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Research Article

Hygiene and Sanitation Practices and the Risk of Morbidity among Children 6–23 Months of Age in Kumbungu District, Ghana

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Background. Poor hygiene and sanitation (WASH) practices are characterised by the manifestation of disease and infections, notably diarrhoea and respiratory tract infections (RTIs) among children. This study aimed to assess the influence of WASH practices on the occurrence of diarrhoea and RTIs among children 6–23 months of age. *Methods*. An analytical cross-sectional study design was conducted in June 2017. Systematic random sampling technique was used to select 300 mothers/caregivers with children aged 6–23 months from 9 communities in the Kumbungu District. We assessed the WASH practices, socio-demographic characteristics of the households and the occurrence of diarrhoea and RTIs among the children with a semi-structured questionnaire. The Hygiene Improvement Framework observational guide was adapted for household sanitation. Backward binary multiple logistic regression was used to determine the WASH practices that significantly predicted morbidity. *Results*. About 53% and 55.3% of the children reportedly experienced diarrhoea and RTIs, respectively, two weeks before the survey. Caregiver handwashing with soap after defecation [OR = 0.32 (95% C.I: 0.19, 0.52)] and before feeding [OR = 0.50 (95% C.I: 0.30, 0.84)] as well as washing the child's hands with or without soap before feeding [OR = 0.21 (95% C.I: 0.04, 1.01)] were associated with lower odds of diarrhoea morbidity. The main determinants of RTI morbidity included caregiver handwashing with or without soap after defecation [OR = 0.29 (95% C.I: 0.10, 0.81)] and washing of the child's hands with soap before feeding [OR = 0.60 (95% C.I: 0.37, 0.99)] However, we found no association between household sanitation and diarrhoea as well as RTI among the children. *Conclusion*. About a half each of the children had diarrhoea and RTI 2 weeks before the survey. The results emphasise the need for urgent targeting of handwashing and waste disposal programmes to avert the high burden of diarrhoea and RTIs among children.

1. Introduction

Globally, diseases such as diarrhoea and respiratory tract infections (RTIs) have been identified as major threats to child survival. Diarrhoea, defined as the passage of three or more loose/liquid stools per day, is one of the leading causes of morbidity and mortality in children under five years [1–3]. According to the WHO [3], an estimated 1.7 billion cases of diarrhoea disease occur annually worldwide, with approximately 525 000 children dying from the disease. Diarrhoea is currently the second most important cause of child morbidity and mortality after malaria.

Similarly, acute respiratory tract infections are a significant cause of death among children under five years of age [4]. Upper Respiratory Tract Infections (URTIs) refers to infections in the respiratory tract down to the larynx and include common cold, pharyngitis, tonsillitis, otitis media and external, sinusitis, stomatitis etc. [5]. Lower Respiratory Tract Infections (LRTIs) refer to infections below the larynx and include pneumonia, bronchitis, bronchiolitis, empyema, lung abscess etc. [5]. These conditions are responsible for between 1.9 million and 2.2 million childhood deaths [4]. According to Williams et al. [4], it is further documented that 42% of RTIs associated deaths occur in Africa [4]. In most cases, RTIs can also be as a result of diarrhoea over an extended period [6].

Underlying reasons for the spread of these diseases are found in poor hygiene and sanitation, limited access to safe drinking water as well as inadequate education of health care providers and recipients [7]. According to the UNICEF conceptual framework of malnutrition, poor hygiene and sanitation are one of the underlying determinants of malnutrition among children with the resultant effect of growth retardation, poor cognitive development, low productivity and death. Mothers and children in low socioeconomic areas with limited hygiene and sanitation facilities tend to have poor hygiene practices such as using dirty cooking or eating utensils for their children.

While poor hygiene practices, especially in food preparation and feeding practices, may increase the risk of having diarrhoea and other infections; up to 70% of diarrhoea episodes are caused by water and food contaminated with pathogens [6]. Sanitation includes the provision and use of facilities and services that safely dispose of human urine and faeces, thereby preventing contamination of the environment while hygiene relates to the practice of handwashing with soap after defecation and disposal of child faeces, prior to preparing and handling food, before eating, and in healthcare facilities, before and after examining patients and conducting medical procedures [8].

Ghana achieved the Millennium Development Goal target of 78% of the population using improved drinking water in 2011 [9]. Furthermore, many hygiene and sanitation improvement programmes have been implemented in northern Ghana, yet diarrhoea and RTIs are still prevalent. According to the 2014 Ghana Demographic Health Survey, about 16% of children under-five in the Northern Region had diarrhoea, and approximately 3.5% had RTI [10]. Improving the level of hygiene practices may be highly effective in reducing diarrhoea [11] and RTI [12] morbidity among children. Nevertheless, the effectiveness of water, hygiene and sanitation (WASH) programmes may be context-specific as social and cultural factors may also have a reinforcing or restraining influence.

