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Study of Malnutrition Factors in Market Gardeners Children in Burkina Faso: Case of Drinking Water and Intestinal Parasitic

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A B S T R A C T

In Burkina Faso, despite the strengthening of food security and household incomes, the malnutrition in market gardeners children remains a concern in some regions. This study aims to assess drinking water quality and intestinal parasitic infections in two market garden sites to understand the persistence of malnutrition in these children.Drinking water (n=43) and stools(n=96) from children aged06-59 months were analyzed. Stool samples were subjected to the Kato-Katz and a formalin-ether concentration method for the diagnosis of helminths and intestinal protozoa infections. In water samples, coliform bacteria, *E. coli* and fecal streptococci were secludedfollowing the membrane filtration method.In both sites, 54.55% of children were infected. Among them, *Giardia lamblia* were diagnosed in 52% of children, *Entamoeba coli* in 04% and whipworms in 10%. 61.90% of children infected by parasites were stunted. In both sites, 91.7%-100% of drinking water was contaminated by at least one fecal bacteria group. Around 45% of children who drink wells water without any treatment were infected. These results show the necessity to improve the access to safe drinking water, hygiene and sanitation in market gardens to reduce the intestinal parasitic infections in children which can lead to malnutrition.

Introduction

Malnutrition, intestinal parasitic infections and diarrheal diseases are public health problems in children in low- and middle-income countries (Prüss *et al.*, 2014; WHO, 2015). After malaria, diarrheal diseases and malnutrition are the second cause of death in children under the age of 5in Burkina Faso (Somé, 2011). In the western central region, the prevalence of malnutrition was 9.7%, one of the highest in Burkina Faso (Health Ministry, 2016). Yet, this region is the 4thproducer of vegetables. Since 2015,a program aiming to modernize familial farming is conducting in many villages in the western central region to strengthen food security and household incomes. Despite the interventions, market gardeners children still suffer from malnutrition (Onadokun, 2017). This situation could be related to the consumption of non-drinkable water and intestinal parasitic infections. In fact, many studies showed that malnutrition, intestinal parasitic infections and inadequate WASH conditions are intricately linked. Inadequate WASH conditions are important risk factors for both malnutrition and intestinal parasitic infections (Strunz *et al.,* 2014; Speich *et al.,* 2016). Parasitic infections contribute to growth stunting by causing a decline in food intake (loss of appetite), diarrhea, malabsorption and/or an increase in nutrient wastage for the immune response, all of which lead to nutrient losses and further damage to the defense mechanisms, causing a vicious cycle (Stephenson *et al.,* 2001; Alum *et al.*, 2010).The pathogenic agents associated with poor WASH conditions are viral pathogens, bacterial pathogens, protozoan cysts or oocysts and helminth eggs found in feces and transmitted through the fecal-oral pathway and can lead to diarrhea and under nutrition, whereby exposure to one increases vulnerability to the other (Feachem *et al.*, 1983; Victora *et al.*, 2008).

In the western central region, around 34% of people have not access to safe drinking water (DGRE, 2018). In market garden, water supply is essentially from wells. Because of lack of hygiene and sanitation in the immediate environment, these wells water could be contaminated by fecal microorganisms. Consequently, these waters consumption could cause diseases as diarrhea that affects children particularly. This study aims to assess the microbiological quality of drinking water and intestinal parasitic infections in market gardeners children in order to understand the persistence of malnutrition in these areas.

Materials and Methods

Study sites

The western central region is located between 11° 45′ north and 2° 15′ west. It stretches on 21 722 km^2, being 8% of Burkina Faso territory. This study was conducted in two villages named Dassaand Nebia located at 47and 53 km from Koudougou respectively. Koudougou is the capital of the western central region. In Dassa and Nebia, the investigations focused on women working in market garden and having children aged 06-59 months.

