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The Prevalence of Malnutrition Among Children
Under 5 years of Age and Associated Factors in
Democratic Republic of the Congo

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The Prevalence of Malnutrition Among Children
Under 5 years of Age and Associated Factors in
Democratic Republic of the Congo

Directed by Professor SUK YONG JANG

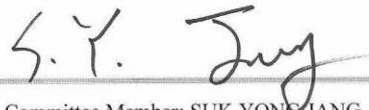
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and The Graduate School of Public Health of Yonsei University
in Partial Fulfillment of the
requirements for the degree of
Master of Public Health

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Abstract

“The Prevalence of Malnutrition Among Children Under 5 Years of Age and Associated Factors in Democratic Republic of the Congo”

Background: The child malnutrition, with high prevalence in low-income and middle-income countries, is responsible of substantial increases in mortality and overall disease burden. In Sub-Saharan Africa countries, child malnutrition is associated with approximately 60 percent of under-five mortality. In DRC, studies focused on the prevalence of malnutrition among under-five children and the factors associated are quasi-inexistent. Hence, the present study was carried out not only to find out the matter but also to fill the gap of insufficient in publication on this topic.

Methods: A quantitative-based cross-sectional design using secondary data from the sample for the MICS-PALU, DRC 2017-2018, which was designed by UNICEF. A total of 21477 under-five children was concerned by the study and descriptive analysis using percent and frequency was calculated for the 2 anthropometric indicators: weight for age and height for age; the regression analysis to identify factors associated with the malnutrition in children under 5 years old and bivariable and multivariable logistic regression were used to identify the risk factors related to malnutrition in the 26 provinces of DRC.

Results: The prevalence of stunting and malnutrition is 43,1 and 24% respectively. 3 years old children, mostly male, are more concerned. The high proportion of stunting and

malnutrition is found in the west part of the DR Congo. The vaccination is not a predictor for stunting and malnutrition but living in a rural area, having an illiterate mother and weighting less than 4 kgs are associated factors for the stunting and malnutrition.

Conclusion: 43,1% of under-five children were stunted and 24% of them, malnourished in DR Congo. 3 years' children have a high proportion of stunting (2.7 times) than children of 0 year, following by children of 4 years age group who were 2.5 times stunted than 0 year age group children in urban area. Contrariwise, the same age groups were respectively 2.7 and 2.8 times more malnourished than 0 year of age children in rural areas. The underlying factors such as child gender especially male, child weight, child from illiterate mother, being from a rural area, from the western part of the country or not having health insurance, not being breastfed, and not having been managed for a minor illness as well as using the unimproved water source for drinking have been associated with the malnutrition and stunting in DR Congo.

Key Words: malnutrition; stunting; under-five; DR Congo

I. INTRODUCTION

1.1 Background

The child malnutrition, with high prevalence in low-income and middle-income countries, is responsible of substantial increases in mortality and overall disease burden (Robert E Black, 2008). If prolonged, the malnutrition prevents children to reach their full physical and mental potential and results in the delay in their physical growth and motor development; lower intellectual quotient (IQ); greater behavioral problems and deficient social skills; and also the susceptibility to contracting diseases (Ngianga-Bakwin Kandala et al., 2011).

In the Democratic Republic of the Congo, an estimated 3.3 million children under five will suffer from acute malnutrition in 2021, including at least 1 million with severe acute malnutrition. These alarming figures are due to ongoing insecurity, the socioeconomic consequences of the COVID-19 pandemic, and limited access to essential services for vulnerable children and families (UNICEF, 2021).

Malnutrition, as a direct, immediate cause of the death, kills children by increasing case fatality of common childhood infections, not by increasing their incidence (Habicht, 2008). Stunting and severe wasting, together with the intrauterine growth restriction were responsible for 2,2 million deaths and 21% of Disability-adjusted life-years (DALYs) for children younger than 5 years (Robert E Black, 2008). In Sub-Saharan Africa countries, child malnutrition is associated with approximately 60 percent of under-five mortality. In

1995, 54% as 6,3 out of 11,6 million deaths among under-five children were associated with malnutrition in developing countries(Vinod N, 2011).

Significant risk factors concerning stunting, wasting and underweight of children less than five years old are classified as Child's related risk factors (CR) such as: Child's age, sex, birth weight, type of birth...; Parental/household (PHR) like: age, mean years of schooling of adults, and language spoken, literacy rate, wealth index...; and community- or area related (AR) as maternal place of residence, zone, forest cover lost. They are based on the UNICEF framework of causes of undernutrition in children (Obasohan et al., 2020).

Healthcare facilities in remote villages, which are often most severely affected by conflicts between local armed groups, suffer the greatest resource deficiencies. This in turn increases the risk of disease transmission. "Poverty, inadequate access to drinking water, lack of hygiene and poor sanitation habits, inappropriate feeding practices, especially for infants, children and women, and a dearth of agricultural inputs contribute to high rates of malnutrition and undermine the economic development potential of the population," (Publikováno, 2020)

By contributing to fill the gap of insufficient in publication on this topic in Democratic Republic of the Congo, this study aims to find out what have been the prevalence of malnutrition among children under-five years in Democratic Republic of the Congo I the period of 2017-2018 and to identify factors associated with the malnutrition at the same time. The study will also provide information to policy makers for planning and

implementation of policy particularly in vulnerable groups such as children of under-five years.

1.2 Research question

What are the factors that have been associated with the malnutrition among under 5 children in Democratic Republic of the Congo? during the period 2017-2018.

1.2.2 Objectives

This study aims to estimate the prevalence and identify the risk factors for undernutrition among under-five children in Democratic Republic of Congo.

II. LITERATURE REVIEW

This study was undergoing literature review to find the existing articles related to malnutrition, which identifies determinants influencing malnutrition among under-five children in Democratic Republic of Congo. The determinants have been studied on the adapted conceptual framework of UNICEF

2.1. Definition of the malnutrition

“Bad nutrition” is a literal meaning of malnutrition that includes both over- and undernutrition (WFP, 2005). Mainly, undernutrition is generally the issue of concern in the context of developing countries. And within the context of World Food Programme (WFP) programs and assessments, malnutrition in child refers to under-nutrition (underweight, wasting and stunting) unless otherwise specified (WFP, 2005).

According to WFP, malnutrition means “a state in which the physical function of an individual is impaired to the point where he or she can no longer maintain adequate bodily performance process such as growth, (pregnancy, lactation) physical work and resisting and recovering from disease.”(Chhetri, 2005; WFP, 2005).

Malnutrition is also defined as “a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients” (Chhetri, 2005). “Malnutrition or undesirable physical or disease conditions related to nutrition can be

caused by eating too little, too much or an unbalanced diet that does not contain all nutrients necessary for good nutritional status” (Latham, 1997).

2.2. Measurement of malnutrition

For assessing children’s up to age 5 nutritional status, the growth indicators are used and for that, anthropometric measurement is done. Malnutrition is diagnosed when deficits are found in one or more than one indicator.

Measurement of nutritional status of under five children are calculated and measured as a Growth indicators , provided by the WHO (WHO, 2009).

- **Length/height-for-age:** reflects attained growth in length or height at the child’s age at a given visit. This indicator can help identify children who are stunted (short) due to prolonged undernutrition or repeated illness. Children who are tall for their age can also be identified, but tallness is rarely a problem unless it is excessive and may reflect uncommon endocrine disorders(Chhetri, 2005);

- **Weight-for-age:** reflects body weight relative to the child’s age on a given day. This indicator is used to assess whether a child is underweight or severely underweight, but it is not used to classify a child as overweight or obese. Because weight is relatively easily measured, this indicator is commonly used, but it cannot be relied upon in situations where the child’s age cannot be accurately determined, such as refugee situations. It is important to note also that a child may be underweight either because of short length/height (stunting) or thinness or both(WHO, 2021);

- **Weight-for-length/height**: reflects body weight in proportion to attained growth in length or height. This indicator is especially useful in situations where children's ages are unknown (e.g. refugee situations). Weight-for-length/height charts help identify children with low weight-for-height who may be wasted or severely wasted. Wasting is usually caused by a recent illness or food shortage that causes acute and severe weight loss, although chronic undernutrition or illness can also cause this condition. These charts also help identify children with high weight-for-length/height who may be at risk of becoming overweight or obese (9);

- **BMI-for-age** is an indicator that is especially useful for screening for overweight and obesity. The BMI-for-age chart and weight-for-length/height chart tend to show very similar results. BMI is determined from a child's weight and length/height by using a reference table or a calculator (WHO, 2021).