A few studies have examined the influence of WASH practices on morbidity among children in Ghana. However, these studies were limited in scope; focussing mostly on diarrhoea [13, 14] and a few determinants. Moreover, data on handwashing is lacking. A more recent study assessed how household wealth status, coupled with the type of place of residence, correlates with the prevalence of childhood diarrhoea in Ghana using nationally representative data [15]. To the best of our knowledge, the only study that examined the effect of WASH practices on diarrhoea among children in Northern Ghana was limited to the Tamale Metropolitan area [16]. The objective of the present study was to assess the influence of hygiene and sanitation practices on the occurrence of diarrhoea and RTIs among children 6–23 months of age in the Kumbungu District to provide evidence for policy formulation and programme planning.

2. Materials and Methods

Analytical cross-sectional study design was employed and involved 300 mothers/caregivers with children aged 6–23 months selected from 9 communities (Zoolan Yili, Cheyohi Number 1, 2 and 3, Cheshegu, Kpalga, Garizegu, Kpachi and Nyoring) in the Kumbungu District. The District is made up of 5 area councils namely, Gupanerigu, Gbullung, Zangbalung, Dalun and Voggu area councils. The Gbullung area council was randomly chosen and the 9 communities selected from this area council based on population size. Participants were selected from the communities through systematic random sampling. Where a household did not meet the inclusion criteria, the next household was selected. In a house with several households with eligible children, only one child aged 6–23 months was randomly selected from the different households through a simple lottery. None of the respondents selected declined to participate in the study. Eligibility included permanent residence in the survey community, having a child aged 6–23 months and willingness of the mother/caregiver to participate.

The sample size was determined using the formula:

$$N = \frac{z^2 p(1-p)}{M.E^2}, \quad (1)$$

[17] where: N is the sample size; z is the abscissa of the normal curve that cut-off an area at the tail (1.96); $M.E$ is the desired level of precision (5% = 0.05); p is the estimated proportion of an attribute (Diarrhoea/RTIs) that is present in the study population. The prevalence of diarrhoea and RTIs are 16% and 5% respectively [10]. The prevalence of diarrhoea (16%) was used in computing the sample size as it is higher than that of RTIs (5%). A sample size of 220 was obtained. Considering a nonresponse rate and or incomplete data of 20%, the sample size was rounded to 300 child-mother pairs.

A pre-tested semi-structured questionnaire was used to collect data on respondents' socio-demographic characteristics (mother/caregiver's sex, age, occupation, educational level, religion, number of children and ethnicity and child's sex and age) and prevalence of diarrhoea and RTIs. A structured questionnaire was used to document the mother's and child's hand washing, food preparation, cleanliness of utensils, water source and safe drinking water, child's bottle-feeding hygiene as well as housing and environmental condition. Schmidt et al. [18] recommended using a recall period of 7–14 days in diarrhoea morbidity studies for improving the precision and power; thus a 14-day (2 weeks) recall period was used in capturing the prevalence of diarrhoea and RTI among the children. Diarrhoea was defined as passage of any watery/loose stool at least 3 times in a day [3] while RTI was defined as any flue/cough, wheezing and/or chest in-drawing and difficulty in breathing [5]. The period prevalence of diarrhoea and RTI was estimated as the percentage of children who had diarrhoea or RTI 14 days prior to the survey. A caregiver was defined in the present study as a person who provides direct care for a child.

An adopted observational guide from the Hygiene Improvement Framework [19] was also employed for the assessment of household sanitation. The observational guide is an 18-item questionnaire on the physical and environmental hygiene and sanitation conditions as observed in the household. Adherence to each item in the questionnaire was scored 1 else 0; resulting in a maximum attainable score of 18. Households were subsequently ranked into terciles of hygiene and sanitation score as poor (≤9), good (10–13) and very good (>13).

