

NOUNKEU, CAROLE DEBORA, M.S. Assessment of the Relationship between Water Insecurity, Hygiene Practices, and the Incidence of Diarrhea among Children from Rural Households of the Menoua Division - West Cameroon. (2017)  
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**Objectives:** 1) Assess the prevalence of water insecurity and its association with water access-related behaviors such as time, distance, and sources of water; 2) identify major themes of concern that are associated with three domains of water insecurity assessed (anxiety, water quality and quantity reduction, and perceived health risk), and; 3) examine the relationship between water insecurity, hygiene practices, and diarrheal incidence among children living in rural areas of the Menoua division-West region of Cameroon.

**Methods:** Cross-sectional semi-quantitative study involving in-person interviews in a private setting. Women living in a village of the Menoua division-West of Cameroon, were recruited based on the following selection criteria: 1) 18 years or older; 2) self-reported as currently not pregnant; 3) main meal preparer of the household, and; 4) taking care of and living with at least one child between 2 to 5 years old (n=134).

**Results:** Participants spent on average 17 minutes walking to a drinking water source at each trip. Prevalence of water insecurity was 58% and it was associated with a lower level of hygiene among caretakers ( $p=0.005$ ). Overall, the incidence of diarrhea among children was 18%, and it was significantly higher among water insecure households.

**Conclusions:** Water security is critical in promoting optimal health and development among children by reducing incidences of diarrhea. Qualitative studies are

warranted to develop a water security scale tailored to capture physical, socio-cultural, and related issues associated with water access in rural areas.

ASSESSMENT OF THE RELATIONSHIP BETWEEN WATER INSECURITY,  
HYGIENE PRACTICES, AND THE INCIDENCE OF DIARRHEA  
AMONG CHILDREN FROM RURAL HOUSEHOLDS OF  
THE MENOUA DIVISION - WEST CAMEROON

by

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Approved by

Jigna M. Dharod  

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APPROVAL PAGE

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## **CHAPTER I**

### **INTRODUCTION**

Diarrhea, a condition of passing at least three loose or liquid stools within 24 hours, is the second leading cause of death among children aged five years or younger.<sup>1</sup> Every day, 1,400 children die due to diarrhea mainly in low and middle income countries where it kills more children than acquired immunodeficiency syndrome (AIDS), malaria, and measles combined.<sup>1, 2</sup> According to the World Health Organization (WHO), 50% of all undernutrition cases are related to repeated diarrhea and intestinal worm infections.<sup>3</sup>

Approximately 155 million children (22.9%) under the age of 5 years are stunted due to undernourishment, including malabsorption of nutrients caused by diarrheal diseases.<sup>4</sup> This situation is more alarming in West and Central Africa where the number of stunted children has increased by 23% in the last 15 years. Cameroon, a low-medium income country in Central Africa, is also facing an issue of loss of productivity due to stunting among children. Especially in Cameroon, the prevalence of stunting has increased by 10% from 1991 (23%) to 2011 (33%).<sup>5</sup>

To improve food utilization and thereby stunting among children, WHO and United Nations International Children Emergency Fund (UNICEF) launched Water, Sanitation, and Hygiene (WASH) promotion in the 1990s.<sup>6</sup> However, the WASH components, which include adequate treatment and storage of ready-to-use water, optimal

hand-washing, proper excreta disposal, and food hygiene at the household level, greatly rely on availability of safe and adequate amount of water on a consistent basis, otherwise named as water security. In a systematic review of 67 interventional studies, Esrey et al.<sup>7</sup> concluded that access to sufficient amounts of clean water or water security, was critical to see a higher than median reduction in diarrheal diseases among children.

Every human has the right to sufficient, safe, physically accessible, and affordable water for personal and domestic use; however, in 2015, about 663 million people around the globe were water insecure, or did not have consistent access to safe and sufficient amount of water for an active and healthy lifestyle.<sup>8,9</sup> According to the United Nations 2015 Millennium Development Goals report, approximately half of water insecure people live in Sub-Saharan Africa.<sup>9</sup> Especially it has been observed that water-related health issues become prominent when access to water is limited to less than 20 liters a day per individual and/or requiring long distance travel ( $\geq 30$  minutes) to get water.<sup>9,10</sup> Additionally, based on water-related issues in conflicted or disputed areas, it has been recognized that even the queuing time ( $> 15$  minutes) and water velocity ( $> 3$  minutes to fill a 20-liter container) due to water shortage play a role in predicting water security.<sup>11</sup>

To date, very limited research has been conducted to understand the prevalence of water insecurity and related water access behaviors in Sub-Saharan Africa. Using a cross-sectional semi-quantitative study design, 18 years or older women who were taking care of at least one young child (2-5 years old), were recruited and interviewed in rural areas of the West region of Cameroon. A face-to-face structured interview was conducted with 134 caretakers to collect information on 1) socio-demographics; 2) water insecurity; 3)

hygiene practices; and 4) diarrheal episodes and other hygiene-related diseases in the past 30 days among 2 to 5 years old selected index children in the household. The three main objectives of the study were to:

- 1) Assess the prevalence of water insecurity and its association with water access-related behaviors such as time, distance, and sources of water.
- 2) Identify major themes of concern that were associated with three domains of water insecurity assessed (anxiety, water quality and quantity reduction, and perceived health risk).
- 3) Examine the relationship between water insecurity, hygiene practices, and diarrheal incidence among children living in rural areas of the Menoua Division-West region of Cameroon.

## **CHAPTER II**

### **LITERATURE REVIEW**

#### **Diarrhea Among Children**

Diarrhea is a condition characterized by the emission of at least three loose or liquid stools during 24 hours.<sup>1</sup> It is one of the most common causes of malnutrition and the second leading cause of death among children, killing more children than AIDS, Malaria, and measles combined.<sup>2</sup> This mainly occurs in low and middle income countries where approximately 1,400 children die every day due to diarrhea.<sup>1</sup> Diarrhea is transmitted via fecal-oral cycle pathogens that impair normal physiologic mechanisms of digestion and absorption leading to an extensive water and electrolytes loss which if left untreated, can rapidly become fatal especially for young children.<sup>12</sup> Oral rehydration solution (ORS) has been effective in combatting dehydration associated with diarrhea. However, ORS cannot prevent the severity or incidence of subsequent diarrheic episodes.<sup>12</sup> According to WHO, 50% of all malnutrition cases are related to repeated diarrhea and in developing countries 85-90% of these diarrhea cases are related to water i.e., unsafe drinking water, inappropriate sanitation, or insufficient hygiene.<sup>3, 13</sup>

#### **Undernutrition Among Children**

Undernutrition among children is a major global concern. In 2016, 155 million (22.9%) children around the world were stunted (low height-for-age) and 52 million (7.5%) wasted (low weight-for-height).<sup>4</sup> One out of three stunted children lived in sub-

Saharan Africa with the situation being alarming in West and Central Africa where stunting prevalence has been increasing for up to 23% during the last 15 years.<sup>4</sup>

Cameroon, a low-medium income country of Sub-Saharan Africa, is also facing an issue of loss of productivity due to poor nutrition among children. Based from Cameroon demographic health surveys (DHS) conducted between 1991 and 2011, stunting prevalence has been increasing—23% (1991), 29% (1998), 32% (2004), and 33% (2011)—among children below age of five.<sup>5</sup> Worldwide, approximately half of all deaths for children under five years are attributed to undernourishment and for millions of survivors, chronic undernutrition will increase the risk for long term negative effects on education, health, and productivity.<sup>4</sup>

### **Diarrhea and Nutrition**

Review of various studies in developing countries indicates that in order to achieve an optimal nutritional status among children consistent access to affordable, varied, and nutrient-dense food, or food security, is critical.<sup>14</sup> However, the ultimate predictor of food security is the biological availability of the food after it has been ingested or food utilization, which strongly depends on water, sanitation, and hygiene.<sup>15</sup> While age, body size, and physical activity levels influence food utilization, the physiopathology of intestinal infections (bacteria, parasites) negatively affects food intake and intestinal absorption. Intestinal infection not only results in reduced food intake, but also leads to nutrient malabsorption, increased nutrients catabolism and losses, and imprisonment of micronutrients necessary for growth and tissue synthesis.<sup>16</sup> A positive relationship between diarrhea/intestinal infection and undernutrition among

children indicates that the mucosal lining of the gastrointestinal tract represents a major interface between the body and the environment. Moreover, a fecal-contaminated environment causes recurring and often subclinical intestinal infections resulting in chronic changes in intestinal epithelium (flattened villa, damaged microvilli), poor gut microbiota, and gut inflammation that lead to chronic malabsorption even in the absence of diarrhea.<sup>16</sup>

### **Water, Sanitation, and Hygiene (WASH)**

Prevention and treatment of diarrhea as well as other fecally-transmitted infections have become a top priority in reducing undernutrition among children, and as a result, WHO has launched the WASH interventions.<sup>6</sup> The WASH interventions aim to reduce the amount of pathogens in the environment and overcome the causes of gastrointestinal tract dysfunctions and infectious diseases.<sup>6</sup> WASH practices have been shown to reduce the prevalence of diarrhea by 30-40%, and include adequate treatment and storage of ready-to-use water, optimal hand washing, proper excreta disposal, and food hygiene at the household level.<sup>6,17</sup> Though WASH is multi-dimensional in nature, all the components are facilitated by the consistent availability of water.<sup>6,18</sup> Hence, access to clean and sufficient quantities of water, referred as water security, is critical for WASH interventions to achieve the greatest impacts on children's health.<sup>6</sup>

### **Water In/Security**

In contrast to water security, water insecurity occurs when there is an uncertain access to sufficient amount of safe and clean water for an active and healthy lifestyle.<sup>8</sup> In 2015, about 663 million people (9%) in the world were still relying on unimproved

sources of water, with nearly half of them living in sub-Saharan Africa.<sup>9</sup> Overall, the amount of water used per household member is used to estimate the risk for water insecurity.<sup>10</sup> As shown in Table 1,<sup>10</sup> the health risk is estimated to increase with limited access to water.

According to WHO, it has been estimated that poor health and health concerns are higher in areas where access to water is limited to < 20 liters/day/individual, generally requiring long distance ( $\geq 30$  minutes) of traveling to get water.<sup>10</sup> The SPHERE—a non-profit humanitarian organization focusing on improving life standards of victims of disasters or conflicts—indicates that besides the distance, the queuing time (< 15 minutes) and water velocity (< 3 minutes to fill a 20 liter container) are important contributors in predicting water insecurity.<sup>11</sup>

Table 1. Level of Health Concerns by Amount and Access to Water by Distance of Time

Service level for households	Quantity collected	Access Measure		Level of health concern
		Distance	Time	
No access	< 5 liters/person/day	>1,000m	>30 min	Very high
Basic access	< 20 liters/person/day	100-1,000m	5-30 min	High
Intermediate access	$\approx$ 50 liters/person/day	0-100m	0-5 min	Low
Optimal access	$\geq$ 100 liters/person/day	Many taps	Continuously	Very low

## Water In/Security Research and Measurement

In spite of its significant role in preventing malnutrition among children, assessment of water insecurity is at preliminary stage and lacks a validated scale to

measure it at the household level. To our knowledge, there are very few studies that assessed water insecurity at the household level.

One of the earliest studies<sup>19</sup> was conducted in a water-scarce region of Bolivia, where 72 women were interviewed using an experience-based water insecurity scale with 33 items from six domains: water quality, water quantity, water acquisition, conflicts, economic issues, and health outcomes. Results showed that water insecurity scores were affected by seasonal changes, negatively associated with income level and water storage capacities, and positively associated with coping strategies such as borrowing water from neighbors and begging for water from private vendors. In a second study conducted in Ethiopian villages by Stevenson et al.,<sup>20</sup> 104 households were interviewed to assess the relationship between water insecurity and psychological distress using a 32 yes/no-item questionnaire from six dimensions: perceived sufficiency and safety of water supply, barriers to water access, opportunity costs of water collection, measures taken to economize on water use, social interactions related to water, and thirst. Results indicated that water insecurity was a significant predictor of psychological distress among women. An interventional-control study<sup>21</sup> conducted a few years later in the same study area demonstrated that water security scores significantly dropped in the intervention group following improvement of communal water supply with a difference-in-difference estimate of the intervention effect being equal to two points on the water insecurity scale.