In 2006, by replacing the NCHS/WHO child growth reference of 1977 with the new growth standards, WHO also recommend the use of **MUAC-for-age** as well as **bilateral oedema** as an independent diagnostic criterion for severe acute malnutrition (SAM)(WHO, 2009).

2.3. Malnutrition burden

According to the WHO, 178 million children are malnourished throughout the world and 20 million of them are seriously affected. As for UNICEF, 195 million children suffer from malnutrition across the globe. The WHO, in 1997, found out that 60% of deaths

among children under-five in developing countries was related to the malnutrition (Nigusu, Kemal and Betela, 2019).

Study in Vietnam, in 2007, assessing the nutritional status and risk factors of malnutrition in children under three years old have found that in the total of 383 children, 27,8% were underweight; 36,3 stunted and 10,2 wasted. And the same study indicates that socio-economic, environmental factors and breast-feeding practices were significantly associated with the malnutrition (Ngoc Hien and Ngoc Hoa, 2009)

Evidence from reviewed studies linked to the Sub-Saharan Africa has found the most consistent factors associated with stunting, wasting and underweight were; low mother's education, increasing child's age, sex of child (male), wealth index/low SES (poor household), prolonged duration of BF (>12 months), low birth weight, mother's age (<20 years), source of drinking water (unimproved), low mother's BMI (<18.5), birth size (small), diarrheal episode, low father's education and place of residence (rural). Other factors also reported were; large family size, geographical region/geopolitical zone, multiple births, short birth interval, high child parity, lack of immunization/vaccination, family type (polygamous), no health care use, lack of health insurance and inappropriate child feeding practices (Akombi et al., 2017).

Another review aimed to explore the determinants of stunting and overweight in sub-Saharan Africa found that their prevalence depended on socioeconomic, demographic, and environmental factors. According to the same review, several studies have proven that

male children and those living in a rural setting are more likely to be stunted, whereas overweight among children depends more on age, household composition, occupation of the mother, and the mother's body mass index. Other factors such as mother's education, mother's occupation, and household income as well as rural or urban setting and sanitation, also was directly linked to stunting (Susan Keino, 2014).

For estimating the prevalence and identifying the risk factors for malnutrition among 385 under-five children in Debre Berhan Town, North Shewa, Ethiopia, a study found that the stunting represented 41%; wasting 33% and 26% of the children was in underweight status. And maternal illiteracy, not breastfeeding exclusively, preterm birth, absence of antenatal care, exposure to infectious diseases and diarrhea was contributor factors (Menalu et al., 2021).

By investigating the impact of geographic location on child nutritional status and mapping the residual net effect of malnutrition while accounting for important risk factors, a study found out that the childhood malnutrition was more pronounced in all provinces of the Democratic Republic of Congo but was significantly higher in rural areas compared to urban centers (Kandala et al., 2011).

2.4. Factors associated with under-five child malnutrition

The under-five years of age children malnutrition risk factors are really complex and interrelated. However, the most common factors associated with children malnutrition are 6 and 4 of them, which are directly linked to the malnutrition, termed underlying

determinants are: women's education, national food availability, women's status related to men's and health environment. The remaining 2, termed basic determinants are national income and democracy. They indirectly influence the malnutrition by facilitating investment of underlying risk factors(Smith LC, 2000).

Other factors such as poverty, lack of breast-feeding practices, source of water, diarrhea, etc, have been significantly associated to the under-five children malnutrition(Derso et al., 2017; Nigusu, Kemal and Betela, 2019)

Mother's education: Mother's educational status, especially the illiteracy, is an underlying determinant of malnutrition by its negative effect in children mean z-scores of height-for-age(Smith LC, 2000). Study in Ethiopia revealed that this situation can result from the illiterate mothers unawareness of feeding practice nutritious value as well as hygiene practice importance(Nigusu, Kemal and Betela, 2019).

Number of household members: Household size is in independent manner a determinant factor of both wasting and underweight. Being a child from household with a big size of members increase the vulnerability of getting malnourished because in this case there is a food limitation and the youngest are more exposed(Nigusu, Kemal and Betela, 2019).

Vaccination: Study in Andhra Pradesh didn't find out association between Polio and DPT immunization and the undernutrition but the immunization have a significant effect on nutrition status(Geervani, 2005). Fully vaccinated status is not a predictor factor

of undernutrition and improve the child nutritional status according to a study in rural Punjab (F. James Levinson and Guy Koppe, 2004).

Child's age: In Ethiopia, children aged 12 to 23 months have more high risk of being stunted than those of 6 to 11 months' age group (Genebo, 2002).

Breast feeding practices: No feeding practice (feeding colostrum) is associated with the increasing risk of childhood malnutrition (Angela Oswalt, 2005). As shown by a study in Uganda, the underweight high incidence is linked with the fact of never consuming breast milk by the children under-five years of old. And at the opposite side, 18 months of breast feeding decreases the risk of stunting (Joyce K. Kikafunda, 1998).

The non-exclusive breast-feeding children below one year of age were found more malnourished (Waters et al., 2004).

Source of water: A good water quality prevents child malnutrition and reduces children and infants' mortality. Malnutrition can result from illness due to water contamination and manifested by diarrhea (RUBIANA CHARMARBAGWALA et al.). The unimproved water source is associated with the underweight as revealed by a study in Uganda (Joyce K. Kikafunda, 1998).

2.5. Justification of the study

Almost half of the mortality rate in children under 5 years old in Asia and Africa caused by malnutrition. This causes the death of 3 million children per year. And the malnutrition, by causing the death of 3 million children under five years old per year in

Africa and Asia, is responsible of almost half of their mortality rate (Setiawan, 2017; UNICEF, 2017).

The findings of this study will help to highlight not only the prevalence of different types of malnutrition but also their associated factors in the Democratic Republic of Congo. And by contributing to fill the gap of lack of literature related to the malnutrition in the country, the study will guide researchers and public health actors to take a good direction in acting on the reduction of the prevalence of malnutrition and alleviate its consequences in children under-five years old in the future.