Lastly, the questionnaire included information on the dietary diversity of the children using a single qualitative 24-hour recall (24 hR). In the 24 hR, mothers/caregivers were asked to mention all the foods and beverages the child ate 24-hours preceding (from wake-up to wake-up) the survey from home and outside of the home. She was next probed for likely forgotten foods and then asked to give a detailed description of foods and beverages consumed, including ingredients for mixed dishes. The 24 hR was used to complete the WHO (2010) 7 food group score for children younger than 24 months of aged namely: (1) staple foods, (2) dairy products, (3) animal source foods, (4) vitamin-A rich fruits and vegetables, (5) other fruits and vegetables, (6) legumes and nuts and (7) eggs. A score of 1 was assigned when a child consumed at least one food item from a particular food group else 0. The individual dietary diversity score was then determined by summing the scores of all the food groups consumed by the child. The score ranged from a minimum of 0 to a maximum of 7. Since the recall was qualitative, the scoring did not consider a minimum intake (in grammes) for the food groups. The minimum dietary diversity score (MDDS) [20] for children younger than 24 months of age was subsequently defined as DDS ≥ 4.

2.1. Statistical Analysis. Data entry and analysis was done using SAS 9.3 (SAS Institute Inc., Cary NC.). Bivariate binary logistic regression analysis was done using the PROC LOGISTIC PROCEDURE [21]. Variables with *P*-values ≤0.25 from the bivariate analyses were included in backward stepwise multiple logistic regression models to determine the prevalence odds ratios (POR) of the significant determinants of diarrhoea, RTIs and co-morbidity in the sample. We entered interaction terms to explore potential nonlinearities, but none was significant. $P < 0.05$ was considered significant at two-tailed tests.

2.2. Ethical Considerations. Approval to conduct the study was given by the Joint Ethical Review Committee of the School of Allied Health Sciences and the School of Medicine and Health Sciences, University for Development Studies (Protocol Number 11-2017). The rationale of the study was explained to the mothers/caregivers of the children and written informed consent obtained before the interview. Concerning participants who were less than 18 years of age, written informed consent was obtained from their parents. Participants were also assured of the confidentiality of the information provided. Permission was also obtained from the opinion leaders of each survey community.

3. Results and Discussion

3.1. Results

3.1.1. Socio-Demographic Characteristics of the Children and Their Mothers/Caregivers. The study revealed that about 55.3% of the children were females and most (70%) of them were aged 12–24 months and were generally Dogombas in ethnic origin; their households were mostly adherents of the Islamic religion. About a half (49.3) of the mothers were aged 26–35 years; about 36% were aged under 25 years and only 14.8% older than 36 years of age. Only a fifth of the mothers was literate and were predominantly farmers (56.3%) with the rest petty traders (22.3%) and unemployed (21.3%). Most (86.6%) of the mothers had given birth to more than 5 children. Table 1 shows the socio-demographic characteristics of the children and their mothers.

Table 1: Socio-demographic characteristics of the children and their mothers.

Variable	Frequency (%)
Sex of child	
Female	166 (55.3)
Age of child	
<12 months	90 (30.0)
12–24 months	210 (70.0)
Ethnicity	
Dagomba	298 (99.3)
Other	2 (0.7)
Religion	
Islam	287 (95.6)
Christianity	11 (3.7)
Other	2 (0.7)
Age of mother	
15–25 years	107 (35.9)
26–35 years	147 (49.3)
≥36 years	44 (14.8)
Educational status of mother	
Nonliterate	242 (80.7)
Literate	58 (19.3)
Occupation of mother	
Unemployed	64 (21.3)
Farmer	169 (56.3)
Petty trader	67 (22.3)
Parity of mother	
≤5 children	40 (13.3)
>5 children	260 (86.7)

3.1.2. Household Hygiene and Sanitation Conditions. Table 2 shows the hygiene and sanitation conditions in the households of the children. Rubbish was generally thrown into a dug pit (91.3%) close to the house, and the pits were regularly burned. The rubbish sites were usually about 50 m (89.7%) from the household. Most (85.9%) of the households swept their rooms or compounds at least twice daily but less than a half (42%) had soak way drainage systems in their households. Generally, less than a fifth of the households used a latrine, public toilet or water closet (WC) with most (83.7%) of them practising open defecation. Similarly, the young children in the household commonly defecated in the compound (40.7%) or surroundings bushes (12%) with about 47.3% of them defecating in a chamber pot. When using the observation guide to rate household sanitation, only 23.3% of the households scored very good with about 39% and 37.7% scoring good and poor respectively.

Table 2: Household hygiene and sanitation conditions.