In a cross-sectional household survey conducted in urban Nepal, Aihara et al.<sup>22</sup> developed a 22-item household water insecurity scale and used it to assess the impact of water insecurity on psychological distress among 371 women. They found that

difficulties in basic activities related to water (personal hygiene, cooking, and drinking) were associated with psychological distress among women. This impact differed depending on water supply service levels with women from the poorest supplied areas experiencing the highest levels of distress. Recently, in an observational study conducted in the same study area, Aihara et al.<sup>23</sup> developed a six-item household water security scale with a moderately acceptable internal consistency (Cronbach's coefficient=0.73). The scale was adapted from the household food insecurity access scale and measured three domains: "anxiety and uncertainty about household water access, insufficient quantity and quality of water, and insufficient water intake and its health/behavior consequences."<sup>23</sup> Results indicated that the women from water insecure households had higher levels of stress and greater risk of probable depression than did women with lower household scores for water insecurity.<sup>23</sup>

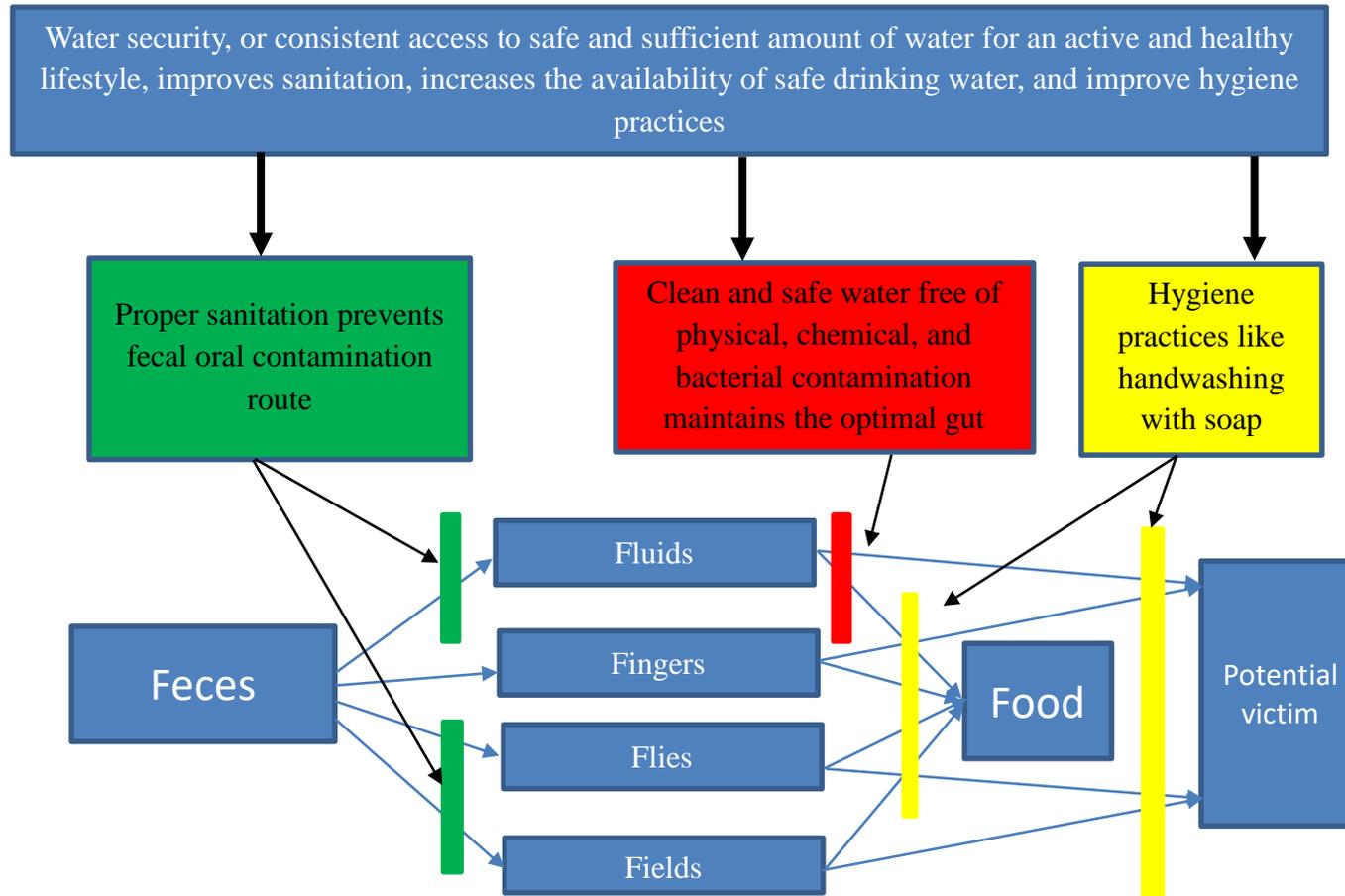
### **Inter-Relationship Between Water Insecurity, Hygiene Behaviors, and Diarrhea Among Children**

Water insecurity encompasses two main components of water—quality/safety of water and water access by distance and time—as both affect the quantity of water available.<sup>10, 11</sup> Poor water quality, i.e. microbiological and chemical contaminations, or the physical aspects of water (taste, color, dirt) limit the water benefits.<sup>11</sup> Additionally, to reduce health concerns, quantity of water—determined by convenient access—obtained via public standpipes, protected wells and springs, and rainwater collection, is critical to ensure water security.<sup>24</sup> As quoted in the report by Mercy Corps<sup>11</sup> "Water is life! Sanitation and hygiene save lives!"

The rate of diarrheal diseases constitutes a good indicator of the development and health status of communities in low-middle income countries, since it is closely linked to availability of safe drinking water and hygiene practices.<sup>25</sup> A community-based study, conducted in India and focusing on nutritional status of children, found that for younger children (< 3 years), water quality was the principal determinant whereas for older children (> 3 years), water quantity was the most important.<sup>26</sup> Another study conducted in Pakistan showed that higher amounts of water available to households were very important in preventing stunting.<sup>27</sup> In a systematic review of 144 interventional studies, Esrey et al.<sup>28</sup> found that, access to sufficient amounts of clean water and improved sanitation facilities were critical to see higher than median reduction in diarrheal diseases among children.

As indicated in earlier sections, clean and safe water is critical in improving WASH practices and preventing diarrhea among children. In turn, diarrhea is a critical predictor of poor growth and development among children due to reduced intake and absorption of nutrients. To our knowledge, the proposed study will be the first study to examine the inter-relationship between water insecurity, hygiene practices, and health status of children. The figure 1 (below) shows the schematic presentation of how water security can help in reducing child mortality and morbidity in developing countries.

Figure 1. Role of Water Security in Diarrhea Prevention Among Children <sup>29</sup>



Note: By improving excreta disposal, increasing the availability of clean and safe drinking water, and improving hygiene practices, water security will interrupt the transmission of germs from feces to the potential human victim, either directly (avoiding feces to contaminate the four main vehicles i.e. fluids, fingers, flies, and fields) or indirectly by avoiding germs from feces to pass from the vehicle to the food. We can see from this figure how adequate hygiene practices such as optimal handwashing with soap will completely stop transmission of diarrheal diseases.

Water security is critical to improve the effectiveness of hygiene campaigns and proper processing/preservation of food among caretakers.<sup>11</sup> Moreover, the ORS treatment for diarrheal diseases involves diluting ORS powder into a certain volume of clean potable water, hence assuming households already have access to clean and safe drinking water. It is highly unlikely that reducing mortality and morbidity among children in developing countries can be achieved unless water security is improved to reduce diarrheal diseases and malabsorption. Furthermore, indirectly, consistent access to clean and safe water improves the time and availability of caretakers to engage in economic activities and food production, two critical indicators for reducing mortality among children in low and middle income countries.

### **Study Area – Menoua Division- West Cameroon**

The study was conducted in a village located in the Menoua division of the West region of Cameroon. Cameroon is divided into 10 regions, with Yaoundé, its administrative capital and Douala, its economic capital. Cameroon is very culturally and geographically diverse, that is why it is called “Africa in miniature.” In fact, English and French are the national languages, the country is inhabited by ancestral human lineages, has more than 250 different ethnic groups as well as multiple religions and beliefs, the eco-climatic conditions are unique, and the topography is very diverse.<sup>30</sup>

#### **Geography**

Cameroon is situated between West and Central Africa in the Gulf of Guinea and shares borders with Nigeria (west), Chad (north-east), Central African Republic (east), Republic of Congo, Gabon, and Equatorial Guinea (south).<sup>30</sup> The four main regions of the

country are: the sudano-sahelian zone, the tropical forest zone, the coastal and maritime zone, and the savanna zone including volcanic highlands of the West region.<sup>31</sup>

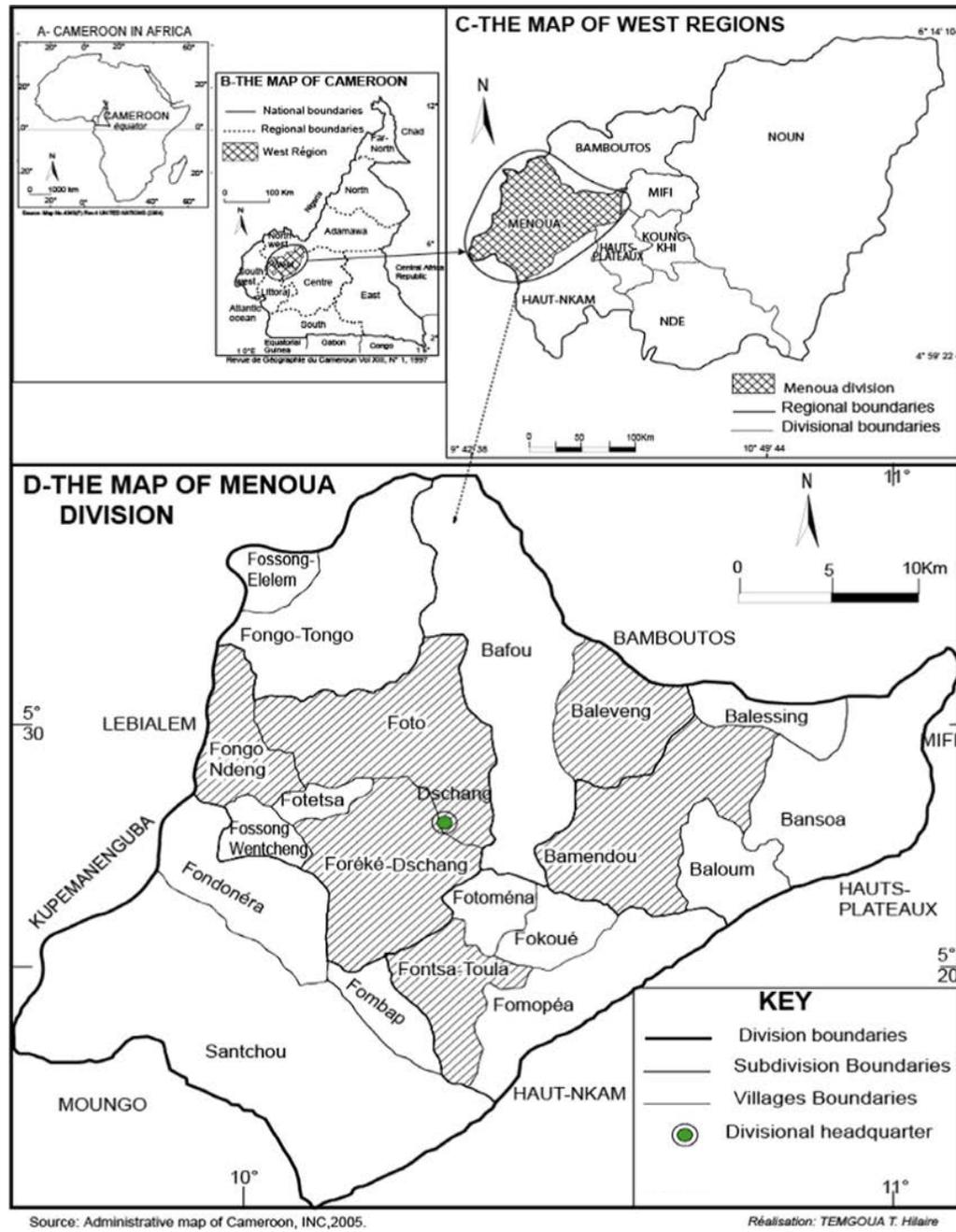
### **West Region of Cameroon**

With its capital Bafoussam, this region is situated at the central-western part of Cameroon, in the “French-Cameroon.” It occupies a surface area of 13,892 km<sup>2</sup> (5363 miles<sup>2</sup>), which makes it the smallest region of the country in terms of surface area. However, it has a population of 1,865,394 inhabitants which contributes to its highest population density and is divided into eight divisions (Menoua, Mifi, Haut-Nkam, Hauts-Plateaux, Koung-Khi, Noun, Nde, and Bamoutos).<sup>32</sup> Bamileke and Bamoun are the two main tribes represented in this region. The main religion is Christianity, practiced along with Islam and Animism. The climate encountered there is of equatorial monsoon type with one dry season of little rain (December-May) and a rainy season (May-June to October-November), and temperatures range from 13.66°C to 25.35°C with annual average rainfall of 1717.7mm.<sup>33</sup> The soil and the climate have rendered this region an excellent agricultural area leading it to be considered as the “Bread basket” of Cameroon.<sup>32</sup>