2.6. Conceptual framework

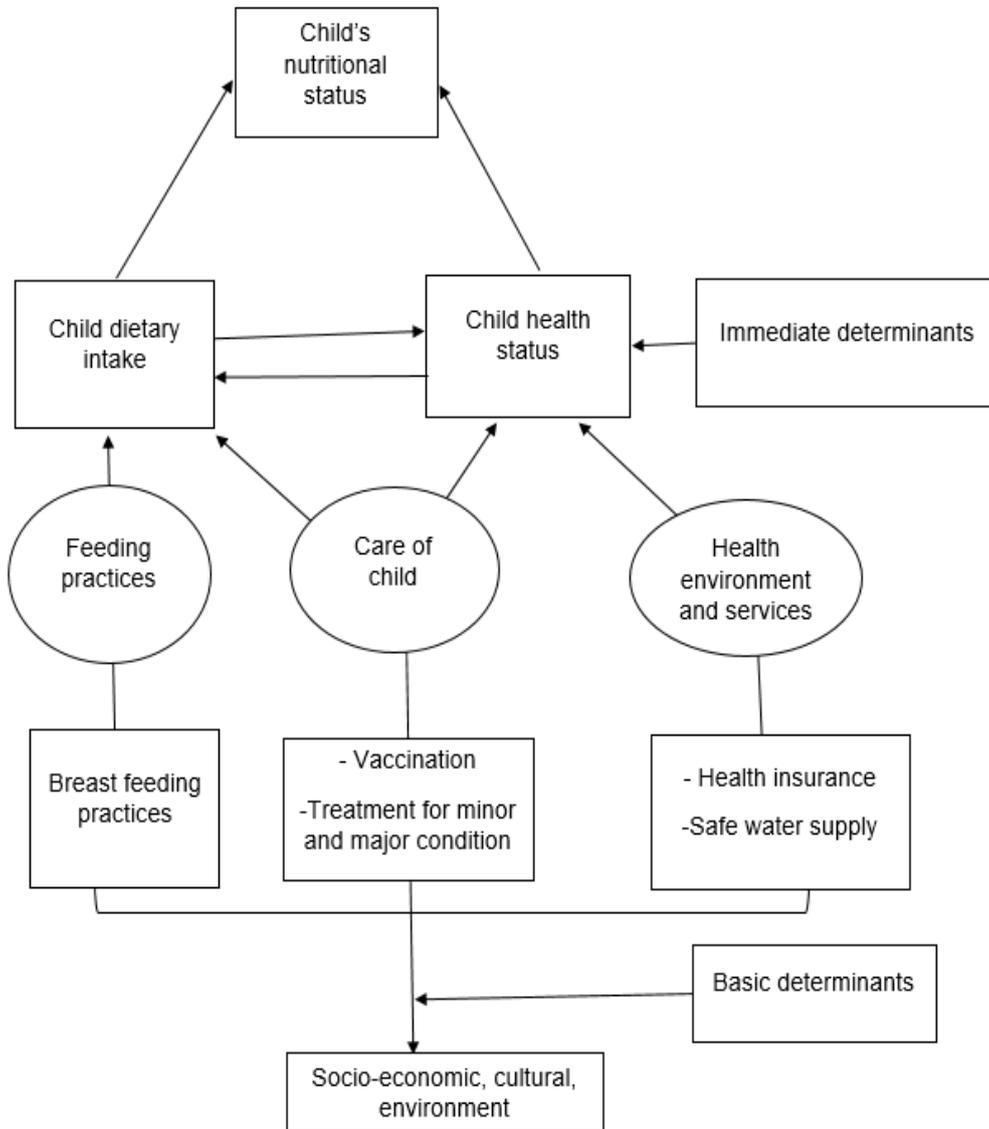


Figure 1 Conceptual framework (Adapted from Smith LC, Haddad L., 2000)

III. MATERIALS AND METHODS

3.1. Research Design

This study focused on a quantitative-based cross-sectional design using the data from The Multiple Indicators Cluster Surveys of Democratic Republic of the Congo (Secondary data from UNICEF website) during the period of time 2017-2018.

3.2. Population and Setting

This study used data from 21477 children under-five years of age who were eligible for the surveys and 20792 households that were interviewed during data collection in the 26 provinces of the Democratic Republic of the Congo.

3.3. Variables

All the dependent and independent variables are classified and subcategorized according to the Z-score of WHO (Table 1).

3.3.1. Dependent variables:

Dependent variables were Height for age, Weight for age and Weight /Height.

3.3.2. Independent variables:

There were Demographic characteristics of the under five children, Health status, Parental and family characteristics and other growth and development factors.

Table 1. Description of variables

	Variables	Classification	Remarks
Dependent variables	Height for age	1=Stunt; 0=Not stunt.	Children Height for age z-score WHO
	Weight for age	1=Malnutrition (Wasted); 2=Not malnutrition (Not wasted)	Children Weight-for-age WHO z-score
	Weight /Height	1=Underweight; 2=Not underweight.	Children Weight for height z-score WHO
Independent variables	Demographic characteristics of under five children		
	Age	0;1;2;3;4	Children's age (Under-five years old) in year
	Gender	1=Male; 2=Female.	Gender category of under five children
	Parental and family characteristics		
	Mother's Education	0=Elementary/less; 1=Middle school; 2=High school and over.	Under five children mother's educational level
	Number of children	1=1 to 3; 2=4 and more	A total number of children in the family including under-five children

	Variables	Classification	Remarks
	Number of household members	1=2 to 10; 2=11 and more.	A total number of members in the under-five children's family
Independent variables	Type of housing	1=Ownership; 2=Lease; 3=Hosted by the family; 4=Other	The household owns the dwelling
	Residence	1=Urban; 2=Rural	Place of residence
	Province	1=North western; 2=North eastern; 3=South western; 4=South Eastern.	26 provinces grouped in four province
	Health insurance	1=With insurance; 2=Without insurance.	Health insurance
	Health status		
	Breast feed	1=Yes; 2=No; 3=No answer.	Breast feeding practices of the mothers of under five children
	Vaccination	1=Yes; 2=No; 3=No answer.	Whether the children under five received Vaccination or immunization.
	Water sanitation	1=Improved water source; 2=Unimproved water source.	Water quality

	Variables	Classification	Remarks	
Independent variables	Weight (Kg)	1=0 to 4.9; 2=5 and over	Child's weight (kilograms); acquired body weight of the under five children at the time of survey.	
	Height(mm)	1=1 to 100; 2=801 to 1000.	Length of the child (mm)	
	BMI	1=Wasting; 2=Not wasting	Children Body Mass Index WHO	
	Weight /Height	1=Underweight; 2=Not underweight.	Children Weight for height z-score WHO	
	Child discipline		1=No one; 2=More than one.	How many children's books or picture books do you have for (name)?
			1= Yes; 2=No; 3=No answer.	Does (name) know or can name at least ten letters of the alphabet?
	Child functioning		1=Yes;2=No; 3=No answer.	Can (name) pick up a small item on the ground with two fingers, such as a stick or a rock?
	Treatment of disease		1= Yes; 2=No; 3=No answer.	Have you sought advice or treatment for diarrhea from any source?
		1=Yes; 2=No; 3=No answer.	Have you sought advice or treatment for the disease anywhere?	

3.4. Data collection

The data for this study come from the sample for the Multiple Indicator Cluster Survey with Malaria in the Democratic Republic of Congo (MICS-PALU, DRC 2017-2018), which was designed by UNICEF to provide estimates for a large number of indicators on the situation of children and women at the national level, by place of residence (urban and rural), and for the 26 provinces of the country.

Type of residence was used as a stratification variable. Thus, in each province, with the exception of Kinshasa, three strata were created: the stratum of statutory cities (stratum 1); the stratum of towns (stratum 2) and the stratum of sectors/chefferies (stratum 3). The first two strata constitute the urban environment and the third, the rural environment. In total, 76 strata were defined.

In each stratum, a certain number of sampling units were selected according to the number of sampling degrees for that stratum. The primary units, selected systematically with probability proportional to size, were the commune neighborhood for stratum 1, the city for stratum 2 and the sector or chiefdom for stratum 3. The secondary units were the city neighborhood for stratum 2 and the village for stratum 3.

The commune neighborhood, city neighborhood and village acted as clusters in this survey. When the city neighborhood, the city district or the village was very large (more than 300 households), a segmentation was made and a segment was randomly drawn. It constituted, in this case, the secondary unit for stratum 1, the tertiary unit for strata 2 and

3. After a list of households (enumeration) from the selected cluster or cluster segment was compiled, a systematic sample of 30 households was drawn from each of the 721 clusters/segments, for an overall sample of 21,630 households. When cluster segments were created within a stratum, then the household was the tertiary unit for stratum 1 and the quaternary unit for strata 2 and 3. Since the sample was not self-weighted, the sample weights were used.

During the survey, 12 clusters were not visited, mainly for security reasons. for security reasons. Eleven of these clusters were in rural areas.

Also in rural areas, many clusters were found to have fewer than 30 households, requiring teams to survey all households in the cluster. This required teams to survey all households in these clusters, so no random selection of households could be made. This meant that no random selection of households could be made.

Several questionnaires were used in the survey:

- 1) a household questionnaire that was used to collect basic demographic information on all de jure household members (usual residents), the household and housing.
- 2) a water quality analysis questionnaire administered in four households in each cluster.
- 3) an individual female questionnaire administered in each household to all women aged 15-49 years old;

- 4) an individual male questionnaire administered in every other household to all males aged 15-49 years old;
- 5) a questionnaire for children under 5 years of age, administered to mothers (or guardians) of children under 5 years of age living in the household. This questionnaire was linked to the anemia and malaria testing module which is administered in two out of three households to all children aged 6-59 months.
- 6) a questionnaire for children aged 5-17, for one child per household randomly selected from among the children aged 5-17 living in the household; it was administered to the mother - or primary caregiver - with the exception of the 'learning skills' module, which is administered to the child him/herself

Each questionnaire had its modules and this study will only take into account some specific data collected by the household and under 5 years old questionnaires.

3.5. Data Analysis:

All the data was analyzed by SPSS version 23 for windows.