Variable	Frequency (%)
Garbage disposal	
Dug pit/burn	274 (91.3)
Otherwise	26 (8.7)
How far garbage disposal is from the house	
0–50 m from house	269 (89.7)
50–100 m from house	31 (10.3)
Sewage channel	
Soak away	126 (42.0)
Otherwise	174 (58.0)
Frequency of cleaning room/compound	
At least once daily	42 (14.1)
At least twice daily	256 (85.9)
Where child defecates	
Chamber pot	142 (47.3)
In the compound	122 (40.7)
Other (surrounding bush)	36 (12)
Household toilet facility	
Public toilet, latrine or WC	49 (16.3)
None (opened defecation)	251 (83.7)
Household sanitation condition based on observational guide	
Poor	113 (37.7)
Good	117 (39)
Very good	70 (23.3)

Table 3: Water and food hygiene practices in the households of the children.

Variable	Frequency (%)
Water safety and hygiene	
Household water source	
Pipe/borehole	287 (95.7)
Other	13 (4.3)
How water is treated before use	
Treated (filtration, boiling or chlorine tablets)	102 (34.00)
No treatment	198 (66.0)
How frequently water storage container is cleaned	
Anytime storage container is being filled	275 (94.5)
Otherwise	16 (5.5)
Food hygiene practices	
Utensils are washed with soap before cooking	
Yes	275 (91.7)
No	25 (8.3)
Treatment of fruits and vegetables before eating/cooking	
Water and salt (saline)	35 (11.7)
Otherwise	265 (88.3)
Leftover food is covered	
Yes	285 (95.3)
No	14 (4.7)
Leftover food is heated before consumption	
Yes	296 (98.7)
No	4 (1.3)

3.1.3. Water and Food Hygiene Practices in the Households of the Children. Nearly all (95.7%) of the households had access to improved water supply either from the piped water or borehole, but a few others (4.3%) had their household water supply from wells, rivers or dams. The majority (94.5%) of mothers reported cleaning their water containers any time they were being filled. Similarly, utensils were commonly washed with soap before cooking, and leftover foods were mostly covered. Furthermore, leftover food was typically heated before consumption. Lastly, only a few (11.7%) of the mothers reported washing fruits and or vegetables in saline before consumption or cooking (Table 3).

3.1.4. Child Feeding Practices and Hygiene among the Mothers/Caregivers of the Children. The mothers (84.7%) were responsible for feeding the children. Furthermore, most (92%) of the mothers reported washing their hands after defecating, but only a little over a half (52.7%) reported washing their hands with soap after defecating. Additionally, almost all (96.7%) the mothers reported washing their hands before feeding; but 65% of them reported washing with soap. Similarly, most (95.7%) of the children had their hands washed before feeding, but about 62.3% of them had their hands washed with soap before feeding. About four-fifths of the children were still breastfeeding and about a quarter were bottle-fed. The mean dietary diversity score of the children was 2.0 ± 1.8 with less than a third of the children meeting the minimum dietary diversity score ($DDS \geq 4$) (Table 4).

3.1.5. Prevalence of Diarrhoea and RTI among the Children. Figure 1 shows that about half of the children had diarrhoea and RTI respectively, 2 weeks prior to the survey. Furthermore, about a third of the children had both diarrhoea and RTI (simultaneous occurrence) while about 78% of them had either diarrhoea or RTI (at least 1 of the conditions) 2 weeks prior to the survey. The sex of the child did not influence the prevalence of morbidity.

3.1.6. Univariate Determinants of Diarrhoea and RTI Morbidity among the Children. Compared to throwing rubbish around the house or on a rubbish dump, using a dug-out pit with regular burning was associated with a 60% lower odds of diarrhoea and RTI co-morbidity [OR = 0.40 (95% C.I: 0.18, 0.90)] (Table 5). Furthermore, the odds of diarrhoea and or RTI among the children were consistently higher for households using open defecation in the bush compared to those who used a latrine or public toilet, but the association was only significant for the presence of either diarrhoea or RTI (Table 5).

The results in Table 5 also showed that caregiver handwashing with soap after defecating was consistently associated with lower odds of diarrhoea [OR = 0.51 (95% C.I: 0.31, 0.83)], co-morbidity of diarrhoea and RTI [OR = 0.38 (95% C.I: 0.23, 0.64)] and the prevalence of either diarrhoea or RTI [OR = 0.40 (95% C.I: 0.22, 0.72)] among the children. Although not statistically significant, a lower odds of diarrhoea and or RTI morbidity was observed for caregiver handwashing with or without soap after defecating. Additionally, among caregivers

Table 4: Child feeding and hygiene practices among the mothers/caregivers of the children.