### **Menoua Division**

Menoua, with its capital Dschang, is one of the eight Divisions of the West region and it covers an area of 532.8 miles<sup>2</sup> (1380 km<sup>2</sup>) for a population of about 372,244 inhabitants.<sup>32</sup> Menoua is divided into six subdivisions (Dschang, Nkong-Ni, Santchou, Fongo-Tongo, Penka Michel, and Fokoue) which are further subdivided into 22 villages.<sup>32</sup>

Figure 2. Study Site Map <sup>32</sup>



More than 80% of the Menoua population is farmer, with the most important plants grown being: Coffee, tea, plantains, Irish potato, tomato, maize, pear, mango, banana, tomato, cabbage, carrot, onion and beans. Animal rearing is also widely practiced notably pigs breeding.<sup>32</sup>

## **Significance**

Water security is tremendously important worldwide because it affects various facets of life. In addition to reducing poverty and improving health (mental, social, and physical), access to water has significant implications on gender-related issues as well as food insecurity. Studies show that water scarcity, through famine which it is highly likely to generate, put populations at high risk for internal displacements, resulting in environmental refugees and potential for conflicts in the receiving area.<sup>34</sup> For instance, in 1984-1985, Ethiopia experienced a nomad-farmer conflict over land and around the same period, there was an insurgency of high intensity in Bangladesh between internal migrants and residents.<sup>35</sup> Similarly, arrival of environmental migrants from Mauritania to Senegal caused high violence and riots in 1980s-1990s. The importance of achieving water security in promoting peace, health, and development has been recognized, and water access and security have become the central piece of several milestone agreements such as the 2030 Agenda for Sustainable Development Goals (SDG). In fact, it has been recognized that addressing water security and thus achieving the SDG of clean water and sanitation could impact upon the successful achievement of most of the other SDG through reducing poverty, gender equity, and food security; especially in promoting optimal growth and development.

## References

1. United Nations International Children Emergency Fund. Monitoring the Situation of Children and Women. Diarrhoea remains a leading killer of young children, despite the availability of a simple treatment solution. <https://data.unicef.org/topic/child-health/diarrhoeal-disease/> (accessed 20 August 2017)
2. Liu L, Johnson HL, Cousens S et al. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *The Lancet*. 2012; 379(9832): 2151-2161. [http://dx.doi.org/10.1016/S0140-6736\(12\)60560-1](http://dx.doi.org/10.1016/S0140-6736(12)60560-1)
3. Prüss-Üstün A. & Corvalán C. Preventing disease through healthy environments: Towards an estimate of the environmental burden of disease. World Health Organization, Geneva, Switzerland. 2006.
4. UNICEF. Undernutrition contributes to nearly half of all deaths in children under 5 and is widespread in Asia and Africa. <http://data.unicef.org/nutrition/malnutrition.html> updated June 2017. Accessed August 20, 2017.
5. Pemunta NV, Fubah MA. Socio-cultural determinants of infant malnutrition in Cameroon. *J Biosoc Sci*. 2015 ;47 :423-448.
6. United States Agency for International Development (2015). WASH & Nutrition – Water and development strategy & multi-sectoral nutrition strategy Implementation Brief. [https://www.usaid.gov/sites/default/files/documents/1865/USAID\\_WASH\\_Nutrition\\_Brief\\_2015.pdf](https://www.usaid.gov/sites/default/files/documents/1865/USAID_WASH_Nutrition_Brief_2015.pdf) (accessed September 6, 2017)
7. Esrey SA, Feachem RG, Hughes JM. Interventions for the control of diarrhoeal diseases among young children: improving water supplies and excreta disposal facilities. *Bull World Health Organ*. 1985;63(4):757-772.
8. Food and Agriculture Organization (2005). The State of Food Insecurity in the World. Rome: Food and Agriculture Organization.

9. United Nation. 2015. The Millennium Development Goals Report. United Nation, New York, USA.  
[http://www.un.org/millenniumgoals/2015\\_MDG\\_Report/pdf/MDG%202015%20rev%20\(July%201\).pdf](http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf) (accessed 27 August 2017)
10. Howard G, Bartram J. Domestic Water Quantity, Service Level and Health. *Bull World Health organ.* 2003.
11. MercyCorps (2009). Water, Sanitation and Hygiene Guidelines 2008-2009.  
[http://www.mercycorps.org/sites/default/files/WASH Guidelines.](http://www.mercycorps.org/sites/default/files/WASH%20Guidelines.pdf) (accessed 17 August 2017)
12. Bzik VA, Medani M, Baird AW, Winter DC, Brayden DJ. Mechanisms of action of zinc on rat intestinal epithelial electrogenic ion secretion: insights into its antidiarrhoeal actions. *J Pharm Pharmacol.* 2012;64:644-53.
13. Ezzati M, Lopez AD, Rodgers A, Murray CJ. Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors. OMS; 2004.
14. United Nations International Children's Emergency Fund (2013). Improving child nutrition: the achievable imperative for global progress.  
[http://www.unicef.org/gambia/Improving\\_Child\\_Nutrition\\_-\\_the\\_achievable\\_imperative\\_for\\_global\\_progress.pdf](http://www.unicef.org/gambia/Improving_Child_Nutrition_-_the_achievable_imperative_for_global_progress.pdf). Accessed September 6, 2017
15. Carletto C, Zezza A, Banerjee R. Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. *Glob Food Sec.* 2013; 2(1):30–40.
16. Scrimshaw NS. Effect of infection on nutritional status. *Proceedings of the National Science Council, Republic Of China. Part B: Life Sciences.* 1992; 16(1): 46-64.
17. Cairncross S, Hunt C, Boisson S et al. Water Sanitation and Hygiene for the prevention of diarrhea. *J Epidemiol.* 2010; 39: i193-i205
18. Cronin AA, Shrestha D, Spiegel P, Gore F, Hering H. Quantifying the burden of disease associated with inadequate provision of water and sanitation in selected sub-Saharan refugee camps. *J Water Health.* 2009;7(4):557-568.
19. Hadley C, Wutich A. Experience-based measures of food and water security: biocultural approaches to grounded measures of insecurity. *Human Organization.* 2009;68(4):451-460.

20. Stevenson EG, Greene LE, Maes KC, et al. Water insecurity in 3 dimensions: an anthropological perspective on water and women's psychosocial distress in Ethiopia. *Soc Sci Med.* 2012;75(2):392-400.
21. Stevenson EG, Ambelu A, Caruso BA, Tesfaye Y, Freeman MC. Community Water Improvement, Household Water Insecurity, and Women's Psychological Distress: An Intervention and Control Study in Ethiopia. *PLoS One.* 2016;11(4):e0153432.
22. Aihara Y, Shrestha S, Kazama F, Nishida K. Validation of household water insecurity scale in urban Nepal. *Water Policy.* 2015; 17: 1019-32.
23. Aihara Y, Shrestha S, Sharma J. Household water insecurity, depression and quality of life among postnatal women living in urban Nepal. *J Water Health.* 2016;14(2):317-324.
24. Cairncross S, Valdmanis V. Water Supply, Sanitation, and Hygiene Promotion. In: Jamison DT, Breman JG, Measham AR, et al., eds. *Disease Control Priorities in Developing Countries.* 2nd ed. Washington (DC)2006.
25. Keusch GT, Walker CF, Das JK, Horton S, Habte D. Diarrheal Diseases. In: Black RE, Laxminarayan R, Temmerman M, Walker N, eds. *Reproductive, Maternal, Newborn, and Child Health: Disease Control Priorities, Third Edition (Volume 2).* Washington (DC)2016.
26. Herbert J. Effects of components of sanitation on nutritional status: findings from South Indian settlements. *Int J Epidemiol.* 1985;14(1): 143-151.
27. Van der Hoek W, Feenstar SG, Konradsen F. Availability of irrigation water for domestic use in Pakistan: its impact on prevalence of diarrhoea and nutritional status of children. *J Health Popul Nutr.* 2002;20(1): 77-84.
28. Esrey SA, Potash JB, Roberts L, Shiff C. Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bull World Health Organ.* 1991;69(5):609-621.
29. Diagram reference [https://herproject.org/downloads/curriculum-resources/training-materials/HERproject\\_Materials\\_Personal\\_Hygiene\\_F\\_Diagram.pdf](https://herproject.org/downloads/curriculum-resources/training-materials/HERproject_Materials_Personal_Hygiene_F_Diagram.pdf)
30. Markham WT, Fonjong L. Geography, Demography, and Environmental Problems. In: *Saving the Environment in Sub-Saharan Africa.* Springer; 2015:49-60.
31. Molua EL, Lambi CM. Climate, hydrology and water resources in Cameroon. *The Centre for Environmental Economics and Policy in Africa (CEEPA), University of Pretoria South Africa.* 2006.

32. Yemele M, Telefo P, Lienou L, et al. Ethnobotanical survey of medicinal plants used for pregnant women' s health conditions in Menoua division-West Cameroon. *Journal of ethnopharmacology*. 2015;160:14-31.
33. Seino RA, Ghogomu RT, Manjeli Y, Dongmo TI, Chifon RN. A faunal survey of the oedipodinae (Acrididae : Orthoptera) of the Menoua Division in Cameroon. *International Journal of Fauna and Biological Studies*. 2013; 1(1):15-19.
34. Falkenmark M. Water scarcity generates environmental stress and potential conflicts. *Water, Development, and the Environment*. 1992;279.
35. Reuveny R. Climate change-induced migration and violent conflict. *Political geography*. 2007;26(6):656-673.

**CHAPTER III**  
**RESEARCH ARTICLE**

**Assessment of the relationship between water insecurity, hygiene practices,  
and incidence of diarrhea among children from rural households of the  
Menoua Division - West Cameroon**

This manuscript has been submitted for publication and was co-authored by:  
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**Shortened title: water insecurity, hygiene practices, and children's health status.**

**Key words: Cameroon, children, diarrhea, food utilization, hygiene, water insecurity**

## Abstract

**Objectives:** 1) Assess the prevalence of water insecurity and its association with water access-related behaviors such as time, distance, and sources of water; 2) identify major themes of concern that are associated with three domains of water insecurity assessed (anxiety, water quality and quantity reduction, and perceived health risk), and; 3) examine the relationship between water insecurity, hygiene practices, and diarrheal incidence among children living in rural areas of the Menoua division-West region of Cameroon.

**Design:** Cross-sectional semi-quantitative study involving in-person interviews in a private setting.

**Setting:** Village of the Menoua division – West region of Cameroon.

**Subjects:** Women meeting the following selection criteria: 1) 18 years or older; 2) self-reported as currently not pregnant; 3) main meal preparer of the household, and; 4) taking care of and living with at least one child between 2 to 5 years old (n=134).

**Results:** Participants spent on average 17 minutes walking to a drinking water source at each trip. Prevalence of water insecurity was 58% and it was associated with a lower level of hygiene among caretakers ( $p=0.005$ ). Overall, the incidence of diarrhea among children was 18%, and it was significantly higher among water insecure households.

**Conclusions:** Water security is critical in promoting optimal health and development among children by reducing incidences of diarrhea. Qualitative studies are

warranted to develop a water security scale tailored to capture physical, socio-cultural, and related issues associated with water access in rural areas.