In this way, a total of 43 households with 96 children were selected. In Dassa, there were 27 households with 62 children and in Nebia16 households with 33 children. In both sites, 15.58% of children were suffered from acute malnutrition. Among them, 11.69% were affected by moderate malnutrition and 03.90%by severe malnutrition (Onadokun, 2017). Moreover, 33.77% of children were underweight in both villages combined. These prevalence were high compared to the national rate (Health Ministry, 2016). This situation justified this study, to better understand malnutrition factors in this region.

Drinking water sampling and microbiological analysis

Fifty-nine (59) drinking water samples including 43 from market garners household and 16 from water sources were collected. Water samples were collected in sterile 100 ml bottles in triplicate. Samples were transferred to the laboratory in cooled boxes and stored in a fridge at 4°C before analysis on the same day according to French standards (ISO 5667-3, 2018).Three bacterial indicators of fecal contamination, namely *Escherichia coli*, fecal coliforms and fecal streptococci were determined by a membrane filtration method. Bacterial cells were concentrated on a 0.2 µm Millipore membrane filter, followed by culture on the chromogenic Rapid *E. coli*2 Agar medium to detect *Escherichia coli* and coliform bacteria, or on the bile-esculine-azide medium to identify fecal streptococci. For *E. coli* and others coliform bacteria, incubation was performed at 44.5°C for 24 hours. Colonies of *E. coli* appeared violet to pink, while other fecal coliforms colonies stained blue. Fecal streptococci appeared as black stains after 24 hours of incubation at 37°C.

Stool sampling and analysis

Stool samples were collected on three consecutive days to assess intestinal protozoa infection. Stool samples were subjected to the Kato-Katz technique which consists in single thick smears, using standard 41.7 mg template and a formalin-ether concentration technique (FECT) for the diagnosis of intestinal protozoa (Katz *et al.,* 1972; Utzinger *et al.,* 2010). Children were considered as positive for a particular infection if at least one of the diagnostic methods revealed a positive result.

Statistical analysis

Statistical analyses were done using IBM SPSS (version 2.0).Prevalence of intestinal parasitic infections and drinking water characteristics were compared according to sex, age group and site using univariate mixed logistic regression. Differences and associations were considered statistically significant if *P-values* were below 0.05 and as indicating a trend if *P-values* were between 0.05 and 0.1.

Results and Discussion

Characteristics of households in Dassa and Nebia

Table 1 shows the number of children aged 06-59 months in households in Dassa and Nebia.

In Dassa, the households had between 1 to 4 children aged 6-59 months. Around 29% had 01 child under 5 years, 50% had 02 children and 20% of households had 03children. There were 4 children in a household in this site. In Nébia, 50% of house holds had 1 child, 33% had 2 children and 8.3% had respectively 4 and 5 children under 5 years (Table 1). Considering all households, the average number of children aged 06-59 monthswere2.5195.

Microbiological quality drinking water

Microbiological quality of water from sources

In each village, there were 7 wells and 1 borehole to supply people in water. In Dassa, 95.8% of household were supplied from boreholes and 4.2% from wells. Unlike Nebia, 91.7% of household were supplied from wells and 8.3% from boreholes. The microbiological analysis showed that boreholes water (12.5%) was free from fecal bacteria. However, wells water (87.5%) were contaminated with one fecal bacteria group at least.In both sites, 72% of wells water were contaminated with *E. coli*, 96.3% with fecal coliforms and 96% with fecal streptococci. Figures 1 and 2 summarize the quality of water from sources in Dassa and Nebia.

In Dassa, 25% of wells water was contaminated with one fecal bacteria group and 63% with both *E. coli*, fecal coliforms and streptococci. In wells water from Nebia, 25% of samples were contaminated with two fecal bacteria group and 63% with both *E. coli*, fecal coliforms and streptococci (Figures 1 and 2). The contamination of wells water is probably cause by a lack of sanitation around water source and the droppings use for soil fertilization amongst others causes (Lalanne, 2012).

