537,274*
Fisher-test validity of	*0,000*	*0,000*
the instrument (1st stage)	*29,43 ****	*89,80****

*Source: Based on EDS-MICS data, 2018. The values in the table are the marginal effects. The values in parentheses are the robust standard deviations. ***p<0.01, **p<0.05, *p<0.1*

From the estimates, it appears, contrary to Kouassi et al. [18], that the supply to the water distribution network has a positive impact on the state of child health (occurrence of diarrhea - 0.772 and exposure to underweight -0.534). It also emerges that all the control variables are explanatory of the state of health of the children.

Household wealth has a positive effect on improvement, and this positive effect is greater as household wealth increases. Thus, in comparison to households with a very low standard of living, children living in households with a high or very high standard of living have respectively 0.414 and 0.654 less chance of exposure to diarrheal risks (these rates are 0.298 and 0.412 for underweight). Kouassi et al. [8] came to the same result in their analysis. Compared to households residing in rural urban areas, the fact that a household is located in an urban or semi-urban area improves the health status of children respectively by 0.928 and 0.622 in terms of diarrheal morbidity (by 0.709 and 822 respectively for nutritional status). This result may reflect the fact of the weak development of health infrastructure and drinking water supply in semi-urban and urban areas. The easier it is to access health care, the more likely the child is to be in good health. This result reflects the fact that the mother receives lessons on the care of the child and the preventive and curative techniques of juvenile diseases [19].

5. CONCLUSION

This study aimed to assess the effect of household access to public water service on the health status of populations in Cameroon. To this end, we used data from the Demographic and Health (EDS 2018) and Multiple Indicator Survey (MICS 2018). We also considered the Juvenile Health indicators, binary variable, and Access to Public Water Services, potentially endogenous factor. From the results of the estimation of the instrumental variable probit model, it was established that household access to public water service, alongside the improvement of household income and its urban status, positively and significantly affects the health status of the population. Also, it is incumbent on the authorities to increase public investments in order to facilitate access to drinking water for the population.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Author has declared that no competing interests exist.

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