## **Introduction**

Diarrhea, a condition of passing at least three loose or liquid stools within 24 hours, is the second leading cause of death among children aged five years or younger.<sup>1, 2</sup> Every day, 1,400 children die due to diarrhea.<sup>1</sup> This mainly occurs in low and middle income countries where it kills more children than AIDS, malaria, and measles combined.<sup>1, 2</sup> According to the WHO, 50% of all undernutrition cases are related to repeated diarrhea and intestinal worm infections and as a result Water, Sanitation, and Hygiene (WASH) promotion has become the number one strategy in improving child's growth.<sup>3, 4</sup> However, the WASH components that include adequate treatment and storage of ready-to-use water, optimal hand-washing, proper excreta disposal, and food hygiene at the household level, rely on availability of safe water.<sup>4</sup> In a systematic review of 67 interventional studies, Esrey et al.<sup>5</sup> concluded that access to sufficient amounts of clean water, or water security, was critical to see a higher than median reduction in diarrheal diseases among children.

Every human has the right to sufficient, safe, physically accessible, and affordable water for personal and domestic use; however, in 2015, about 663 million people around the globe were water insecure, or did not have consistent access to safe and sufficient amount of water for an active and healthy lifestyle.<sup>6-8</sup> According to the United Nations-Millennium Development Goals report, approximately half of water insecure people live in Sub-Saharan Africa.<sup>8</sup> Especially It has been observed that water related health issues

become prominent when access to water is limited to less than 20 liters a day/individual and/or requiring long distance travel ( $\geq 30$  minutes) to get water.<sup>9</sup> Additionally, in conflicted or disputed areas, it has been recognized that even the queuing time ( $> 15$  minutes) and water velocity ( $> 3$  minutes to fill a 20 liter-container) due to water shortage play a role in predicting water insecurity.<sup>10</sup>

To date, very limited research has been conducted to understand the prevalence of water security and related water access behaviors in Sub-Saharan Africa. Results of one of the earliest studies<sup>7</sup> conducted in Bolivia among 72 households in a water-scarce region indicated that water insecurity scores were negatively associated with income level and water storage capacities, and were positively associated with coping strategies such as borrowing water from a neighbor and begging for water from private vendors. In a cross-sectional study conducted in Ethiopia<sup>11</sup>, it was found that water insecurity was positively associated with psychosocial distress among women. An interventional-control study conducted a few years later in the same study area demonstrated that water security scores significantly dropped (from  $3.05 \pm 3.79$  to  $1.16 \pm 1.67$ ) in the intervention group following improvement of communal water supply with a difference-in-difference estimate of the intervention effect being equal to 2 points on the water insecurity scale.<sup>12</sup> Recently, in an observational study conducted in urban Nepal, Aihara et al.<sup>13</sup> developed a six-item household water security scale with a moderately acceptable internal consistency (Cronbach's coefficient=0.73). The scale was adapted from the household food insecurity access scale and measured three domains: "anxiety and uncertainty about household

water access, insufficient quantity and quality of water, and insufficient water intake and its health/behavior consequences.”<sup>13</sup>

Though access to sufficient amount of clean and safe water, or water security, is recognized as a key element in preventing diarrhea among children, to our knowledge, no study has been conducted to understand the inter-relationship between water security, hygiene practices, and incidence of diarrhea among children. Hence, the objectives of this study were to: 1) assess the prevalence of water insecurity and its association with water access related behaviors such as time, distance, and sources of water; 2) identify major themes of concern that were associated with three domains of water insecurity assessed (anxiety, water quality and quantity reduction, and perceived health risk), and; 3) examine the relationship between water insecurity, hygiene practices, and diarrheal incidence among children living in rural areas of the Menoua division-West region of Cameroon.

## **Study Area**

Cameroon, a Central African country situated below the Gulf of Guinea, is divided into four zones: the sudano-sahelian zone, the tropical forest zone, the coastal and maritime zone, and the savanna zone including volcanic highlands of the West region.<sup>14</sup> Menoua division is one of the eight divisions of the West region and includes 22 villages. It covers an area of 532.8 miles<sup>2</sup> (1380 km<sup>2</sup>) for a population of about 372,244.<sup>15</sup> The climate encountered there is of equatorial monsoon type with one dry season of little rain (December-May) and a rainy season (May-June to October-November), and temperatures range from 13.66°C to 25.35°C with annual average rainfall of 1717.7mm.<sup>14, 15</sup>

Agriculture constitutes the mainstream of its economy with more than 80% of the inhabitants being farmers, and animal weaning, mainly pigs rearing, is widely practiced.<sup>15</sup> In fact, the area is rich in volcanic soils, quite fertile, and benefits from an adequate climate, fresh with high amount of precipitations.<sup>14, 15</sup>

## **Study Design**

A cross-sectional semi-quantitative study involving in-depth interviews with caretakers was conducted in a village of the Menoua division from January 2017 to April 2017. Approval was obtained from the University of North Carolina Institutional Review Board and Cameroon National Committee of Ethics for Human Research to collect information on food security, water security, and child health status. A sample size of 134 was calculated to detect differences in frequency of food insecurity between water secure and insecure households using an  $\alpha$  level of .05 and 80% power. Food security prevalence in the study area was used since there was no published data about water security. We collected information on water security, food security, and health status of children, but for this manuscript, we are focusing on data relative to water security, water-related behaviors, and child health status.

Women meeting the following selection criteria: 1) 18 years or older; 2) self-reported as currently not pregnant; 3) main meal preparer of the household, and; 4) taking care and living with at least one child between 2 to 5 years old, were recruited using either a door-to-door approach or by going to congregational places such as clinics and schools. Upon indicating interest, caretakers were given details about the study and their written consents were sought. The consent forms were orally interpreted for those who

only spoke the local dialect (Yemba). The interviews were conducted at the participants' homes or in a private setting in their preferred language i.e., English, French, or Yemba. During the interviews, one child between the ages of 2 to 5 (or the youngest, if more than a child within this age range) in the household was selected as an index child to enquire about diarrheal episodes and other hygiene-related diseases in the past month.

### **Structured Interview Guide**

The interview questionnaire included the following five sections:

- 1) *Socio-economic characteristics*: Questions were asked to collect information on variables such as age, gender, education, household size, marital status, religion, household income, and assets (farms, livestock, and having electricity).
- 2) *Water security status*: It was measured using a 6-item household water security scale developed by Aihara et al.<sup>13</sup> The 6-item scale was divided into the following three domains of water security: 1) anxiety and worries about water access at the household level (1 item); 2) availability of sufficient quantity and quality of water (4 items), and; 3) health consequences due to water scarcity (1 item). The reference period “of the past 30 days” was used. For instance, one of the statements was: “*During the last 30 days how often did you worry about your household not having enough water?*” The answer choices were never/rarely (score=0), sometimes, and always with the two latter grouped as affirmative responses (score=1). The number of affirmative responses for each item was noted for each participant, and households were divided into the following two categories: no affirmative answers for all the six items (score=0): water secure; at least one affirmative answer (score  $\geq 1$ ): water insecure.

3) *Sources, amount of time, and behaviors related to water access:* Under this section, a range of questions were asked under the two major purposes of water use: 1) for drinking and 2) for household chores. For the water sources, based on the pilot study results, participants were given the following options of river, wells (individual or community), household piped water, public standpipes. The “other” option was also provided to cover any unique source of water used. Even if the same source of water was used for both drinking and household purposes, to maintain consistency, the following set of questions was asked for each source separately: a) the total quantity of water fetched at each trip; b) the number of days that the water fetched lasted; c) was the caretaker involved in water fetching activity--(Yes/No); d) one-way walking distance time, assessed as the time spent to walk from the house to the water source, and; e) if participant used any water treatment methods before use;

4) *Frequency of hand washing practices:* the participants were asked about how frequently they washed hands with soap and water at the following five key stages: before cooking, before eating, before feeding the child, after defecation, and after cleaning the child’s stool. For each stage, the following three choices were given and scored accordingly: a) never/rarely (score 0); b) sometimes (score 1); c) always (score 2). Hence, the total score ranged from 0-10, with the maximum score representing always washing hands with soap and water at all the five critical steps of hygiene.

5) *Occurrence of diarrhea, other hygiene-related illnesses, and mother’s perception of child’s health:* participants were asked if the index child had any episode of diarrhea in the past 30 days. To maintain consistency, diarrhea was described to participants as three

or more stools of soft or water consistency in 24 hours. The response options provided were yes and no. Similarly, questions were asked about the occurrence of respiratory diseases, skin infections, appetite trouble, fever, and apparent weight loss in the past 30 days. Caretaker was also asked to evaluate the index child's overall health as either excellent/good (good health status) or average/poor (poor health status).

### **Pilot Phase: Survey Questionnaire Development**

A three-step approach was used to make the survey questionnaire appropriate and relevant for the study area and participants of West Cameroon. As a first step, two local public health specialists and medical practitioners reviewed the first draft of the survey. Each question and its options were reviewed for clarity, language use, and cultural relevance.

Then, as a second step, we did three face-to-face interviews with caretakers in the study area meeting the selection criteria. Based on the participants' feedback, the section on sources of water was updated and sources of water were separated by drinking water and water used for other household chores. Additionally, some questions were reworded and rearranged to ensure clarity and logical flow.

Lastly as third step, the pilot study was conducted with 15 caretakers. The main purpose of the pilot phase was to ensure questions were easy to understand and the options were relevant for participants. The pilot phase was also used to estimate the average length of the interview, establish timeline for the main phase study, and finalize logistic of recruitment and data collection process.

## Data Analyses

Data were analyzed using SPSS 23 (IBM Corporation, Somers, NY, USA). Descriptive statistics were conducted to describe socio-demographic and economic characteristics and affirmative responses on water security. Bivariate tests (chi-square, one-way ANOVA) were conducted to detect differences in water sources, walking distance in minutes, and related behaviors by water security versus insecurity status. Bivariate comparisons were also made to detect differences in hygiene score and incidence of diarrhea in the past 30 days between water secure and insecure households. Results were considered significant at a probability value of  $\leq 0.05$ .

## Results

A total of 134 interviews were conducted. Among them, 128 (96%) and three (2%) interviews were conducted in French and English, respectively while the remaining three interviews (2%) were carried out in Yemba with the help of interpreter.

### **Socio-Demographics**

The mean age of the caretakers was  $36\pm 11$  years, while on average, the age of the children selected for the study was  $3\pm 1$  years. As shown in table 2, average household size was  $6\pm 2$ , with the number of children living in the household ranged from one to six. The monthly median household income was \$60-\$90, and only 17% of the caretakers had high school or more education. A majority (78%) of the participants were either married or living with a partner and about 72% of them were Christian (table 2).

Table 2. Description of Socio-Demographic Characteristics of Women Living in Rural Areas of the Menoua Division-West Region of Cameroon (n =134)

<b>Socio-demographic characteristics</b>	
	<b>Mean ± SD</b>
<b>Womens' age</b> (in years)	36 ± 11
<b>Infants' age</b> (in months)	39 ± 10
<b>Household size<sup>a</sup></b>	6 ± 2
<b>Number of children living in the household</b> (below 18 years)	4 ± 2
	<b>n (%)<sup>c</sup></b>
<b>Household income (\$) <sup>b</sup></b>	
\$0-\$30	20 (15%)
\$30-\$60	38 (28%)
\$60-\$90	14 (10%)
\$90-\$120	21 (16%)
\$120-\$150	8 (6%)
≥ \$150	16 (12%)
<b>Education</b>	
No formal schooling	4 (3%)
Some school	107 (80%)
High school	20 (15%)
College education	3 (2%)
<b>Marital Status</b>	
Married/having a partner	105 (78%)
Single	19 (14%)
Widower	10 (8%)
<b>Occupation</b>	
Housewife	52 (39%)
Small scale food/grocery seller	29 (22%)
Working on the farms	16 (12%)
Dress stylist/hair stylist	16 (12%)
Other <sup>c</sup>	21 (16%)
<b>Religion</b>	
Christian	96 (72%)
Muslim	6 (5%)
Other <sup>d</sup>	32 (24%)
<b>Owned a farm</b>	128 (95%)
<b>Owned a livestock</b>	102 (76%)
<b>Had electricity at home</b>	127 (95%)

SD=Standard deviation; <sup>a</sup> age of an index child; <sup>b</sup>self-reported in local currency, which was later converted into dollar amount, and n = 117: since 17 participants did not know or refused to answer. This amount represents an earned income and does not include non-monetary resources such as food from farms and livestock products; <sup>c</sup>others: animal breeding, community health worker, teacher, office worker; <sup>d</sup>traditional beliefs such as animism and skull cult; <sup>e</sup>percentages are rounded to a nearest full digit.