- **Descriptive statistics:** Descriptive analysis using percent and frequency was calculated for the 2 anthropometric indicators: weight for age and height for age.
- **Chi-square analysis:** Association and prevalence of malnutrition and stunting - comparison was calculated by Chi-square analysis or Fisher's Exact test.
- **Univariable and multivariable logistic regression** were used to identify the risk factors related to malnutrition in 26 provinces of DRC.

3.6. Ethical statement

This study used the data publicly available from United Nations Children's Fund (UNICEF) and the approval for access was obtained by explaining the purpose of the study dated on 2021.07.21. All information is kept confidential, encrypted, and used only for research purposes. The results will be used to propose and recommend the improvement of the population's health and healthcare system for under five children in under-five children in Democratic Republic of Congo.

IV. RESULTS

Characteristics of the Study Population

4.1. General Characteristics

A total of 21477 children under-five years old distributed in twenty-six provinces of the Democratic Republic of the Congo were included in this study. General characteristics and distribution of demographic and health status of the study population were presented in table 2.

Among the study population 50.5% (10844) were females and 49.5% (10633) were males. Only 1.6% of under-five years age children's mothers had attended the educational level of university and over, and 39.2% the middle school. More than three quarters of the children are from households with 1 to 3 children and less than a quarter from 4 and more children households. 59.7% of the study population were living in households of 11 and more members and 40.3% from 2 to 10 members' households. 72.8% owned the dwelling and 14.1% leased it. The others were either staying with family (12%) or using another form of housing (1.1%). Only 26.9% of the study population lived in urban area, the majority of them was living in rural area (73.1%). 31.1% of them was from the North eastern part of the DR Congo; 24.5%, 22.3% and 22.1% from the South eastern, South western and North western respectively.

Almost all the children under-five years of age were without health insurance at the moment of the data collection (98%), only 56.4% was breast fed and 55.1% vaccinated. 86.7% of under-five years age children's household was using the unimproved water source. Very few (3.9%) of under-five years age children could name at least ten letters of the alphabet and 48.4% of them could pick-up a small item on the ground with 2 fingers.

Table 2. Distribution of demographic characteristics and health status of children under 5 years of age. (N=21,477)

Variables	Characteristics	N	%
Child's Age (Years)	0	4453	20.7
	1	4246	19.8
	2	4148	19.3
	3	4458	20.8
	4	4172	19.3
Gender	Male	10633	49.5
	Female	10844	50.5
Mother's Education	Elementary or less	5055	23.5
	Middle school	8421	39.2
	High school	7650	36.6
	University and over	351	1.6
No.of Children	1 to 3	16564	77.1
	4 and more	4913	22.9
Number of household members	2 to 10	8659	40.3
	11 and more	12818	59.7
Type of housing	Ownership	15638	72.8
	Lease	3028	14.1
	Hosted by the family	2578	12
	Other	233	1.1
Residence	Urban	5781	26.9
	Rural	15696	73.1
Province	North western	4760	22.1
	North eastern	6561	31.1

Variables	Characteristics	N	%
	South western	4886	22.3
	South eastern	5270	24.5
Health insurance	With insurance	397	2
	Without insurance	21080	98.0
Breast feeding	Yes	12122	56.4
	No	718	3.3
	No answer	8637	40.2
Vaccination	YES	6046	28.2
	NO	3586	16.7
	No answer	11845	55.1
Water quality	Unimproved water source	18629	86.7
	Improved water source	2848	13.3
Reading (books)	No one	21162	98.5
	More than 1	315	1.5
Speaking (alphabets)	Yes	841	3.9
	No	11864	55.2
	No answer	8772	40.9
Grasping (small objects)	Yes	10385	48.4
	No	2355	11
	No answer	8737	40.7
Treatment (minor illness)	Yes	1455	6.8
	No	1581	7.4
	No answer	18441	85.8
Treatment (major condition)	Yes	3031	14.1
	No	3693	17.2

Variables	Characteristics	N	%
	No answer	14753	68.7
Child length/height(cm)	1-200	21424	99.6
	801-1000	53	0.2
Length-for-age* (stunting)	Stunt (1)	9264	43.1
	Not stunt (0)	12213	51.2
Weight-for-age*	Malnutrition (1)	5150	8.2
	Normal and over (0)	16327	76.0
Weight-for-height*			
(wasting)	Wasting	1505	7.0
	Not wasting	19972	93.0
Body Mass Index*	Wasting	1268	5.9
	Not wasting	20209	72.4

* Measured by z-score WHO

4.2. Comparison of Stunting among children under 5 years-age in DR Congo

(N=21,477)

The comparison between stunted and not stunted children under-five years' age in DR Congo is given in the table 3. The results showed the differences between stunted and not stunted children retained in this study. 46.2% of males' children under-five years of age were stunted. 47.3% of children from illiterate mothers were stunted but the difference was not statistically significant. More than a half of stunted children lived in the North-western and the South-western provinces, respectively in the proportion of 55.4 and 53.6%. The non-respondent children under-five years of age were more stunted (54.6%) followed by the vaccinated children (30.2%). A small difference was seen in the proportion of stunted under-five children between the ones using improved water source and the ones using unimproved water source (43.9 and 43% respectively).

Table 3. Comparison of stunting among children under 5 years-age in DR Congo (N=21,477)

Variables	Characteristics	Stunting		Not stunting		P*
		N	%	N	%	
	Total	9264	43.1	12213	56.9	
Age (Years)	0	1038	23.3	3415	76.7	0.072
	1	1585	37.3	2661	62.7	
	2	1767	42.6	2381	57.4	
	3	2574	57.7	1884	42.3	
	4	2284	55.0	1867	45.0	
Gender	Male	4915	46.2	5718	53.8	<.001
	Female	4349	40.1	6495	59.9	
Mother's Education	Elementary or less	2393	47.3	2662	52.7	0.602
	Middle school	3583	42.5	4838	57.5	
	High school and over	3288	41.1	4713	58.9	
No.of Children	1 to 3	7258	43.8	9306	56.2	0.079
	4 to 7	2006	40.8	2907	59.2	
Number of household members	2 to 10	3744	43.2	4915	56.8	0.277
	11 to 20	4951	43.6	6409	56.4	
	21 to 30	569	39.0	889	61.0	
Type of housing	Ownership	1094	36.1	1934	63.9	0.300
	Lease	1069	41.5	1509	58.5	
	Hosted by the family	111	47.6	122	52.4	
Residence	Urban	2123	36.7	3658	63.3	0.534
	Rural	7141	45.5	8555	54.5	
Province	North western	2635	55.4	2125	44.6	<.001
	North eastern	2359	35.4	4302	64.6	
	South western	2563	53.6	2223	46.4	
	South eastern	1707	32.4	3563	67.6	
Health insurance	With insurance	153	38.5	244	61.5	0.152
	Without insurance	9111	43.2	11969	56.8	

Variables	Characteristics	Stunting		Not stunting		P*
		N	%	N	%	
	Total	9264	43.1	12213	56.9	
Breast feeding	Yes	4124	34.0	7998	66.0	0.969
	No	263	36.6	455	63.4	
	No answer	4877	56.5	3760	43.5	
Vaccination	YES	1827	30.2	4219	69.8	<.001
	NO	971	27.1	2615	72.9	
	No answer	6466	54.6	5379	45.4	
Water quality	Unimproved water source	8014	43.0	10615	57.0	<.001
	Improved water source	1250	43.9	1598	56.1	
Reading (books)	No one	9230	43.1	12174	56.9	0.858
	More than 1	34	46.6	39	53.4	
Speaking (alphabets)	Yes	413	49.1	428	50.9	0.851
	No	6187	52.1	5677	47.9	
	No answer	2664	30.4	6108	69.6	
Grasping (small objects)	Yes	2648	30.3	6089	69.7	0.062
	No	5340	51.4	5045	48.6	
	No answer	1276	54.2	1079	45.8	
Treatment (minor illness)	Yes	586	40.3	869	59.7	0.057
	No	694	43.9	887	56.1	
	No answer	7984	43.3	10457	56.7	
Treatment (major condition)	Yes	1320	43.5	1711	56.5	0.091
	No	1617	43.8	2076	56.2	
	No answer	6327	42.9	8426	57.1	

*=Chi-square p value

4.3. Comparison of malnutrition among children under 5 years-age in DR Congo

(N=21,477)

The findings of the comparison between children under-five years of age malnourished or not in DR Congo are given in the table 4. 32.6% of children aged 3 years and 32.1% of 4 years old children were malnourished. 25.6% of males were malnourished and 25.4 % of malnourished children were from illiterate mothers. Almost a quarter (24.6%) of malnourished children came from household counting 1 to 3 children. The other group as type of housing had 33% of malnourished children comparatively to 24.4% of malnourished children found in household owning the dwelling. 24.5% of malnourished children lived in rural areas and respectively 39.9 and 33.6% of malnourished children under-five years were from the North Western and South Western provinces. 13.5% of vaccinated children were malnourished and this result showed a small difference from the non-vaccinated children among who 13.1% were also malnourished. 32.6% of children under-five years old who couldn't grasp a small object were malnourished.