Microbiological quality of water from households

In household, 91.7% of drinking water was contaminated in Dassa versus 100% in Nebia. Among contaminated water, 50% were contaminated with *E. coli*, and 96% with both fecal coliforms and streptococci. Specifically, among household that supply from boreholes in Dassa, only 8% of their drinking water were potable, 17% were contaminated with one fecal bacteria group, 33% with two fecal bacteria group and 42% with both *E. coli*, fecal coliforms and streptococci (Figure 3). All drinking water of those supply from wells were still contaminated in household. In Nebia, all water from household were contaminated. 42% of them were contaminated with two fecal bacteria group and 58% with both *E. coli*, fecal coliforms and streptococci (Figure 4). Figure 3 shows the average of fecal coliforms, *E. coli* and fecal streptococci in household drinking water in Dassa and Nebia. Among contaminated water in Dassa, we isolated on average 1267 fecal coliforms, 20 *E. coli* and 479 fecal streptococci. For household drinking water from Nebia, there were on average 3888 fecal coliforms, 105 *E. coli* and 4589 fecal streptococci in 100 ml (Figure 3).

Overall, it appears that the contamination of drinking water increased in household compared to sources. In fact, fecal bacteria content is higher in 80% of household drinking water than source. This situation could be explain by the lack of hygiene in water use and the poor storage conditions before consumption. Indeed, drinking water was storage in pot or canary which is not covered (Lalanne, 2012). With animals roaming freely in household, drinking water is easily contaminated by faeces. Figure 4 summarize household drinking water quality according to the degree of contamination in both site and source.

In both site, only 4% of household drinking water from boreholes was still potable. For water from boreholes 11% was contaminated with a one fecal bacteria group, 41% with two groups and around 44% with both fecal coliforms, *E. coli* and fecal *Streptococci* in household (Figure 4). These contaminations are probably due to the poor conditions of transportation and conservation from borehole to house. In fact, some women domestic activities (childcare, cooking, gardening, breeding, etc.) are sources of hand contamination that can contaminate again water during its transportation, while filling storage containers or using stored water (Pickering *et al.,* 2011; Devamani *et al.*, 2014). In households, the lack of sanitary infrastructure, latrines and hand washing devices in particular can also contribute to contaminated drinking water (Diagbouga *et al.*, 2018).

In households that supplied from wells, all drinking water was still contaminated. Results shows that 34% of these water were contaminated with two fecal bacteria group and 66% with both fecal coliforms, *E. coli* and fecal streptococci (Figure 4).

This persistence of drinking water contamination is cause by the lack of water treatment in households. Moreover, the long storage time could be a contamination factor of wells water because of organic matter that can stimulate bacterial growth (Lalanne, 2012).

Table.1 Number of children aged from 06-59 months in household in Dassa and Nebia

Site	Number of children in household				
	1	2	3	4	5
Dassa	29.2%	45.8%	20.8%	4.2%	0.0%
Nébia	50.0%	33.3%	0.0%	8.3%	8.3%

Table.2 Intestinal parasitic infections among market garden children in Dassa and Nebia

	Infected children (%)	Uninfected children (%)	*p value*
Sex			
Male	57.78	42.22	
Female	50.00	50.0	*0.4993*
Age group			
[06-23 months]	38.46	61.54	
[24-59 months]	62.75	37.25	*0.0429*
Site			
Dassa	60.38	39.62	
Nébia	41.67	58.33	*0.1266*

Table.3 prevalence of intestinal parasitic infections stratified by water source and water treatment in household

	Infected children%	Uninfected children%	*p value*
Water source			
Drilling	44.44	55.56	
Well	62.5	37.50	***0**.0931*
Water treatment			
Treated water	41.67	58.33	
Untreated water	60.78	39.22	*0.1208*