A majority of the caretakers reported having a farm and owning a livestock. Though many caretakers identified themselves as housewives, working on their farms was common to produce food for the household and grow cash crops such as coffee, beans, maize, peanuts, tubers, sweet potatoes, Irish potatoes, fresh vegetables (tomatoes, green peppers, leafy vegetables) etc. Approximately 22% were small scale food or grocery sellers, mainly involved in selling items such as salt, Maggi, palm and refined oil, tomato paste, bread, beignets, or even ready-to-eat food.

#### **General Water Access-Related Behaviors Practiced at the Household Level**

Out of the 134 participants, only five reported having access to a running tap water, while 39 caretakers reported having a well in their compound. Among the participants, 60% reported using a separate source of water for drinking and general household chores. In general, participants were more concerned about drinking water, and used the water source they perceived as cleaner and safer. For those who used a different source of water for drinking versus household chores, on average they spent  $17 \pm 12$  minutes walking to reach the water source used for drinking water, while for household chores, it took an average of  $11 \pm 10$  minutes from home to the water source (table 3). The return time was not noted specifically, but participants reported it was longer, since walking with full containers of water or carrying water on trolleys slowed down the walking pace. Participants reported using containers such as plastic cans, buckets, and big bottles to fetch water. The frequency of making a trip to fetch water was higher for water needed for household chores than for drinking water, and the mean volume of water collected during each trip was  $106 \pm 134$  liters (table 3).

Table 3. Description of the Sources, Time, Distance, and Other Water Access-Related Behaviors Practiced among Households from Rural Areas of the Menoua Division-West Region of Cameroon (n = 80) <sup>a</sup>

Sources, distance, time and other water access related variables	For Drinking water	For Chores water
	Mean ± SD	
<b>One-way walking time from house to water source</b> (in minutes) <sup>b</sup>	17 ± 12	11 ± 10
<b>How long the water lasted</b> (in days)	6 ± 5	2 ± 2
<b>Quantity of water fetched each turn</b> (in liters)	35 ± 22	106 ± 134
<b>Sources of water</b> <sup>c</sup>	<b>n (%)</b>	
Individual well/community well	--	45 (56%)
Public groundwater	34 (45%)	--
Public standpipe	39 (51%)	14 (18%)
River	3 (4%)	21 (26%)
<b>Caretaker involved in fetching water activity</b>	33 (25%)	41 (31%)
<b>Treated water before use</b> <sup>d</sup>	4 (3%)	17 (13%)

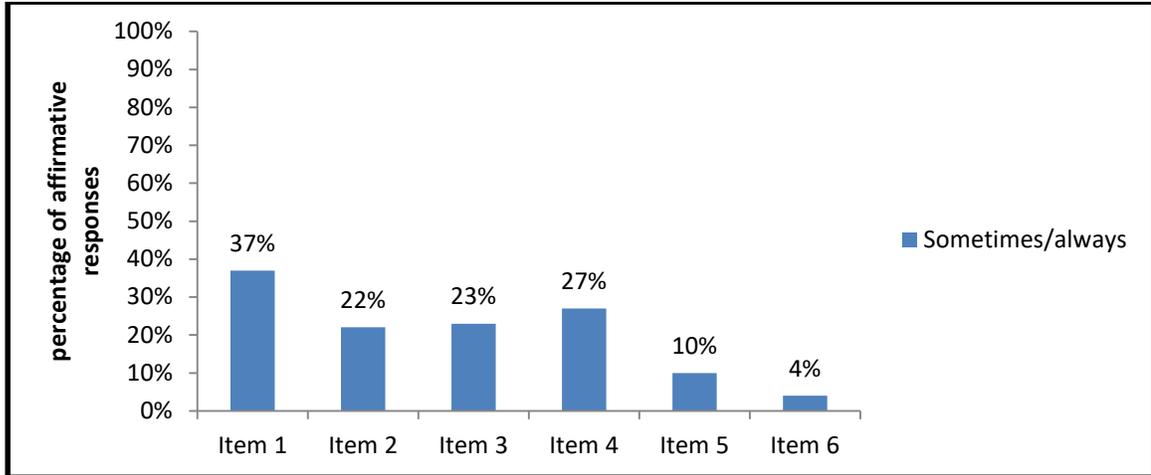
<sup>a</sup> To maintain consistency in examining variables such as walking time and days the water lasted, participants who reported using same source of water for drinking and household chores were excluded from the analyses. Hence, the sample size for this table is 80 i.e., 60% who used separate sources of water for drinking and household chores. <sup>b</sup> Participants were asked to estimate the time they spent walking from their houses to the specific water source. <sup>c</sup> For drinking water, n = 76, since one participant who reported using piped water at home and three others who used purchased bottled water were excluded for the analysis. <sup>d</sup>Chlorine and salt were the main agents used to treat water.

For water for household chores, households often used trolley-like equipment (metal board on small wheels) to bring substantial amounts of water at each trip. About one-fourth of the caretakers reported fetching water, but overall everyone in the household except the head of the household was responsible for fetching water. Filter and water purification practices were not very common, however, many of those who owned wells, reported treating its water with salt and chlorine, and that water was then mainly used for household chores.

### **Prevalence of Water Insecurity**

Using the six-item water insecurity scale, caretakers were asked how frequently they experienced each of the items during the last 30 days. As shown in figure 3, the highest level of affirmative response (37%) was obtained for item 1, enquiring if caretaker was worried about not getting enough water. About one-fourth of participants reported issues related to the household not getting enough water for household chores affecting even hygienic behaviors and drinking poor quality of water. Though not common, 10% of the participants reported borrowing water and 5% reported that they sometimes or always became sick due to unclean water (figure 3). Based on the following scoring scheme: 0 - water secure and  $\geq 1$  - water insecure, 42% of households were secure, while the remaining 58% were water insecure.

Figure 3. Number of Affirmative Responses on Water Security Scale by Each Item (n=134)



**Item 1:** worries about household not having enough water; **Item 2:** used just a little water day after day because of lack of resources; **Item 3:** not able to maintain good hygiene because of lack of resources; **Item 4:** drank poor quality water because of lack of resources; **Item 5:** borrowed water from somebody in the village for daily chores; **Item 6:** became sick because of lack of clean water supply. The reference period for each item used was the “past 30 days”. The response of sometimes or always was considered as an affirmative response.

### Comparison in Amount of Time, Distance, and Source of Water Used

#### Between Water Secure and Insecure Participants

To maintain consistency, those who reported using a separate source of water for drinking and chores were selected to compare differences in time, distance, and source of water utilized between water secure and insecure participants.

For drinking water, no significant difference in time, distance, and source of water was seen between water secure and insecure households. However, for household chores, among water insecure participants, the amount of time it took to reach the water source was significantly higher than their secure counterparts ( $13.1 \pm 11.3$  minutes and  $7.3 \pm 5.3$  minutes respectively,  $F_{(1,44)} = 3.5$ ,  $p = 0.068$ ). In addition, a difference was seen in the

source of water. Having a water source at home (individual wells) was more common among water secure (52%) than insecure (37%) households. Similarly, the use of unimproved sources of water such as rivers or public groundwater was more common among insecure than secure households (35% vs. 10%, respectively).

### **Major Themes Emerging Under the Three Domains of Water Insecurity**

Justifications of affirmative responses to the six items of the water security scale were grouped into themes under the following three major domains and summarized below:

*Anxiety/Worry:* For all the participants, having pipe-borne water was not common. Walking a certain distance to fetch water for the household was common practice. Hence, anxiety related to water occurred when the ‘normal’ routine of fetching water from the river, community well, or other sources was disrupted. The main thing that disrupted this routine was when a household member or caretaker was sick. Additionally, there was anxiety when water demand increased, for instance, having a newborn baby forced the caretakers to carry water from a cleaner water source which most of the time was farther from their houses. Participants reported that the worry of having enough water also increased, when the main person responsible for fetching water, including the caretaker, had other demanding activities such as working in the farm or going to school.

Participants were also worried about the water source drying up during the dry season. This concern was especially for drinking water. Due to the dry season, the main public groundwater and standpipe in the village were getting dry thus the fetching time greatly increased because of the reduced water flow. Since the public standpipe water

source remained open only for certain hours in the morning and late afternoon, participants reported waking up earlier for water fetching activities during dry season as queuing time also became longer.

*Quantity/quality of water:* Both, the quantity and quality of water was a concern in the study area. Participants reported that during the dry season, often the water they used for chores was brown in color (because of the mud). They also had the habit of doing laundry directly at the river site in order to spare the water they had at home. In the rainy season, participants often collected rain water and used it for both drinking and household purposes making the water fetching process less a burden for them. Those who borrowed water said they did it because their supply was finished and there was either nobody available to carry more or the water source was closed or dry.

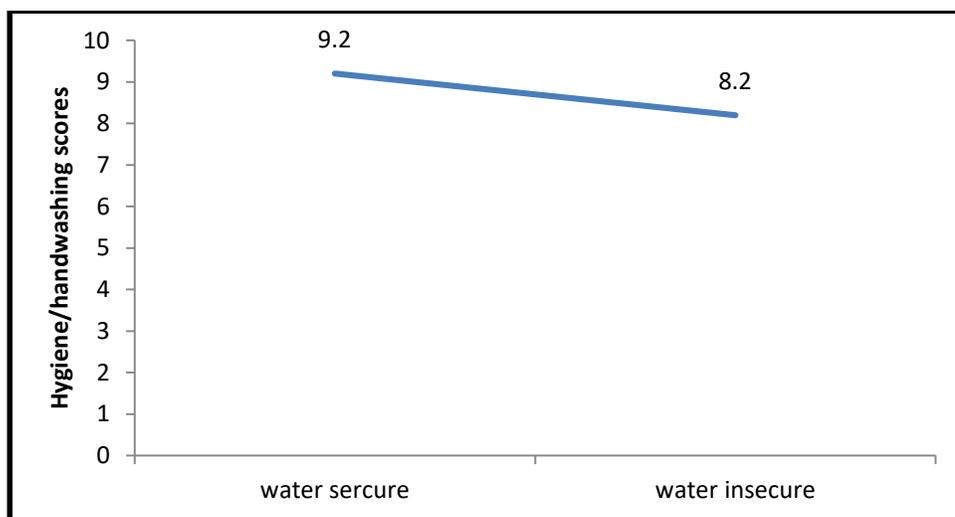
*Sickness due to water:* Only 4% of the participants reported becoming sick during the past 30 days because of lack of a clean water supply. In fact, most of the caretakers felt they had been using poor quality water all their life and couldn't relate to the fact that fever or diarrhea could be due to the water. Nevertheless, some did acknowledge that sickness might be due to the water but then they showed some resignation since there was no other option than what they had access to.

### **Comparison in Hygiene/Hand-Washing Behaviors and Child's Health Status by Water Security and Insecurity Status**

In estimating the frequency of washing hands with soap and water at the five critical stages (before cooking, before eating, before feeding the child, after defecation, and after cleaning child's feces), it was found that on average, participants scored 8.6

(SD: 1.9) with a minimum score of 0 and maximum score of 10. As indicated in figure 4, it was seen that the water secure group had significantly higher levels of hygiene/handwashing scores ( $9.2 \pm 1.2$ ) than their water insecure counterparts ( $8.2 \pm 2.3$ ), ( $F_{(1, 132)} = 8.096, p = 0.005$ ).