Table 4. Comparison of malnutrition (Yes/No) among children under 5 years-age in DR Congo (N=21,477)

Variables	Characteristics	Malnutrition		Not malnutrition		<i>p</i> *
		N	%	N	%	
	Total	5150	23.90	16327	76.1	
Age	0	723	16.2	3730	83.8	0.022
	1	827	19.5	3419	80.5	
	2	799	19.3	3349	80.7	
	3	1452	32.6	3006	67.4	
	4	1334	32.1	2817	67.9	
Gender	Male	2720	25.6	7913	74.4	<.001
	Female	2430	22.4	8414	77.6	
Mother's Education	Elementary or less	1285	25.4	3770	74.6	0.003
	Middle school	1891	22.5	6530	77.5	
	High school and over	1974	24.7	6027	75.3	
No.of Children	1 to 3	4072	24.6	12492	75.4	0.036
	4 and more	1078	21.9	3835	78.1	
Number of household members	2 to 10	2098	24.2	6561	75.8	0.481
	11 and more	3052	23.8	9766	76.2	
Type of housing	Ownership	3820	24.4	11818	75.6	0.008
	Lease	648	21.4	2380	78.6	
	Hosted by the family	605	23.5	1973	76.5	
	Other	77	33	156	67	
Residence	Urban	1302	22.5	4479	77.5	<.001
	Rural	3848	24.5	11848	75.5	
Province	North western	1599	33.6	3161	66.4	<.001
	North eastern	936	14.1	5725	85.9	
	South western	1911	39.9	2875	60.1	
	South eastern	704	13.4	4566	86.6	
Health insurance	With insurance	121	30.5	276	69.5	0.055
	Without insurance	5029	23.9	16051	76.1	
Breast feeding	Yes	2241	18.5	9881	81.5	

	No	107	14.9	611	85.1	0.592
	No answer	2802	32.4	5835	67.6	
Vaccination	Yes	815	13.5	5231	86.5	
	No	469	13.1	3117	86.9	<.001
	No answer	3866	32.6	7979	67.4	
Water quality	Unimproved water source	4526	76.3	14153	23.7	0.674
	Improved water source	674	23.7	2174	76.3	
Reading (books)	No one	5131	24.0	16273	76.0	0.735
	More than 1	19	26.0	54	74.0	
Speaking (alphabets)	Yes	279	33.2	562	66.8	0.052
	No	3296	27.8	8568	72.2	
	No answer	1575	18.0	7197	82.0	
Grasping (small objects)	Yes	2887	27.8	7498	72.2	0.028
	No	693	29.4	1662	70.6	
	No answer	1570	18.0	7167	82.0	
Treatment (minor illness)	Yes	346	23.8	1109	76.2	0.371
	No	386	24.4	1195	75.6	
	No answer	4418	24.0	14023	76.0	
Treatment (major condition)	Yes	763	25.2	2268	74.8	0.055
	No	877	23.7	2816	76.3	
	No answer	3510	23.8	11243	76.2	

*=Chi-square p value

4.4. Factors associated with malnutrition among children under 5 years-age in DR

Congo

From the findings of the multiple logistic regression given in the table 5, the following factors were associated with the probability of having malnutrition and stunting in a child: child age (aOR=1.77, 95% CI=1.61-1.95, $p<.001$ and aOR=1.61, CI=1.48-1.76, $p<.001$), child weight (aOR=0.26, 95%CI=0.22-0.30, $p<.001$ and aOR=1.61, 95%CI=1.48-1.76, $p<.001$), males' children (aOR=1.51, 95%CI=1.40-1.64, $p<.001$ and aOR=1.36, 95%CI=1.26-1.46, $p<.001$), child from illiterate mothers (aOR=3.20, 95%CI=1.79-5.71, $p<.001$ and aOR=2.88, 95%CI=1.81-4.57, $p<.001$), not breast-fed child (aOR=1.78, 95%CI=1.44-2.21, $p<.001$ and aOR=2.09, 95%CI= 1.72-2.52, $p<.001$) and child not treated for a minor illness (aOR=1.53, 95%CI=1.31-1.78, $p<.001$ and aOR=1.24, 95%CI=1.08-1.43, $p=0.003$).

The children who have been treated for major condition were only associated with stunting (aOR=1.19, 95%CI=1.07-1.33, $p=.002$) and the absence of submission for the health insurance was associated with malnutrition (aOR=0.53, 95%CI=0.29-0.75, $p<.001$).

Table 5. Factors associated with malnutrition among children under 5 years-age in DR Congo

Variables		Malnutrition*				Stunting			
		aOR	95% CI		<i>p</i>	aOR	95% CI		<i>p</i>
Child's age		1.77	1.61	1.95	<.001	1.61	1.48	1.76	<.001
Child's weight (kilograms)		0.26	0.22	0.30	<.001	0.62	0.54	0.70	<.001
Gender	Male	1.51	1.40	1.64	<.001	1.36	1.26	1.46	<.001
	Female	1.00							
Mother's Education	Elementary or less	3.20	1.79	5.71	<.001	2.88	1.81	4.57	<.001
	Middle school	2.75	1.55	4.89	<.001	2.51	1.59	3.97	<.001
	High school	2.11	1.19	3.75	.011	2.22	1.41	3.49	<.001
	University and over	1.00							
No.of Children	1 to 3	1.07	0.97	1.19	.195	1.04	0.95	1.14	.379
	4 and more	1.00							

Variables		Malnutrition*				Stunting			
		aOR	95% CI		<i>p</i>	aOR	95% CI		<i>p</i>
Number of household members	2 to 10	0.95	0.79	1.14	.548	1.02	0.86	1.20	.829
	11 to 20	1.00	0.84	1.18	.973	1.07	0.91	1.25	.417
	21 and more	1.00							
Type of housing	Ownership	1.05	0.71	1.56	.810	1.21	0.83	1.76	.316
	Lease	0.78	0.51	1.19	.254	1.16	0.78	1.71	.463
	Hosted by the family	1.05	0.69	1.58	.825	1.23	0.83	1.81	.299
	Others	1.00							
Province	North western	0.70	0.62	0.79	<.001	0.00	0.85	0.77	.954
	North eastern	1.08	0.97	1.20	.169	0.33	1.05	0.95	1.161
	South western	0.82	0.72	0.92	.001	0.27	0.94	0.84	1.048
	South eastern	1.00							
Residence	Urban	0.62	0.55	0.70	<.001	0.63	0.57	0.70	<.001
	Rural	1.00							

Variables		Malnutrition*				Stunting			
		aOR	95% CI		<i>p</i>	aOR	95% CI		<i>p</i>
Health insurance	With insurance	0.47	0.29	0.75	<.001	0.47	0.29	0.75	<.001
	Without insurance	1.00				1.00			
Breast feeding	Yes	1.00				1.00			
	No	1.78	1.44	2.21	<.001	2.09	1.72	2.52	<.001
	Others	1.76	1.30	2.38	<.001	2.11	1.63	2.73	<.001
Vaccination	YES	1.00				1.00			
	NO	1.03	0.87	1.21	.762	0.89	0.78	1.03	.110
	No answer	1.14	0.99	1.33	.073	1.04	0.92	1.17	.581
Speaking (alphabets)	Yes	1.00				1.00			
	No	2.08	0.96	4.51	.064	0.97	0.54	1.73	.913
	No answer	1.28	0.57	2.85	.551	0.63	0.34	1.16	.139
Grasping (small objects)	Yes	1.00				1.00			
	No	2.08	0.96	4.51	.004	0.94	0.84	1.05	.282