Variable	Frequency (%)
Person who feeds the child	
Mother	254 (84.7)
Other	46 (15.3)
Caregiver washes hands with or without soap after defecating	
Yes	276 (92)
No	24 (8)
Caregiver washes hands with soap after defecating	
Yes	158 (52.7)
No	142 (47.3)
Caregiver washes hands with or without soap before feeding child	
Yes	290 (96.7)
No	8 (2.7)
Caregiver washes hands with soap before feeding	
Yes	195 (65)
No	105 (35)
Child's hands washed with or without soap before feeding	
Yes	287 (95.7)
No	13 (4.3)
Child's hands are washed with soap before feeding	
Yes	187 (62.3)
No	113 (37.7)
Is child bottle fed?	
Yes	72 (24.0)
No	228 (76.0)
Is child still breastfeeding?	
Yes	244 (81.6)
No	55 (18.4)
Child dietary intake meets minimum dietary diversity (DDS ≥ 4)	
Yes	85 (28.3)
No	215 (71.7)
Dietary diversity score (mean ± SD)	2.0 ± 1.8

who washed their hands with soap before feeding, the odds of diarrhoea was 49% lower among their children compared to caregivers who did not do same [OR = 0.51 (95% C.I: 0.31, 0.83)]. Lastly, compared to children whose hands were not washed before feeding, those whose hands were washed with or without soap had an 81% lower odds of diarrhoea [OR = 0.19 (95% C.I: 0.04, 0.89)] (Table 5).

3.1.7. Multivariate Determinants of Diarrhoea and RTI Morbidity among the Children. In the backward multiple logistic regression (Table 6), the odds of diarrhoea among the children was 68% lower for caregivers who washed their hands with soap after defecating compared to those who did not [OR = 0.32 (95% C.I: 0.19, 0.52)]. Likewise, caregiver handwashing with soap before feeding was significantly associated with a 50% lower odds of diarrhoea among the children [OR = 0.50 (95% C.I: 0.30, 0.84)]. Washing of the child's hand with or without soap also seemed to be relevant in reducing the odds of diarrhoea among the children [OR = 0.21 (95% C.I: 0.04, 1.01)].

Furthermore, the primary determinants of RTI prevalence among the children were caregiver handwashing with or without soap after defecating [OR = 0.29 (95% C.I: 0.10, 0.81)] and washing of the child's hands with soap before feeding [OR = 0.60 (95% C.I: 0.37, 0.99)]. Additionally, compared to open defecation in the surrounding bushes, use of a latrine or public toilet was somewhat associated with a 48% lower odds of RTI among the children [OR = 0.52 (95% C.I: 0.27, 1.02)] (Table 6).

The results also showed that caregiver handwashing with soap after defecating was associated with a 61% lower odds of diarrhoea and RTI co-morbidity [OR = 0.39 (95% C.I: 0.23, 0.67)]. Moreover, the odds of diarrhoea and RTI co-morbidity was 2.68 times higher among children those households dumped rubbish in the surrounding bushes or a rubbish dump site close to the house compared to children whose households use a dugout out pit with regular burning [OR = 2.68 (95% C.I: 1.10, 6.53)]. The caregiver handwashing with soap before feeding also seemed relevant in reducing the odds of diarrhoea among the children.

When modelling the prevalence of either diarrhoea or RTI, the significant multivariate determinants included: caregiver handwashing with soap before feeding [OR = 0.39 (95% C.I: 0.21, 0.72)], the place where the child defecates (P-trend = 0.03) and treatment of fruit and vegetables before eating/cooking [OR = 0.4.07 (95% C.I: 1.15, 14.18)].

3.2. Discussion. Diarrhoea and RTIs are major causes of morbidity and mortality among infants and young children globally. Hence the present study investigated the influence of WASH practices on the period prevalence of diarrhoea and RTIs among children 6–23 months.

Regarding diarrhoea, the study revealed that about 53% of the children experienced diarrhoea 2 weeks preceding the study and this may be attributable to the consumption of food or water which has been contaminated with human waste through open defecation and improper dumping of rubbish, as a majority of the households practised open defecation and disposed waste in a dumpsite/pit close to the households. Similarly, the odds of diarrhoea was higher when children defecated outside the compound or the surrounding bushes compared to defecating in chamber pot. The frequent open defecation may be related to unavailability and poor access to toilet facilities in the district. This can also be a contributing factor to the spread of diseases as rainwater coupled with poor drainage may carry all faecal matter to water bodies which may be used for household consumption without proper treatment.