Figure 4. Differences in the Total Hygiene Score Between Water Secure and Insecure Caretakers Living in Rural Areas of the Menoua Division-West Region of Cameroon (n = 134)

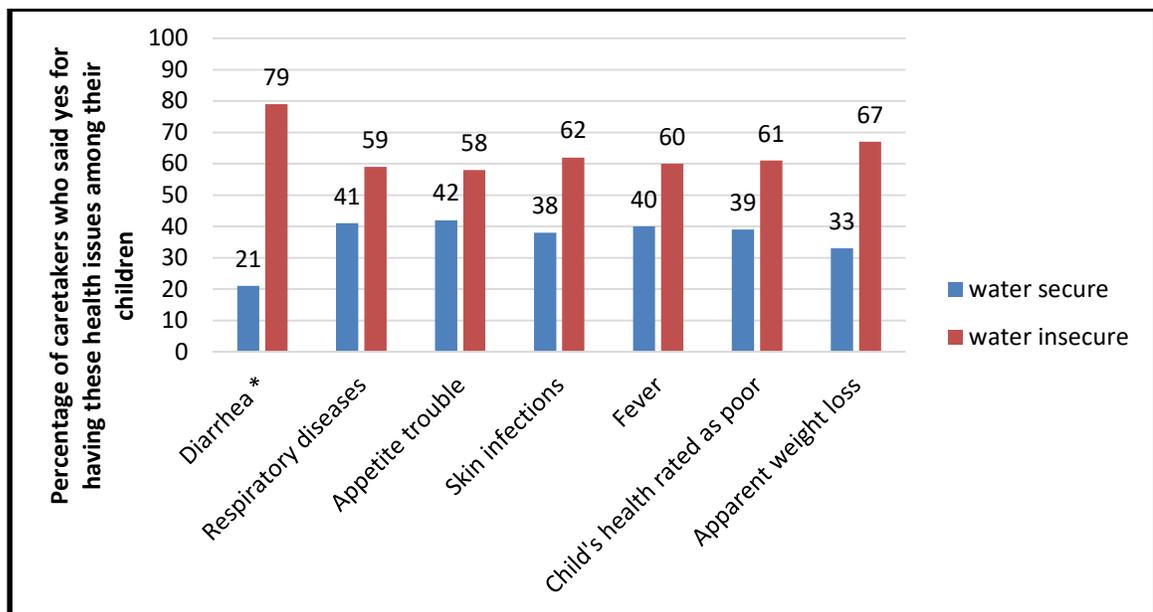


Higher hygiene/handwashing scores meant better levels of hygiene/handwashing practices. Differences in level of hygiene/handwashing scores were compared between water secure (0 score) and insecure ( $\geq 1$  score) participants using one-way ANOVA. Mean level of hygiene/handwashing scores for water secure: 9.2 (SD: 1.2) versus insecure: mean time 8.2 (SD:2.3),  $p = 0.005$

Differences in incidence of diarrhea and other health conditions among index children were compared between water secure and insecure households. Overall, for diarrhea, 18% of caretakers reported that the child had diarrhea in the past 30 days. In a self-assessment of health status of the index child, overall 17% of the caretakers reported

child's health as poor. 54% of children from water insecure households had episodes of diarrhea in the past 30 days compared to 46% children from water secure households ( $p = 0.022$ ). Concerning other health conditions, though not significant, more children from water insecure households were affected compared to their secure counterparts (figure 5).

Figure 5. Comparison of Presence of Diarrhea and Other Health Issues in the Past Month Among Children Living in Water Secure and Insecure Households in Rural Areas of the Menoua Division-West Cameroon (n = 134)



Chi-square.  $*p = 0.022$ ; significant difference in episodes of one or more diarrhea in the past 30 days was seen between children from water secure (score = 0) and insecure ( $\geq 1$ ) households.

## Discussion

Water security is considered a basic human right and critical in promoting peace and humanity worldwide.<sup>8</sup> However, more than half a billion people are estimated to be water insecure around the world.<sup>8</sup> Water-related diseases cause about 3.4 million deaths

annually and it is projected that approximately 34 to 76 million people, mostly children, will die by 2020 from water-related illnesses.<sup>16, 17</sup> Water security facilitates agricultural production and animals breeding, improves access to food, reduces water-related infections, and is critical in promoting optimal nutrition and health for children.<sup>10</sup> Therefore, it is essential to understand the prevalence of water insecurity and related water access behaviors in sub-Saharan Africa. The results of our study indicated that water access is an issue in rural areas of West region of Cameroon. Though less than half of the participants reported anxiety/distress related to water availability, water fetching-related behaviors indicated that their access to water on premises was rare, the most common sources of water being public standpipes, rivers, and ground water. In a study conducted in Nepal, it was found that, families used various strategies, including using various water sources such as wells, rivers, and even public standpipes to collect water for the household.<sup>18</sup>

The participants in our study spent an average of 17 minutes walking from their houses to their drinking water sources. A study that used DHS results from 26 sub-Saharan Africa countries showed that, on average walking time from home to main water source was 23 minutes.<sup>19</sup> Similarly, in alignment with our study results, the DHS results from 2004 in Cameroon showed that the mean one-way walking time from the household to the water source was approximately 20 minutes.<sup>19</sup> In terms of overall time resources used in accessing water, participants in our study reported that it took longer walking back home, since the weight of the containers they were carrying or pushing had considerably increased, resulting in more than 30 minutes of walking time, not including

fetching and queuing times. This situation is highly representative of water insecurity since studies have shown that basic drinking needs are compromised if the total time spent per round trip including time to draw water exceeds 30 minutes.<sup>20</sup> Results from a study conducted in Nepal showed that fetching water was a time consuming activity and depended upon walking time to and fro, queuing time and number of trips. Furthermore, that time spent collecting water represented 56% of the total coping costs for poor households.<sup>18</sup>

Based on water access behaviors, such as average distance, time and resources it took households to collect water, we could identify water insecurity was a huge issue in the study area even though our results showed a relatively high prevalence of water security (42%). The discrepancy between the actual behaviors—poor water access (long distance walking), poor water safety (half of participants fetching drinking water from unimproved sources), and poor water adequacy (cutting on quantity of water used for chores and hygiene)—and self-report on water security scale, indicates that participants had become accustomed to the water insecurity situation. Similar to other studies, results of our study indicated that women and children were mainly involved in water fetching activities, indicating that these population groups are taking the highest burden of water insecurity issues.<sup>20</sup>

Similar to results of this study, assessment study conducted by Ahaira et al.<sup>13</sup> in Nepal, indicated that water insecurity led to a marked reduction of the quantity of water used for household chores and even for personal hygiene. Our results also showed that hygiene/handwashing level was significantly better among water secure households than

water insecure. Similarly, an interventional study conducted in Ethiopia demonstrated that improving water access resulted in significant improvement of the amount of water used for drinking and for some household chores (bathing, house cleaning, laundry), reduction of water borrowing habits, and amelioration of the quality of water used for drinking.<sup>12</sup> Hence, our results and those of other studies indicated that there is a direct link between access to clean water and hygiene practices.<sup>5, 12, 21</sup> A model developed by Pickering & Davis revealed that a 5-minute reduction in the one-way walking time to the water source could lead to a 14% decrement in diarrhea incidence.<sup>19</sup> In our study, drinking water was on average stored for 6 days in order to reduce trips to the drinking water sources. Such a long storage of drinking water, generally offers greater opportunities for pathogen contamination via repeated water withdrawal from the containers with dirty utensils and/or hands, resulting in more diarrhea episodes.<sup>19</sup> The common sources of water in our study included public groundwater and wells. But these sources of water could be causing water related-diseases since according to the results of a study conducted in an urban area of Cameroon, 100% of wells and public groundwater sources were fecally contaminated.<sup>22</sup>

Furthermore, many studies have demonstrated that optimal handwashing was associated with a reduction of diarrhea incidence among children.<sup>23, 24</sup> However, optimal handwashing practices at all the five critical stages mean washing hands at least 10 times per day.<sup>25</sup> This will be difficult for people who are already struggling to have water for drinking and for main household chores.

## **Limitations**

There is a possibility of social desirability bias especially in reporting hygiene practices, and there is a possibility of over reporting of hand washing practices both in water secure and insecure groups. Thirdly, the water insecurity scale that was used was originally developed for an urban setting; hence, there is the possibility that certain aspects of a rural setting were not captured in the scale. Nevertheless, the relationship between water security, hand washing, and diarrhea incidence found in our study, indicates that the scale was able to capture key issues related to water security among our study participants. The study period started at dry season, but about one third of the interviews were conducted during the wet season. Hence, there is a possibility of season bias in the study. Future studies, comparing seasonal variation in water access, including quantity and quality are warranted.

## **Conclusion**

Results of this study confirm that water security is critical in promoting optimal health and development among children by reducing incidences of diarrhea. Nevertheless, there was a relatively low water insecurity prevalence in the study area despite a garish restrictive access to a poor quality water. Therefore, qualitative studies are warranted to develop a water security scale tailored to capture physical, socio-cultural, and related issues associated with water access in rural areas. Especially besides self-reported surveys, objective environmental measurements should be developed to assess water security and components that address accessing water in non-socially acceptable ways should be highlighted.

## References

1. United Nations International Children Emergency Fund. Monitoring the Situation of Children and Women. Diarrhoea remains a leading killer of young children, despite the availability of a simple treatment solution. <https://data.unicef.org/topic/child-health/diarrhoeal-disease/> (accessed August 20, 2017)
2. Liu L, Johnson HL, Cousens S et al. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *The Lancet*. 2012; 379(9832): 2151-2161. [http://dx.doi.org/10.1016/S0140-6736\(12\)60560-1](http://dx.doi.org/10.1016/S0140-6736(12)60560-1)
3. Prüss-Üstün A. & Corvalán C. Preventing disease through healthy environments: Towards an estimate of the environmental burden of disease. World Health Organization, Geneva, Switzerland. 2006.
4. United States Agency for International Development (2015). WASH & Nutrition – Water and development strategy & multi-sectoral nutrition strategy Implementation Brief. [https://www.usaid.gov/sites/default/files/documents/1865/USAID\\_WASH\\_Nutrition\\_Brief\\_2015.pdf](https://www.usaid.gov/sites/default/files/documents/1865/USAID_WASH_Nutrition_Brief_2015.pdf) (accessed September 6, 2017)
5. Esrey SA, Feachem RG, Hughes JM. Interventions for the control of diarrhoeal diseases among young children: improving water supplies and excreta disposal facilities. *Bull World Health Organ*. 1985;63(4):757-772.
6. Food and Agriculture Organization. The State of Food Insecurity in the World. Food and Agriculture Organization, Rome, Italy. 2005.
7. Hadley C, Wutich A. Experience-based measures of food and water security: biocultural approaches to grounded measures of insecurity. *Human Organization*. 2009;68(4):451-460.
8. United Nation. 2015. The Millennium Development Goals Report. United Nation, New York, USA. [http://www.un.org/millenniumgoals/2015\\_MDG\\_Report/pdf](http://www.un.org/millenniumgoals/2015_MDG_Report/pdf) (accessed 27 August 2017)

9. Howard G, Bartram J. Domestic Water Quantity, Service Level and Health. *Bull World Health organ.* 2003.
10. MercyCorps (2009). Water, Sanitation and Hygiene Guidelines 2008-2009. [http://www.mercycorps.org/sites/default/files/WASH Guidelines](http://www.mercycorps.org/sites/default/files/WASH%20Guidelines). (accessed August 17, 2017)
11. Stevenson EG, Greene LE, Maes KC, et al. Water insecurity in 3 dimensions: an anthropological perspective on water and women's psychosocial distress in Ethiopia. *Soc Sci Med.* 2012;75(2):392-400.
12. Stevenson EG, Ambelu A, Caruso BA, Tesfaye Y, Freeman MC. Community Water Improvement, Household Water Insecurity, and Women's Psychological Distress: An Intervention and Control Study in Ethiopia. *PLoS One.* 2016;11(4):e0153432.
13. Aihara Y, Shrestha S, Sharma J. Household water insecurity, depression and quality of life among postnatal women living in urban Nepal. *J Water Health.* 2016;14(2):317-324.
14. Molua EL, Lambi CM. Climate, hydrology and water resources in Cameroon. *The Centre for Environmental Economics and Policy in Africa (CEEPA), University of Pretoria South Africa.* 2006.
15. Seino RA, Ghogomu RT, Manjeli Y, Dongmo TI, Chifon RN. A faunal survey of the oedipodinae (Acrididae : Orthoptera) of the Menoua Division in Cameroon. *International Journal of Fauna and Biological Studies.* 2013; 1(1):15-19.
16. Gleick PH. *Dirty-water: estimated deaths from water-related diseases 2000-2020.* Pacific Institute for Studies in Development, Environment, and Security Oakland; 2002.
17. World Health Organization. Water for health, taking charge. [http://www.who.int/water\\_sanitation\\_health/takingcharge.html#Acknowledgements](http://www.who.int/water_sanitation_health/takingcharge.html#Acknowledgements) (accessed 27 August 2017)
18. Pattanayak SK, Yang J-C, Whittington D, Bal Kumar KC. Coping with unreliable public water supplies: Averting expenditures by households in Kathmandu, Nepal. *Water Resources Research.* 2005;41(2).