Variables		Malnutrition*				Stunting			
		aOR	95% CI		p	aOR	95% CI		p
	No answer	1.28	0.57	2.85	.742	0.75	0.41	1.36	.337
Treatment (minor illness)	Yes	1.00				1.00			
	No	1.53	1.31	1.78	<.001	1.24	1.08	1.43	.003
	No answer	1.40	1.19	1.65	<.001	1.05	0.90	1.22	.569
Treatment (major condition)	Yes	1.00				1.00			
	No	1.07	0.94	1.21	.294	1.19	1.07	1.33	.002
	No answer	0.97	0.87	1.09	.644	1.15	1.05	1.27	.004

4.5. Factors associated with malnutrition among children under 5 years-age in DR Congo's urban and rural areas.

Table 6 shows the association of malnutrition in urban and rural areas. Children aged 3 and 4-years age group were respectively 2.7 and 2.5 times higher and significantly associated with the malnutrition than children of age 0 year in urban area and the same age group showed 2.4 and 2.5 times more likely to get malnutrition than children of 0 year age group in rural area. Males children under-five years old were 1.2 and 1.1 more malnourished respectively in urban and rural areas. Only in rural area, children in the South-western provinces were 1.5 times more likely to be malnourished than children in the North-eastern provinces. The non-respondents for breast-feeding practices and vaccination were respectively 2.4 and 4.6 more malnourished than breast-fed and vaccinated children under-five in the urban areas and 2 and 3 times likely to be malnourished than breast-fed and vaccinated children in the rural areas. The same category of children under-five years old (non-respondents) were 1.9 times malnourished than children under-five years who can grasp a small object both in urban and rural area. The previous result was similar for children under-five years who couldn't grasp a small object. They were 1.8 times more malnourished than the who could grasp a small object both in urban and rural area.

Table 6. Factors associated with malnutrition among children under 5 years in DR Congo’s urban and rural areas.

Variables	Malnutrition (Yes)											
	Urban					Rural						
	N	%	aOR	95% CI		p	N	%	aOR	95% CI		p
1302	24.0					3848	24.0					
Age												
0	176	15.5	1.00				547	16.5	1.00			
1	219	17.2	1.13	0.91	1.41	0.279	620	20.4	1.30	1.14	1.47	<.001
2	176	15.6	1.01	0.81	1.27	0.928	625	20.6	1.31	1.16	1.49	<.001
3	393	32.9	2.68	2.19	3.27	0.000	1059	32.4	2.43	2.16	2.73	<.001
4	337	30.4	2.47	2.01	3.03	<.001	997	32.8	2.46	2.19	2.77	<.001
Gender												
Male	698	24.3	1.00				2022	26.0	1.00			
Female	604	20.8	0.82	0.72	0.92	0.001	1826	23.0	0.85	0.79	0.91	<.001
Mother's Education												
Elementary or less	101	20.9	1.00				1184	25.9	1.00			
Middle school	276	19.2	0.90	0.70	1.16	0.411	1615	23.1	0.86	0.79	0.94	0.001
High school and over	925	23.1	1.04	0.90	1.44	0.280	1049	21.0	0.96	0.87	1.06	0.412

Variables	Malnutrition (Yes)											
	Urban					Rural						
	N	%	aOR	95% CI		p	N	%	aOR	95% CI		p
	1302	24.0					3848	24.0				
No.of Children												
1 to 3	1044	23.9	0.71	0.61	0.82	<.001	3028	24.8	0.93	0.85	1.01	0.101
4 and more	258	18.2	1.00				820	23.5	1.00			
Number of household members												
2 to 10	490	24.6	0.84	0.74	0.95	0.007	1608	24.1	1.04	0.96	1.12	0.329
11 and more	812	21.4	1.00				2240	24.8	1.00			
Type of housing												
Ownership	615	23.2	1.00				3205	24.7	1.00			
Lease	504	20.9	0.87	0.76	1.00	0.045	144	23.4	0.93	0.77	1.13	0.466
Hosted by the family	177	26.2	1.17	0.97	1.43	0.104	428	22.5	0.89	0.79	0.99	0.039
Other	6	12.8	0.48	0.20	1.14	0.098	71	38.2	1.89	1.40	2.54	<.001
Province												
North western	322	42.3	1.00				177	6.1	1.00			

Variables	Malnutrition (Yes)											
	Urban						Rural					
	N	%	aOR	95% CI		p	N	%	aOR	95% CI		p
	1302	24.0					3848	24.0				
North eastern	120	8.4	0.13	0.10	0.16	<.001	316	6.7	0.39	0.36	0.44	<.001
South western	723	41.2	0.96	0.81	1.14	0.628	1188	39.2	1.37	1.24	1.52	<.001
South eastern	137	7.5	0.11	0.09	0.14	<.001	567	16.5	0.42	0.38	0.47	<.001
Health insurance												
With insurance	77	29.8	0.67	0.51	0.88	0.004	44	31.7	0.70	0.49	1.00	0.051
Without insurance	1225	22.2	1.00				3804	24.5	1.00			
Breast feeding												
Yes	529	16.4	1.00				1712	19.2	1.00			
No	29	11.7	0.68	0.45	1.01	0.054	78	16.6	0.83	0.65	1.07	0.152
No answer	744	32.1	2.40	2.12	2.73	<.001	2058	32.6	2.03	1.88	2.19	<.001
Vaccination												
Yes	144	8.8	1.00				671	15.2	1.00			
No	49	9.4	1.07	0.76	1.51	0.687	420	13.7	0.89	0.78	1.01	0.069
No answer	1109	30.6	4.58	3.81	5.51	<.001	2757	33.5	2.81	2.56	3.09	<.001

Variables	Malnutrition (Yes)											
	Urban					Rural						
	N	%	aOR	95% CI		p	N	%	aOR	95% CI		p
	1302	24.0					3848	24.0				
Water quality												
Improved water source	22.4	1.00				3363	24.6	1.00				
Unimproved water source	23.1	1.04	0.87	1.24	0.667	485	23.9	0.96	0.86	1.07	0.484	
Reading (books)												
No one	1293	22.5	1.00				3838	24.5	1.00			
More than 1	9	27.3	1.29	0.60	2.79	0.513	10	25.0	1.03	0.50	2.10	0.943
Speaking (alphabets)												
Yes	115	29.7	1.00				164	36.1	1.00			
No	787	26.0	0.83	0.66	1.05	0.120	2509	28.4	0.70	0.58	0.85	<.001
No answer	400	16.9	0.48	0.38	0.61	<.001	1175	18.3	0.40	0.32	0.49	<.001
Grasping (small objects)												
Yes	396	16.8	1.00				1174	18.4	1.00			
No	784	26.3	1.77	1.55	2.03	<.001	2103	28.4	1.76	1.62	1.91	<.001
No answer	122	28.0	1.94	1.53	2.45	<.001	571	29.7	1.87	1.67	2.11	<.001

Variables	Malnutrition (Yes)											
	Urban						Rural					
	N	%	aOR	95% CI		p	N	%	aOR	95% CI		p
	1302	24.0					3848	24.0				
Treatment (minor illness)												
Yes	79	19.8	1.00				267	25.3	1.00			
No	99	23.0	1.21	0.87	1.69	0.259	287	24.9	0.98	0.81	1.19	0.850
No answer	1124	22.7	1.19	0.92	1.53	0.183	3294	24.4	0.95	0.83	1.10	0.529
Treatment (major condition)												
Yes	229	23.6	1.00				534	25.9	1.00			
No	218	25.3	1.29	0.80	1.92	0.890	659	23.9	0.90	0.79	1.02	0.107
No answer	855	22.1	0.92	0.78	1.08	0.299	2655	24.4	0.92	0.83	1.03	0.148

4.6. Factors associated with stunting among children under 5 years-age in DR

Congo's urban and rural areas.