Fig.1 Microbiological quality of water from household in Dassa

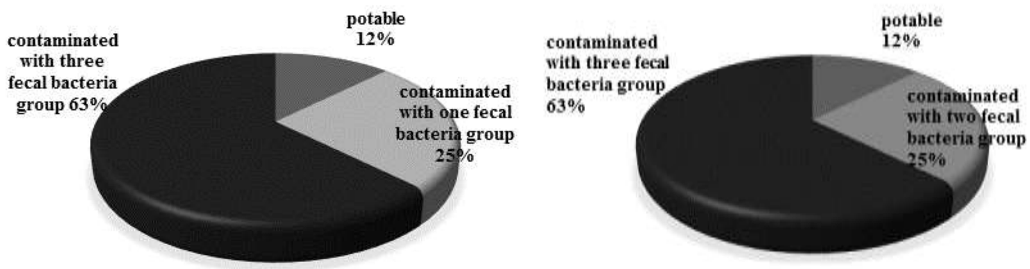


Fig.2 Household drinking water quality in Dassa

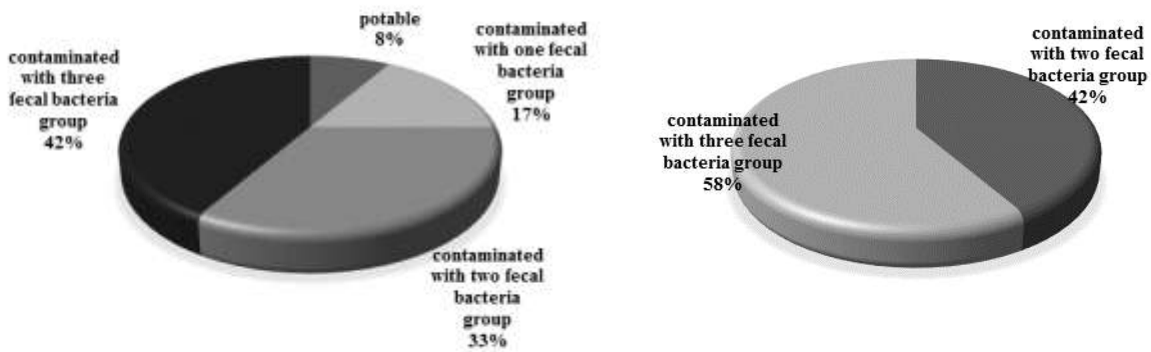


Fig.3 Mean of fecal germs in 100 ml of drinking water from households in Dassa and Nebia

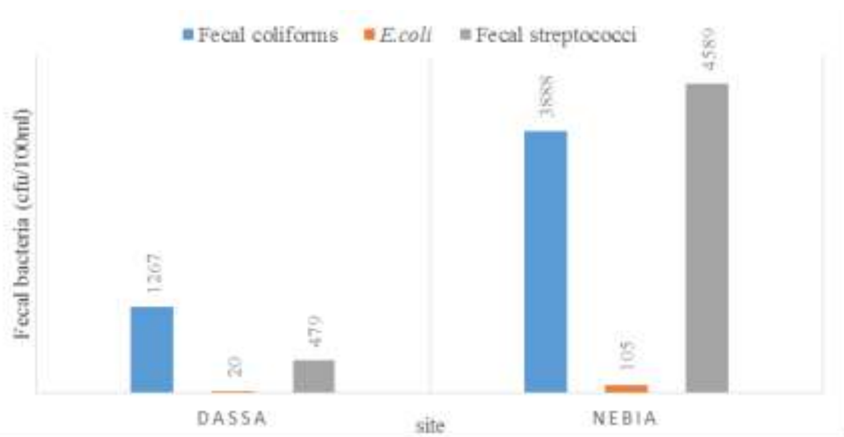
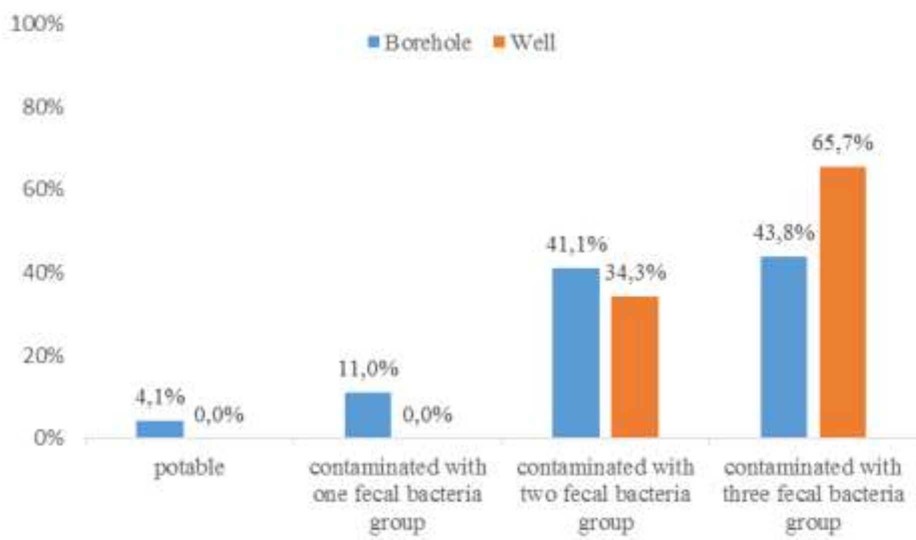