19. Pickering AJ, Davis J. Freshwater availability and water fetching distance affect child health in sub-Saharan Africa. *Environmental science & technology*. 2012;46(4):2391-2397.
20. Ako AA, Shimada J, Eyong GET, Fantong WY. Access to potable water and sanitation in Cameroon within the context of Millennium Development Goals (MDGS). *Water science and technology*. 2010;61(5):1317-1339.
21. Esrey SA, Potash JB, Roberts L, Shiff C. Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bull World Health Organ*. 1991;69(5):609-621.
22. Yongsri HBN. Suffering for water, suffering from water: access to drinking-water and associated health risks in Cameroon. *Journal of health, population, and nutrition*. 2010;28(5):424.
23. Iyer P, Sara J, Curtis V, Scott B, Cardosi J. *The handwashing handbook. A guide for developing a hygiene promotion program to increase handwashing with soap*, World Bank, Washington DC, USA. 2005.
24. Ejemot-Nwadiaro RI, Ehiri JE, Arikpo D, Meremikwu MM, Critchley JA. Hand washing promotion for preventing diarrhoea. *The Cochrane Library*. 2015.
25. Luby SP, Halder AK, Huda T, Unicomb L, Johnston RB. The effect of handwashing at recommended times with water alone and with soap on child diarrhea in rural Bangladesh: an observational study. *PLoS medicine*. 2011;8(6):e1001052.

## **CHAPTER IV**

### **EPILOGUE**

At the beginning of this project in August 2015, we wanted to conduct a study aiming to understand the triangulation between water insecurity, food insecurity, and health status of children living in refugee's camps of East and North regions of Cameroon. In fact, since 2010, these areas have been occupied by more than 100,000 refugees mainly fleeing from Centrafrican Republic and Nigeria. Dr. Dharod gave me the opportunity to work on the project from the real beginning.

During my first two semesters, we wrote a proposal and started with the IRB procedure to obtain approvals. We also developed a questionnaire. During the Summer 2016, I went to Cameroon in order to evaluate the feasibility of our project: 1) access to the refugee's camps; 2) security in the villages harboring the camps; 3) the material and logistic needed, and finally; 4) the authorizations that were required since refugees are considered vulnerable populations and thus, are protected. Unfortunately, our findings were not what we expected: 1) the access and living conditions were extremely difficult in the village harboring those camps—the majority of the international organizations' officers working there were living in a neighboring town—I had to sleep at a hospital because there were no other places where I could stay; 2) those areas were not safe with kidnapping of local authorities that had occurred few months earlier in the East

region and terrorism attacks from Boko-Haram in the North, and; 3) Transportation means to get to one of the camps was really an issue and in contrary to what we thought, most of the refugees couldn't say a word either in French or in English. Based on that, we ended up deciding to change the study area.

From the literature review we could make before and during my third semester, we found that except for refugee camps where water and food insecurity issues were common, the West region of the country, also known as the bread basket of the country, was experiencing severe level of food insecurity (In third position after both northern regions). This situation of sudden food insecurity in that area which had not yet been investigated, the fact that water access has always been a real problem in all rural areas of Cameroon, and my good knowledge of the west region of my country, led us to select the West Region of Cameroon, specifically the Menoua division, as the replacing study area.

During the end of summer 2016 and fall 2016, we updated the proposal as well as the questionnaire to the new study population. The main objective of our research i.e. understand the inter-relationship between water insecurity, food insecurity, and health status of children has not changed. But for the purpose of this thesis, we are just limiting to data relative to water insecurity, hygiene practices, and health status of children.

We were able to secure all the required authorizations by mid-January 2017, finalized our questionnaire (appendix A), and immediately started with data collection process. The first step was to recruit and form an interpreter since I couldn't speak the local dialect of the village. "Megni" Veronique (She is called "Megni" because she has twins among her children), our interpreter, was a local community worker in her forties.

Villagers were really reluctant in participating in the study. But having “Megni” Veronique with me really helped building confidence. Also, the fact I could understand their dialect (even though I couldn’t speak) was a little bit reassuring for them. The second problem we encountered during the data collection was the fact that women were going to their farms during week days and to funerals during the weekends. There was no real day when they were really available making it really difficult some days for us to be able to find women to interview. The third difficulty was the distance. Without a mean of transportation at our disposal, we walked several miles a day to be able to meet women to interview. Sometimes we had to walk in the rain because houses were spread apart and there was nowhere to stand and wait until the rain was over.

Once they accepted to participate in the study, caretakers were in general really friendly with me. But sometimes their husband was there and just wouldn’t leave. So I had to conduct some interviews (just a few fortunately) with the husband being there whereas he was not supposed to. The news rapidly spread in the village about me being there interviewing people and villagers were really interested in how the study will profit them in a long term. They were highlighting their water issues, the fact they couldn’t have water on premises, and were hoping I was going to come back and help them fixing that.

After I finished collecting data, I started the analysis process during the summer 2017 in Cameroon and have been continuing it since then. Our results showed that water insecurity is a real problem in the study area even though people seem to have gotten

used to it. We hope that we will be able to continue this study by conducting an interventional research at the study area.

**APPENDIX A**

**STRUCTURED INTERVIEW GUIDE**

**Assessment of the Triangulation of food insecurity, water insecurity, and health status among rural populations of the Menoua Division - West Region of Cameroon**

*First contact's date:* \_\_\_\_/\_\_\_\_/\_\_\_\_ *Village:* \_\_\_\_\_ *Residence* \_\_\_\_\_ *ID#:* \_\_\_\_\_  
Month Day Year

*Site of the recruitment:*  Home  Work place  Other (please specify: \_\_\_\_\_)

*Season:*  Dry  Rainy  Transition dry to rainy  Transition rainy to dry

**I. Selection criteria**

- |   |   |  |
|---|---|--|
| 1. Is the person a woman?   | <input type="checkbox"/> Yes (Continue)           | <input type="checkbox"/> No (Exclude from study) |
| 2. Is the woman pregnant?   | <input type="checkbox"/> Yes (exclude from study) | <input type="checkbox"/> No (continue)           |
| 2. Is the woman the main preparer of the household?               | <input type="checkbox"/> Yes (Continue)           | <input type="checkbox"/> No (Exclude from study) |
| 3. Is the woman older than 18 years old?                          | <input type="checkbox"/> Yes (continue)           | <input type="checkbox"/> No (Exclude from study) |
| 4. Is any child of the household aged between 2 and 5 years old?  | <input type="checkbox"/> Yes (Continue)           | <input type="checkbox"/> No (Exclude from study) |
| 6. Is the index child (between 2 and 5 years old) in good health? | <input type="checkbox"/> Yes (continue)           | <input type="checkbox"/> No (exclude from study) |

**II. IDENTIFICATION SHEET**

- Name of the respondent: \_\_\_\_\_ Year of birth? \_\_\_\_\_
- What is the child's name (the index child)? \_\_\_\_\_ Date of birth? \_\_\_\_/\_\_\_\_/\_\_\_\_  
Month day year
- What is your relationship with the child (the one selected for the study) \_\_\_\_\_
- What is the child gender?  Boy  Girl
- Is (index child's name) ----- going to school?  Yes  No

Setting an appointment							
Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Time							
Preferences							

Date of Interview: \_\_\_/\_\_\_/\_\_\_ Start time of Interview: \_\_\_ End time of Interview: \_\_\_ Location: \_\_\_\_\_  
Month day year

### SECTION I: DEMOGRAPHICS

(Note for fieldworker: Now, I am going to ask you questions that pertain to your household structure.)

1. Who is the head of the household (the person financially responsible of the household)?  
 Yourself       Someone else (Please specify the relationship: \_\_\_\_\_)
2. How many people (Children and adults) including yourself are living in your household? \_\_\_\_\_
3. How many children (less than 18 years) are living with you in your household? \_\_\_\_\_
4. How many children living in this house have you given birth to? \_\_\_\_\_
5. What religion do you practice?  None     Catholic     Protestant     Animist     Muslim  
 Other: \_\_\_\_\_

### SECTION II: CHILD HEALTH STATUS, IMMUNIZATION AND WORM PROPHYLAXIS

(Note for fieldworker: Now, I will ask you questions about the health of the study child

\_\_\_\_\_)

1. What was the child: birth weight? \_\_\_\_\_ kg      birth height \_\_\_\_\_ cm
2. Has ----- (child's name) experienced diarrhea in the past month?  Yes  No  
(If No, please skip questions a-b)
  - a. How many episodes/times (beginning until recovery) of diarrhea has he/she experienced in the past month? \_\_\_\_\_
  - b. What do you do when your child is having diarrhea? \_\_\_\_\_
3. Has your child had fever in the past month?  Yes  No
4. Has your child had cough in the past month?  Yes  No
5. Has your child had running nose in the past month?  Yes  No
6. Has your child had skin infections in the past month?  Yes  No
7. Has your child had eating troubles/stomach pains in the past month?  Yes  No
8. Do you think your child lost weight in the past month?  Yes  No
9. How would you rate the health of your child in general?  
Very poor     Poor     Average     Good     Very good
10. Does ----- (child's name) received vaccines from recent immunization campaigns?  Yes  No
11. Does ----- (child's name) received worm medicines recently?  Yes  No

### SECTION III: HOUSEHOLD DIET DIVERSITY SCALE

(Note for fieldworker: Now I am going to ask you about the types of food that you ate yesterday-day and night)

	<b>Food groups and examples</b>	<b>Yes</b>	<b>No</b>	<b>Specify what you ate</b>
A	Any pasta, bread, biscuits, cookies, or any food made from millet, maize, sorghum, rice or wheat			
B	Any Pumpkin, carrots, squash, or sweet potatoes that are yellow or orange inside?			
C	Any white potatoes, white yams, cassava or any other foods made from roots or tubers?			
D	Any dark, green, leafy vegetables such as cassava leaves, bean leaves, kale, spinach, pepper lives, okra, taro leaves, cabbage, and amaranth leaves?			
E	Any other vegetables (tomatoes, mushrooms, etc.)?			
F	Any fruits?			
G	Any beef, pork, lamb, goat, rabbit wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ meats?			
H	Any eggs?			
I	Any fresh or dried fish or shellfish?			
J	Any foods made from beans, peas, or lentils?			
K	Any food made from nuts?			
L	Any cheese, yogurt, milk or other milk products?			
M	Any food made with oil, fat, or butter?			
N	Any sugar or honey?			
O	Any other foods, such as condiments, coffee, tea?			