Table 7 shows the associated factors of stunting in urban and rural areas. Under-5 children of 3- and 4-years age group were respectively 2,8 (51.7%, 95% CI=1.55-4.89, $p<.001$) and 2,1 times (44.9% 95% CI=1.19-3.75, $p<.001$) more likely to get stunted than children of 0-year age group in urban areas. However, In the rural areas, only children of 1-year sub-group of age were 2.3 times (40.2%, 95% CI=2.04-2.57, $p<.001$) more likely to be stunted than 0 year of age under-5 children and the same age group children were 1,5 times (30.1%, 95% CI=1.40-1.64, $p<.001$) more likely to get stunted than 0-year children in urban areas.

In urban areas, non-respondent children for the breast-feeding practices were 1.6 times (48.4%, 95% CI=0.99-1.93, $p=0.073$) more likely to get stunted than breast fed children even though this result is not statistically significant. The same group of children were 3.1 (45.3%, 95% CI=2.64-3.77, $p<.001$) and 3.2 times (58.7%, 95% CI=2.84-3.59, $p<.001$) more likely to be stunted than vaccinated under-5 children respectively in urban and rural areas.

Only in urban areas, the non-respondent under-5 children were 1.8 times (45.3%; 95% CI=1.30-2.38; $p=.004$) more likely to be stunted than under-5 children that can grasp small object.

Table 7. Factors associated with stunting among children under 5 years-age in DR Congo's urban and rural areas.

Variables	URBAN						RURAL					
	Stunting N (9264)						Stunting (12213)					
	Yes		aOR	95% CI		p	Yes		aOR	95% CI	p	
	N	%				N	%					
Total	2123	36.7				7141	45.5					
Age												
0	237	20.9	1.00			801	24.1	1.00				
1	363	30.1	1.51	1.40	1.64	<.001	1222	40.2	2.29	2.04	2.57	<.001
2	402	35.7	2.02	1.64	2.49	<.001	1365	45.2	2.05	0.63	6.67	0.231
3	617	51.7	2.75	1.55	4.89	<.001	1957	59.9	2.09	0.48	9.09	0.324
4	504	44.9	2.11	1.19	3.75	<.001	1793	58.9	2.04	0.47	8.85	0.342
Gender												
Male	1136	39.6	1.00				3779	48.7	1.00			
Female	987	33.9	0.76	0.67	0.85	<.001	3362	42.4	0.75	0.70	0.80	<.001
Mother's Education												
Elementary or less	193	40.0	1.00				2200	48.1	1.00			

Middle school	501	34.8	0.83	0.66	1.05	0.122	3082	44.1	0.87	0.80	0.94	0.001
High school and over	1429	36.8	0.75	0.60	0.93	0.010	1859	44.8	0.85	0.77	0.93	0.001
No.of Children												
1 to 3	474	33.4	0.98	0.85	1.14	0.830	1532	43.8	0.93	0.85	0.99	0.025
4 to 7	1649	37.8	1.00				5609	46.0	1.00			
Number of household members												
2 to 10	777	39.0	1.00				2967	44.5	1.00			
11 to 20	1130	35.8	0.87	0.76	0.99	0.037	3821	46.6	1.07	1.00	1.16	0.060
21 to 30	216	34.4	0.82	0.66	1.03	0.096	353	42.5	1.03	0.87	1.21	0.748
Type of housing												
Ownership	1000	37.8	1.00				5990	46.1	1.00			
Lease	814	33.7	0.80	0.70	0.92	0.001	280	45.5	1.05	0.88	1.25	0.599
Hosted by the family	294	43.6	1.06	0.87	1.29	0.573	775	40.7	0.85	0.76	0.94	0.002
Other	15	31.9	0.99	0.50	1.93	0.968	96	51.6	1.05	0.76	1.44	0.764
Province												
North western	452	59.3	1.00				2183	54.6	1.00			
North eastern	371	26.0	0.20	0.17	0.25	<.001	1988	38.0	0.45	0.41	0.49	0.000
South western	878	50.1	0.70	0.58	0.85	<.001	1685	55.6	1.01	0.91	1.11	0.917
South eastern	422	23.0	0.20	0.16	0.24	<.001	1285	37.4	0.45	0.40	0.49	0.000
Health insurance												

With insurance	88	34.1	1.00				65	46.8	1.00			
Without insurance	2035	36.8	1.08	0.81	1.44	0.609	7076	45.5	1.25	0.86	1.81	0.236
Breast feeding												
Yes	920	28.6	1.00				3204	36.0	1.00			
No	81	32.8	1.05	0.71	1.56	0.810	182	38.6	0.87	0.71	1.07	0.185
No answer	1122	48.4	1.58	0.99	1.93	0.073	3755	59.4	0.69	0.24	1.97	0.489
Vaccination												
Yes	366	22.3	1.00				1461	33.1	1.00			
No	117	22.4	1.18	0.91	1.53	0.205	854	27.9	0.94	0.84	1.05	0.274
No answer	1640	45.3	3.15	2.64	3.77	<.001	4826	58.7	3.19	2.84	3.59	<.001
Water quality												
Unimproved water source	1819	36.7	1.00				6195	45.3	1.00			
Improved water source	304	37.2	1.03	0.87	1.22	0.706	946	46.6	1.05	0.95	1.16	0.353
Reading (books)												
No one	2110	36.7	1.00				7120	45.5	1.00			
More than 1	13	39.4	0.88	0.42	1.86	0.736	21	52.5	1.11	0.57	2.16	0.758
Speaking (alphabets)												
Yes	165	42.6	1.00				248	54.6	1.00			
No	1338	44.2	1.08	0.85	1.36	0.542	4849	54.9	1.17	0.96	1.43	0.111
No answer	620	26.2	0.62	0.55	0.70	0.041	2044	31.9	0.83	0.43	1.58	0.564
Grasping (small objects)												

Yes	616	26.1	1.00				2032	31.9	1.00			
No	1310	43.9	1.21	0.56	2.63	0.218	4030	54.4	1.03	0.34	3.13	0.964
No answer	197	45.3	1.76	1.30	2.38	0.004	1079	56.2	1.16	0.38	3.56	0.789
Treatment (minor illness)												
Yes	123	30.8	1.00				463	43.8	1.00			
No	159	37.0	1.16	0.90	1.49	0.192	535	46.5	1.08	0.90	1.30	0.384
No answer	1841	37.2	1.24	0.90	1.72	0.245	6143	45.5	0.94	0.82	1.08	0.389
Treatment (major condition)												
Yes	368	37.9	1.00				952	46.2	1.00			
No	345	36.9	0.94	0.76	1.15	0.539	1272	46.1	0.92	0.81	1.05	0.219
No answer	1410	36.4	0.90	0.77	1.07	0.230	4917	45.2	0.92	0.83	1.02	0.122

V. DISCUSSION

The study results suggested that the prevalence of malnutrition and stunting in under-five years children in Democratic Republic of Congo was 24 and 43.1 percent respectively. These findings are not so far different from findings of a study assessing the prevalence and determinants of undernutrition among under-five children residing in slums and rural area, Maharashtra, in India for what findings were 45,9% and 17,1% of under-five children were stunting and wasting(malnourished) respectively(Murarkar et al., 2020).

Analysis to find out factors associated with the stunting shows clearly that children aged 3 and 4-years age group were respectively 2.7 and 2.5 times higher and significantly associated with the malnutrition than children of age 0 year in urban area and the same age group showed 2.7 and 2.8 times more likely to get malnutrition than children of 0-year age group in rural area.

Children of 3 years old were more stunted than children of the other ages and the trend of stunting prevalence was going increasingly from 0 to 3 years and decreases in the group of children aged 4 years. This is similar with the findings of other studies in which the prevalence of stunting increases with the increasing in age (Chhetri, 2005; Genebo, 2002).

In DR Congo, the nutritional status of under-five years children also depends on the gender, the educational level of their mother, the residence, the subscription on the health insurance, the breast-feeding practices and the lack of treatment for minor illness as

well as the water quality with similarities in other studies. The male under-five years children are more stunted and malnourished than female like in previous studies(Susan Keino, 2014); children who didn't breast-feed are likely to be more stunted and malnourished(Angela Oswalt, 2005; Joyce K. Kikafunda, 1998; Waters et al., 2004); children with illiterate mothers have high risk of developing stunting and malnutrition(Akombi et al., 2017; Nigusu, Kemal and Betela, 2019; Smith LC, 2000) like children in rural area and without health insurance(Akombi et al., 2017); and children using unimproved source for drinking water(Joyce K. Kikafunda, 1998).