Fig.4 Household drinking water quality according to the degree of contamination



Regarding to these causes of the consumption of non-potable water, it is necessary to implement the intervention concerning WASH in these areas.

Intestinal parasitosis in market garden children in Dassa and Nébia

Overall, the results of stools analysis showed around 66% of market garden children were infected with one parasite group at least. Thus, in both sites, 51.95% of children were infected with *Giardia lamblia*, 03.9% with *Entamoeba coli* and 10.39% with whipworm. The prevalence of intestinal parasitic infections stratified by sex, age group and site are summarized in table 2.

The prevalence of intestinal parasitic infections was higher in Nebia compared to Dassa (Table 2), but this difference are not significant. Among infected children, 57.78% were boys versus 50% of girls.

The children between 24-59 months were more infected (62.38%) compared to those of 06-23 months (38.46%). This significant difference ($p = 0.0429$) could be related to the great mobility of older children who are more exposed to environmental contamination.

Microbiological quality of drinking water and intestinal parasitic infections

In both site, 62.33% of children was from households that supply from boreholes and 37.67% from whose using wells. The statistical analysis showed 44.44% of children who consumed water from boreholes were infected versus 62.5% of those who consumed wells water. Table 3 presents the prevalence of intestinal parasitic infections stratified by WASH conditions in household.

It appeared that children drinking well water were more infected (62.5%) compared to those drinking boreholes water (44.44%) in both site. This difference was significant (Table 3). Moreover, there were few infected children in household which applied water treatment (41.67%) compared to those which drunk without any treatment (60.78%). These results showed that there is a link between drinking water quality and intestinal parasitic infections in these two areas that could explain the persistence of malnutrition in these children. In fact, studies showed 88% of these cases of diarrhea are attributable to the consumption of unsafe water and inadequate sanitation and hygiene conditions (Montresor *et al.,* 2002).

Overall, we notified that there wasfew drinking water infrastructure in both site. Moreover, the only borehole was far from market garden. For this reason, market gardener consumed contaminated wells water located in vegetables garden. Thus, it is necessary to improve the access to safe drinking water through the realization of water infrastructure near to market garden. That will permitted to market gardener to access to safe water. In addition, WASH interventions have to be implemented to guarantee drinking water quality from these boreholes. The improving of WASH conditions will reduce intestinal parasitic infections in children which can favors a better nutrition. Drinking water quality of market gardeners in the western central region is worrying. The high levels of fecal bacteria in their drinking water increase the risk of diarrheal diseases and malnutrition in children under 5 years. A link between drinking water quality and intestinal parasitic infections was showed. In view of these results, interventions have to be implemented to improve drinking water quality, hygiene and sanitation in household and market garden.

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