1. Which do you usually drink: water, alcohol, sweet drinks, diet drinks? \_\_\_\_\_
2. How much Beverage do you approximately drink per day? \_\_\_\_\_ bottles (1 liters)

**SECTION IV: FOOD SECURITY** (*Now, I am going to ask questions about the food situation in your home during the past 30 days. Please be totally forthcoming pay attention to each question. Some may appear similar but it is important that you answer each one of them. Should you have the need for me to clarify any questions please ask.*)

<b>Questions referring to Respondent and/or Other Adults in the Household (circle the number of the corresponding answer)</b>		
1. During the last 30 days, were you worried about running out of food?	1. Yes 2. No	88. Don't Know 99. Refused
2. Did your home run out of food at any time during the last 30 days?	1. Yes 2. No	88. Don't Know 99. Refused
3. Was your home unable to eat the kind of foods that make you healthy at any time during the last 30 days?	1. Yes 2. No	88. Don't Know 99. Refused
4. Did you or anybody in your home usually have to eat the same foods almost every day during the last 30 days?	1. Yes 2. No	88. Don't Know 99. Refused
5. Was there any day during the last 30 days, which you or any other adult in your home skipped a meal because of lack of food?	1. Yes 2. No	88. Don't Know 99. Refused
6. During the last 30 days did any adult in your home eat less food than what they needed because there wasn't enough food?	1. Yes 2. No	88. Don't Know 99. Refused
7. During the last 30 days was there any day when you or any other adult in your home felt hungry but did not eat because there wasn't enough food?	1. Yes 2. No	88. Don't Know 99. Refused
8. Was there any day during the last 30 days when you or any other adult in your home didn't eat for a whole day or just ate once during the day because there wasn't enough food?	1. Yes 2. No	88. Don't Know 99. Refused
9. During the last 30 days, did you do things that you would have preferred not to do, such as begging or sending children to work, to get food?	1. Yes 2. No	88. Don't Know 99. Refused
<b>Questions referring to Children in the Household (circle the number of the corresponding answer)</b>		
10. During the last 30 days were you unable to provide the children in your home with the kinds of food they need to be healthy?	1. Yes 2. No	88. Don't Know 99. Refused
11. Did any children in your home usually have to eat the same food almost every day during the last 30 days?	1. Yes 2. No	88. Don't Know 99. Refused
12. During the last 30 days did any child in your home eat less food than what s/he needed because there wasn't enough food?	1. Yes 2. No	88. Don't Know 99. Refused
13. During the last 30 days did you have to serve less food to any child because there wasn't enough food?	1. Yes 2. No	88. Don't know 99. Refused
14. During the last 30 days was there any day when any child in your home felt hungry but could not be fed because there wasn't enough food?	1. Yes 2. No	88. Don't know 99. Refused
15. Did any child in your home go to bed hungry in any day during the last 30 days because of lack of food?	1. Yes 2. No	88. Don't know 99. Refused
16. Was there any day when any child in your home didn't eat for a whole day or just ate once during the day because there wasn't enough food during the last 30 days?	1. Yes 2. No	88. Don't know 99. Refused

**SECTION V: MEAL EATING PATTERNS AND FOOD SHOPPING** (Note for fieldworker: Now, I am going to ask you questions about your meal eating patterns)

1. Who usually does the shopping for foods for your family?  
 Yourself     Someone else (Please specify the relationship: \_\_\_\_\_)
2. Where do you/or someone else usually go shopping for food? \_\_\_\_\_
3. How much time do you have to walk from home to get there? \_\_\_\_\_ minutes
4. How often do you/someone else go for shopping? \_\_\_\_\_ times per  day     week     month
5. How many times do you eat per day? \_\_\_\_\_
6. How often do you cook for your household? \_\_\_\_\_ times per  day     week     month

**SECTION VI: WATER INSECURITY**

(Note for the investigator: If it is the separate source of water, please first ask all the questions for drinking water source and then start with chores water source.)

	Drinking water source	Chores water source	Both purposes source
1. Where do you get the water you are using at home	<input type="checkbox"/> Running river <input type="checkbox"/> community well <input type="checkbox"/> individual well <input type="checkbox"/> household piped water <input type="checkbox"/> public standpipe <input type="checkbox"/> From other sources (Please specify): _____	<input type="checkbox"/> Running river <input type="checkbox"/> community well <input type="checkbox"/> individual well <input type="checkbox"/> household piped water <input type="checkbox"/> public standpipe <input type="checkbox"/> From other sources (Please specify): _____	<input type="checkbox"/> Not Applicable
<b>If the same water source for drinking and chores...</b>			
2. At the household level do you separate the water by its use that is drinking water versus chores water? <input type="checkbox"/> Yes <input type="checkbox"/> No			
3. If yes, describe what you do: _____			
<i>AND then use the third column (both purposes source)</i>			
4. Who is responsible for fetching water/filling the storage container	<input type="checkbox"/> Myself <input type="checkbox"/> family member <input type="checkbox"/> A village brother/sister	<input type="checkbox"/> Myself <input type="checkbox"/> family member <input type="checkbox"/> A village brother/sister	<input type="checkbox"/> Myself <input type="checkbox"/> family member <input type="checkbox"/> A village brother/sister
5. How long do you/the person have to walk to get to the water source?	<input type="checkbox"/> ___ Minutes ___ hours <input type="checkbox"/> Not applicable	<input type="checkbox"/> ___ Minutes ___ hours <input type="checkbox"/> Not applicable	<input type="checkbox"/> ___ Minutes ___ hours <input type="checkbox"/> Not applicable

6. Do you have to wait in line?	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, How much time? <input type="checkbox"/> ___ Minutes ___ hours	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, How much time? <input type="checkbox"/> ___ Minutes ___ hours	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, How much time? <input type="checkbox"/> ___ Minutes ___ hours
7. How long does it take approximately for the water to fill a 20 liters container?	_____ Minutes	_____ Minutes	_____ Minutes
8. What quantity of water do you/the person carry at each trip?	_____	_____	_____
9. Where do you store the water that you get?	<input type="checkbox"/> bottles <input type="checkbox"/> can <input type="checkbox"/> buckets <input type="checkbox"/> barrel	<input type="checkbox"/> bottles <input type="checkbox"/> can <input type="checkbox"/> buckets <input type="checkbox"/> barrel	<input type="checkbox"/> bottles <input type="checkbox"/> can <input type="checkbox"/> buckets <input type="checkbox"/> barrel
10. Do you spend any form of payment (cash/in kind) for the water you use?	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
11. If yes, specify the amount of the payment or reward?	_____	_____	_____
12. How long does that water last?	___ Hours ___ days ___ weeks	___ Hours ___ days ___ weeks	___ Hours ___ days ___ weeks
13. Do you treat the water for household use?	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes what do you do? _____ _____	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes what do you do? _____ _____	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes what do you do? _____
14. Which amount of water is available at the household at the moment of the interview	_____	_____	_____

Now, I will ask a series of question about how often you have to change some of your habits because of water scarcity

<b>Questions referring to Respondent and/or Other Adults in the Household</b>	
<b>A</b>	During the last 30 days how often did you worry about your household not having enough water? <input type="checkbox"/> Never/Rarely <input type="checkbox"/> Sometimes <input type="checkbox"/> Always If sometimes/always, explain why? _____ _____
<b>B</b>	During the last 30 days how often did you or your household members use just a little water day after day because of lack of resources (water source/storage container)? <input type="checkbox"/> Never/Rarely <input type="checkbox"/> Sometimes <input type="checkbox"/> Always If sometimes/always, explain why? _____ _____
<b>C</b>	During the last 30 days how often did you or your household members not able to maintain good hygiene because of lack of resources (water source/storage container)? <input type="checkbox"/> Never/Rarely <input type="checkbox"/> Sometimes <input type="checkbox"/> Always If sometimes/always, explain why? _____ _____
<b>D</b>	During the last 30 days how often did you or your household members drink poor quality water because of lack of resources (water source/storage container) to obtain other type of water sources? <input type="checkbox"/> Never/Rarely <input type="checkbox"/> Sometimes <input type="checkbox"/> Always If sometimes/always, explain why? _____ _____
<b>E</b>	During the last 30 days, how often did you have to borrow water from somebody in the village for you daily chores? <input type="checkbox"/> Never/Rarely <input type="checkbox"/> Sometimes <input type="checkbox"/> Always If sometimes/always, explain why? _____ _____
<b>F</b>	During the last 30 days how often did you or your household members become sick because of lack of clean water supply? <input type="checkbox"/> Never/Rarely <input type="checkbox"/> Sometimes <input type="checkbox"/> Always If sometimes/always, explain why? _____ _____

## SECTION VII: SOCIO-ECONOMIC STATUS

*(Note for fieldworker: Now, I am going to ask you questions about the socio-economic status, the house you live in and the water you are using in your household)*

1. Have you ever been to school?  Yes  No If yes, what is your last grade in school? \_\_\_\_\_
2. What is your current marital status?  Single/never married  Married  Living together but not married  Separated/divorced/widowed  Married not living together
3. Do you work for paid job?  Yes  No  
 If yes, what? \_\_\_\_\_  
 If no, what is your main work related activities? \_\_\_\_\_
4. How many farms do you have?  None  \_\_\_Small  \_\_\_Medium  \_\_\_Big
5. Does your household own animals (including chicken)?  Yes  No  
 If yes, which ones (specify the number)? \_\_\_\_\_
6. Do you have electricity available at home?  Yes  No
7. What mean of transportation do you own? \_\_\_\_\_

8. What kind of fuel do you use to cook your foods at home? (Please check all that apply)
- Electricity  Gas  Kerosene  Coal  Woods  Pailles (palm leaves, bamboo leaves...)  Other (Please specify: \_\_\_\_\_)

9. How much money does your family earned in the past month (from all sources of income?)
- | <u>US currency (Dollars)</u>                   | <u>Cameroon currency (Franc CFA)</u> |
|--|--------------------------------------|
| <input type="checkbox"/> US\$0-US\$30.00       | 0-16500.00                           |
| <input type="checkbox"/> US\$30.00-US\$60.00   | 16500.00- 33000.00                   |
| <input type="checkbox"/> US\$60.00-US\$90.00   | 33000.00-49500.00                    |
| <input type="checkbox"/> US\$90.00-US\$120.00  | 49500.00-66000.00                    |
| <input type="checkbox"/> US\$120.00-US\$150.00 | 66000.00-82500.00                    |
| <input type="checkbox"/> >US\$150.00           | >82500.00                            |

### SECTION IX: SANITATION

- Which type of latrine do you use to defecate?  Pit hole latrine  Flush-latrine  Others
- Describe \_\_\_\_\_
- Where is it? Within the household  Around the household   
If around the household, how far is it? \_\_\_\_\_ Minutes of walking distance
- Index child defecation habits (Describe—the place, how do you dispose the feces, what is used to clean the child after the defecation) \_\_\_\_\_

### SECTION X: HYGIENE

<b>HOW OFTEN DO YOU wash hands:</b>			
Key times	NEVER/rarely (0)	Sometimes (1)	Always (2)
Before preparing food			
before feeding the child			
Before eating			
After defecation			
After handling child feces			

- Describe how you wash your hands (place, quantity of water, scrubbing agent, drying):  
\_\_\_\_\_
- Do you cut the child's hand nails regularly?  Yes  No
- How often do you make sure --- hands are always clean?  Never/Rarely  Sometimes  Always
- How often do you wash fruits/vegetables before eating?  Never/Rarely  Sometimes  Always
- Describe how you store (cooked/prepared) food? \_\_\_\_\_

## SECTION XI: 24 HOUR RECALL (TO CHILDREN)

24 hour dietary recall date: \_\_\_\_\_/\_\_\_\_\_/\_\_\_\_\_ Day of the week: \_\_\_\_\_  
Month      Day      Yea

### METHODS OF PREPARATION: FOR PREVIOUS DAY - FOOD AND BEVERAGE INTAKE

*(Fieldworker: Today, I will ask you questions about what you ate or drank from the time you woke up yesterday morning to the time you woke up in the morning today. Can you please tell me what did you eat and during that period of time? I will also ask you about the ingredients and how each food was prepared.)*

**KEY STEPS:**

- 1- Quick list of all the food items that have been eaten starting on last awakening then working forward to 24 hours later
- 2- Detailed description of food in the quick list: clarify description of items, preparation methods, amounts eaten
- 3- Review de data collected: precisions on additional eating occasions, clarification of portion sizes

### INDEX CHILD

Time of Day	Location (household, street, restaurant)	Food	Beverage	Mixed Dish Recipes		Method of Preparation (boiled, fried, etc...)	Amount Consumed by the child	Unit of Amount Consumed by child (cups, slice, cm, etc...)
				Dish Ingredients	Ingredient Amount			

## SECTION XII: REFERENCE CHILD'S ANTHROPOMETRIC MEASUREMENTS

Date of Measurement: \_\_\_/\_\_\_/\_\_\_ Start time: \_\_\_\_\_ End time: \_\_\_\_\_ Location: \_\_\_\_\_  
Month day year

**KEY STEPS:**

- 1- *As much outer clothes as possible will be removed, as well as any object inside the pockets*
- 2- *The child stands straight and still over the center of the scale facing away from the read out (precision 0.1 kg)*
- 3- *The child stands straight, his/her back against the board of the stadiometer, legs together, and looking straight ahead (precision 0.1 cm)*

14.1. Child's weight	kg	Kg
14.2. Child's height	cm	Cm

## SECTION XII: FIELDWORKER OBSERVATIONS

- |   |                                     |  |                                     |
|---|-------------------------------------|--|-------------------------------------|
| How is the general appearance of the child? | <input type="checkbox"/> poor       | <input type="checkbox"/> average       | <input type="checkbox"/> good       |
| How are the child clothes?                  | <input type="checkbox"/> poor state | <input type="checkbox"/> average state | <input type="checkbox"/> good state |
| How are the child hands?                    | <input type="checkbox"/> Dirty      |  | <input type="checkbox"/> Clean      |

Thank you for your time and efforts. We really appreciate your input. Do you have any questions for me?