By assessing factors associated with malnutrition and stunting in urban and rural areas, this study found that Under-5 children from mothers of university and over as educational level was 3.3 and 1.9 times more likely to get malnourished than the children from elementary school as mother's educational level in urban and rural areas respectively.

In rural areas, only children from the other group for type of housing were 1,9 times more likely to get malnutrition than under-5 children from the ownership type of housing group. Children from the South Western Province were 1.5 times more likely to get malnourished than the ones in the North Western Provinces. Under-5 children non-respondent for the breast-feeding practices were 2.4 and 2 times more likely to be malnourished than breast fed children in rural and urban areas respectively. The same category of children were 4.6 and 2.8 times more likely to get malnutrition than vaccinated under-5 children respectively in urban and rural areas.

Both in urban and rural areas, under-5 years of age children that can't grasp a small object were 1.8 times more likely to be malnourished than the under-five years of age children that can grasp small object. But the non-respondent under-5 children were 2 times more likely to get malnourished than children who can grasp small object in the 2 areas. Niger reported the highest prevalence for both stunting and malnutrition in both rural and urban in West Africa with nearly half of its children under 5 years being undernourished; this could be a result of the meagre farming and stockbreeding season for the year 2009–2010, when the country was hit by a serious food crisis (Hollinger F et al, 2015)

The assessment of stunting situation in comparison between urban and rural areas found out associated factors as follow: the age group 1;2 and 3 years were respectively 1,5;2,8 and 2,1 times more likely to be stunted than children of age group 0 year in the urban areas and in the rural, only the children age group 1 year was 2,3 times more likely to be stunted than children under five years of age group 0 and the difference was statistically significant; Burundi reported the highest prevalence for stunting in the East Africa sub-region with nearly six in ten children under the age of five being stunted in 2010 [20]. The trend of stunting in Burundi has remained stable at 57.5% since it was first measured in 2005; without intervention, no improvements will be achieved and a further deterioration of the situation is inevitable (Nkunzimana T,et al, 2016). Under-five children non-respondent for the breast feed practices were 1,6 times more likely to be stunted than breast fed children under-five years of age in urban areas. For the vaccination, the same category of children under-five years were 3,1 and 3,2 times more likely to be stunted than

vaccinated under-five children in urban and rural areas respectively while the children non-respondent for grasping a small object were 1,8 times more likely to be stunted only in urban areas. Delayed introduction of solid foods was associated with stunting and underweight among children in this study. Persistent stunting and underweight among children under five years of age in the current study could be due to inappropriate food supplementation during the weaning period when infants should undergo a transition from exclusive breastfeeding to including complementary foods in their diet (Kekana M et al, 2020).

In general, the underlying causes of child malnutrition are similar across all countries in SSA and globally as outlined in the UNICEF conceptual framework for child nutrition (Hunger Notes., 2020). However, poverty remains the principal cause of child undernutrition in SSA with 48.55% of the population living on less than \$1.25 per day (Nigusu, Kemal and Betela, 2019). The rapid rise in world food prices and cost of living has transformed food insecurity from a difficult development problem into a nutrition crisis for underprivileged households((Kekana M et al, 2020).). The majority of the poor people reside in the rural areas and lack access to basic health services. The causes of poverty are related to harmful economic systems, conflict, environmental factors such as drought and climate change, and population growth. Therefore, addressing poverty with a goal to improve health status and child nutrition is critical in strengthening livelihoods among vulnerable populations in DRC.

Limitations of the study

In this study, secondary data collected by UNICEF was used. This resulted sometimes in the lack of its quality with missing information as well as biases information on some variables for a considerable number of under-5 children. Also, by the fact I was not the owner of the data, other useful information that could help to fit the needs of this research were also missed.

VI. CONCLUSION

In conclusion, 43,1% of under-five children were stunted and 24% of them, malnourished in DR Congo. 3 years' children have a high proportion of stunting (2.7 times) than children of 0 year, following by children of 4 years age group who were 2.5 times stunted than 0 year age group children in urban area. Contrariwise, the same age groups were 2.7 and 2.8 times more malnourished than 0 year of age children in rural areas.

The following underlying factors have been associated with both malnutrition and stunting in DR Congo: child age (3- and 4-years group), gender especially male, child weight, being a child from illiterate mother, being from a rural area and western part of the country, being a not breast-fed child, haven't being treated for minor illness. Particularly, children not treated for major condition were associated with stunting and the lack of submission for health insurance was associated with malnutrition.

Findings from this study will enable policy makers, global organizations, government and non-governmental organizations, the private sector as well as public health researchers to ascertain the most vulnerable region in DRC for policy actions in the fight to reduce malnutrition in DRC.

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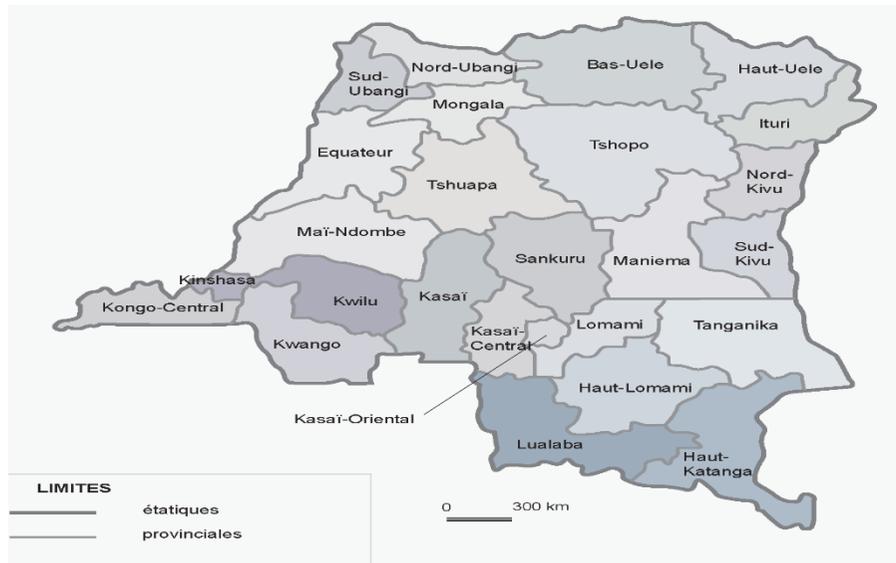
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Annex 1

DR Congo 26 provinces in 4 categories



North Western: 1. Nord-Ubangi; 2. Sud-Ubangi; 3. Mongala; 4. Equateur; 5. Tshuapa; 6. Maindombe.

North Eastern: 1. Bas-Uele; 2. Haut-Uele; 3. Ituri; 4. Tshopo; 5. Nord-Kivu; 6. Sud-Kivu; 7. Maniema; 8. Sankuru.

South western: 1. Kinshasa; 2. Kwilu; 3. Kasai; 4. Kwango; 5. Kongo Central; 6. Kasai.

South eastern: 1. Kasai Central; 2. Lomami; 3. Tanganyika; 4. Haut-Lomami; 5. Lualaba; 6. Haut-Katanga.

Annex 2

Growth indicators interpretation

Classification	Status	Z-score
Based on weight-for-age for children aged 0-60 months	Malnutrition	< -3 SD
	Undernutrition	-3 SD to < -2 SD
	Normal Nutrition	-2 SD to 2 SD
	Obese	> 2 SD
Based on length-for-age or height-for-age for children aged 0-60 months	Very Short	-3 SD
	Short	-3 SD to < -2 SD
	Normal	-2 SD to 2 SD
	Tall	> 2 SD
Based on weight-for-length or weight-for-height for children aged 0-60 months	Very Thin	< -3 SD
	Thin	-3 SD to < -2 SD
	Normal	-2 SD to 2 SD
	Fat	> 2 SD
Based on Body Mass Index-for-Age for children aged 5-18 years	Very Thin	< -3 SD
	Thin	-3 SD to < -2 SD
	Normal	-2 SD to 1 SD
	Fat	> 1 SD to 2 SD
	Obese	> 2 SD

Annex 3

Access to United Nations Children’s Fund approval

Access to MICS datasets approved



noreply.unicef.mics@gmail.com <noreply.unicef.mics@gmail.com>

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