A single gram of human faeces can hold up to 10 million viruses, and 1 million bacteria and infant faeces are particular pathogenic [22], hence the need for proper disposal. Diarrhoea results in malnutrition and dehydration, increasing mortality risk while regarding morbidity results in long-term burdens such as impaired growth and cognitive function [23]. As established by the WHO, [24], diarrhoea is mainly caused by the intake of pathogens from faeces improperly disposed or from poor hygiene and sanitation, thus stopping open defecation through the use of toilet facilities, access to safe and clean drinking water as well as good hygiene and sanitation practices

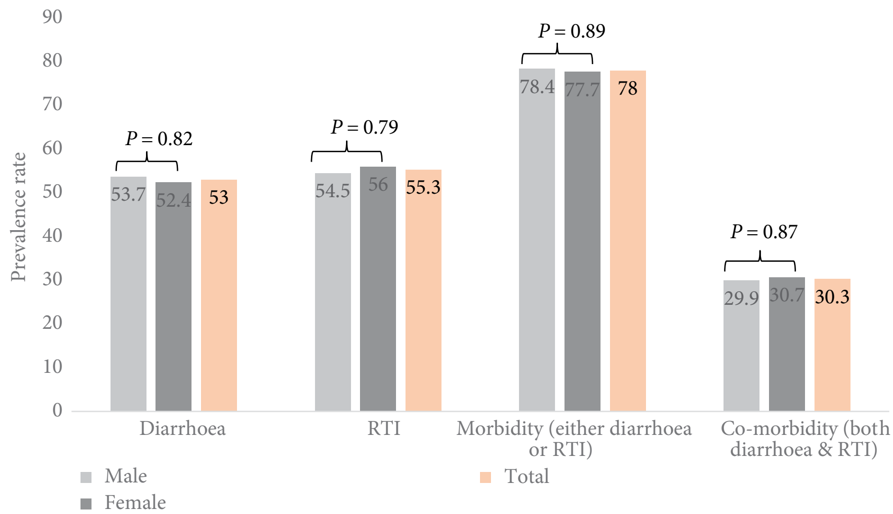

Figure 1: Prevalence of diarrhoea and respiratory tract infections (RTIs) among the 6–23 months old children 2 weeks prior to the survey.

can immensely curtail diarrhoea frequency among young children.

Generally, socio-demographic factors did not appear to have much influence on diarrhoea and RTI prevalence, which may in part be related to the homogeneity of the sample. Nonetheless, the present study emphasises the importance of behavioural factors in diarrhoea causation. It was also revealed in the present study that majority of the mothers (86.7%) had more than 5 children. This finding is in consonance with the finding of a previous study [10] in Northern region of Ghana, where the average number of children per woman was reported to be 6.6. Moreover, majority (70%) of the children were aged 12–24 months in the present study. This finding is also comparable to the findings of other studies [25–27] in Ghana.

Mother/caregiver handwashing with soap and water after defecation was significantly associated with a decreased occurrence of diarrhoea among the studied children. When modelling diarrhoea and RTI co-morbidity as well as the occurrence of either, mother/caregiver handwashing with soap and water after defecation remained a significant determinant. Similarly, several other studies have shown that caregiver's handwashing with soap after defecation is independently linked with a low prevalence of diarrhoea among children [16, 28–30]. Caregiver handwashing with soap before feeding was also significantly associated with decreased occurrence of diarrhoea among the children (Table 6). This finding agrees with that of Curtis & Cairncross [31] who revealed that handwashing with soap before feeding reduces diarrhoea risk. Similarly, Mattioli et al. [32], Danquah et al. [13] and Motarjemi et al. [33] also indicated that handwashing with soap reduces the risk of diarrhoea. Washing of hands with soap before feeding rids off diarrhoea-causing pathogens thereby preventing faecal-oral transmission of these pathogens. Likewise, children who had their hands washed with or without soap before feeding had a lower odds of diarrhoea.

Furthermore, it was revealed in the present study that the prevalence of RTIs was 55.3% 2 weeks preceding the study. As the prevalence of diarrhoea increases, so does the prevalence of RTIs, in that, diarrhoea increases the risk of RTIs in children [24, 34]. Diarrhoea causes micronutrient loss, immune system stress and dehydration, thereby increasing the risk of RTIs and this may partly account for the corresponding rise in RTIs prevalence. Washing of child's hands with soap before feeding was independently associated with decreased RTI risk in the present study which is similar to the findings of studies by Luby et al. [28] and Rabie & Curtis [12]. Hands are known to be a vehicle for bacterial and viral pathogens transmission [35]; hence, proper handwashing with soap before feeding can prevent RTIs in children. Caregiver handwashing with or without soap after defecating was significantly associated with decreased risk of RTIs. Washing hands after defecation may reduce diarrhoea risk resulting in lower risk of RTIs since diarrhoea increases childrens vulnerability to RTI.

We found no association between household sanitation and diarrhoea and RTI morbidity. The lack of association may be partly due to the method used for data collection or the study design. We relied on an observational guide to evaluate the sanitation conditions of households, but it is possible some of the observations at the time of visit may not be the usual pertaining conditions in the household; repeated observations could probably have captured the usual pertaining conditions.

Surprisingly, we found a reverse causation for treatment of fruits or vegetables with saline before consumption or cooking as children from households where mothers/caregivers treated fruits/vegetables with saline before consumption and or cooking were 4 times significantly more likely to have diarrhoea compared to those in households where mothers did not treat fruits and/or vegetables with saline. It was also observed that majority (60%) of mothers/caregivers who treated fruits/vegetables with saline before consumption and or cooking lived in households with poor sanitation based on the observational guide. This could partly explain the high prevalence of diarrhoea among their children as poor household sanitation can result in the contamination of water and food with pathogens [24].

Table 5: Univariate determinants of diarrhoea and RTI morbidity and co-morbidity among the 6–23 months old children.

Variable	Diarrhoea		Respiratory tract infection (RTI)		Both diarrhoea and RTI		Either diarrhoea or RTI	
	Odds ratio (95% C.I)	*P*-value	Odds ratio (95% C.I)	*P*-value	Odds ratio (95% C.I)	*P*-value	Odds ratio (95% C.I)	*P*-value
Demographics								
Sex of child (ref = female)								
Male	1.05 (0.67, 1.66)	0.82	0.94 (0.59, 1.49)	0.79	0.96 (0.59, 1.58)	0.87	1.04 (0.60, 1.80)	0.89
Age of child (ref = 12–24 months)								
<12 months	0.90 (0.55, 1.47)	0.67	1.08 (0.66, 1.78)	0.76	1.34 (0.67, 1.93)	0.64	0.82 (0.46, 1.47)	0.50
12–23 months (ref)	1		1		1		1	
Age of mother		0.60		0.46		0.62		0.76
15–25 years (ref)	1		1		1		1	
26–35 years	1.25 (0.76, 2.06)		0.74 (0.45, 1.22)		0.80 (0.46, 1.37)		1.19 (0.65, 2.17)	
≥36 years	1.34 (0.66, 2.72)		0.74 (0.36, 1.49)		1.06 (0.51, 2.24)		0.92 (0.40, 2.07)	
Parity of mother								
≤5 children (ref)	1		1		1		1	
>5 children	0.91 (0.47, 1.78)	0.79	1.02 (0.52, 1.98)	0.96	0.78 (0.39, 1.58)	0.49	1.21 (0.56, 2.63)	0.62
Occupation of mother		0.46		0.44		0.71		0.14
Unemployed	0.72 (0.36, 1.44)		0.99 (0.49, 1.98)		1.00 (0.48, 2.07)		0.55 (0.22, 1.39)	
Farmer	0.70 (0.39, 1.24)		0.73 (0.41, 1.30)		0.81 (0.44, 1.49)		0.46 (0.21, 1.00)	
Petty trader (ref)	1		1		1		1	
Educational status of mother								
Nonliterate	0.69 (0.39, 1.24)	0.22	0.85 (0.47, 1.51)	0.58	0.79 (0.43, 1.45)	0.44	0.60 (0.28, 1.29)	0.19
Literate (ref)	1		1		1		1	
Household sanitation								
Household sanitation condition based on observational guide		0.56		0.26		0.13		0.71
Poor (ref)	1		1		1		1	
Good	0.75 (0.45, 1.27)		1.23 (0.73, 2.06)		1.09 (0.61, 1.94)		0.81 (0.43, 1.52)	
Very good	0.86 (0.47, 1.56)		1.66 (0.90, 3.06)		1.85 (0.98, 3.48)		0.75 (0.37, 1.55)	
How garbage is disposed								
Dug pit/burn (ref)	0.57 (0.25, 1.32)	0.19	0.76 (0.33, 1.73)	0.51	0.40 (0.18, 0.90)	0.03*	1.07 (0.41, 2.78)	0.89
Otherwise[1]	1		1		1		1	
How far garbage disposal is from the house								
50–100 m from house (ref)	1		1		1		1	
0–50 m from house	1.23 (0.58, 2.59)	0.59	0.65 (0.30, 1.42)	0.28	0.66 (0.31, 1.42)	0.29	1.27 (0.54, 2.98)	0.59
Sewage channel								
Soak away	1		1		1		1	
Otherwise[2]	1.23 (0.78, 1.95)	0.38	1.23 (0.78, 1.95)	0.38	1.32 (0.80, 2.18)	0.28	1.30 (0.75, 2.25)	0.36
Number of times compound is cleaned								
At least once daily	1.72 (0.87, 3.38)	0.12	1.07 (0.55, 2.07)	0.84	1.16 (0.58, 2.33)	0.67	2.27 (0.85, 6.02)	0.10
At least twice daily (ref)	1		1		1		1	
Toilet facility in household								
Latrine/pubic toilet or WC (ref)	1		1		1		1	
None (open defecation)	1.49 (0.81, 2.76)	0.20	1.64 (0.89, 3.05)	0.11	1.61 (0.78, 3.32)	0.19	1.97 (1.04, 3.86))	0.049*
Where child shits		0.95		0.26		0.99		0.066
Chamber pot (ref)	1		1		1		1	
Outside the compound	1.08 (0.67, 1.76)		1.31 (0.80, 2.13)		1.00 (0.59, 1.70)		1.63 (0.91, 2.92)	
Other[3]	1.03 (0.49, 2.14)		1.94 (0.90, 4.19)		1.03 (0.46, 2.24)		3.03 (1.01, 9.13)	

Table 5: Continued.

Variable	Diarrhoea		Respiratory tract infection (RTI)		Both diarrhoea and RTI		Either diarrhoea or RTI	
	Odds ratio (95% C.I)	*P*-value	Odds ratio (95% C.I)	*P*-value	Odds ratio (95% C.I)	*P*-value	Odds ratio (95% C.I)	*P*-value
Water and food hygiene practices								
Washing of utensils with soap before cooking								
Yes (ref)	1		1		1		1	
No	0.96 (0.42, 2.17)	0.92	0.72 (0.32, 1.64)	0.44	0.88 (0.36, 2.20)	0.79	0.70 (0.28, 1.76)	0.45
Frequency of cleaning water container before use								
Any time container is being filled	1		1		1		1	
Otherwise	2.09 (0.71, 6.18)	0.18	0.77 (0.28, 2.12)	0.62	1.05 (0.35, 3.12)	0.93	2.04 (0.45, 9.21)	0.36
Frequently used water source								
Pipe/borehole (ref)	1		1		1		1	
Other[4]	1.04 (0.34, 3.16)	0.95	0.94 (0.31, 2.86)	0.91	0.68 (0.18, 2.53)	0.56	1.58 (0.34, 7.31)	0.56
Treatment of fruits and vegetables								
Washed with saline	1.58 (0.76, 3.27)	0.22	1.26 (0.61, 2.58)	0.53	1.25 (0.59, 2.63)	0.56	2.36 (0.80, 6.96)	0.12
Otherwise (ref)[5]	1		1		1		1	
Leftover food is covered								
Yes (ref)	1		1		1		1	
No	1.20 (0.41, 3.55)	0.74	1.49 (0.49, 4.55)	0.49	1.80 (0.60, 5.33)	0.29	1.04 (0.28, 3.84)	0.95
Child feeding practices								
Caregiver washes hands with or without soap after defecation								
Yes	0.79 (0.34, 1.84)	0.59	0.39 (0.15, 1.00)	0.05	0.48 (0.21, 1.12)	0.09	0.48 (0.14, 1.67)	0.25
No (ref)	1		1		1		1	
Caregiver washes hands with soap after defecation								
Yes	0.28 (0.18, 0.46)	<.0001*	0.83 (0.53, 1.31)	0.43	0.38 (0.23, 0.64)	0.0002*	0.40 (0.22, 0.72)	0.002*
No (ref)	1		1		1		1	
Caregiver washes hand with soap before feeding								
Yes	0.51 (0.31, 0.83)	0.006*	1.01 (0.62, 1.62)	0.98	0.62 (0.37, 1.02)	0.06	0.70 (0.38, 1.26)	0.23
No (ref)	1		1		1		1	
Child's hands washed with or without soap before feeding								
Yes	0.19 (0.04, 0.89)	0.03*	1.07 (0.35, 3.25)	0.91	0.49 (0.16, 1.50)	0.21	0.70 (0.38, 1.26)	0.23
No (ref)	1		1		1		1	
Child's hands washed with soap before feeding								
Yes	0.89 (0.56, 1.42)	0.62	0.65 (0.40, 1.04)	0.07	0.64 (0.39, 1.06)	0.08	0.79 (0.44, 1.40)	0.41
No (ref)	1		1		1		1	
Child is bottle fed								
Yes	0.71 (0.39, 1.29)	0.26	0.70 (0.41, 1.19)	0.19	0.71 (0.39, 1.29)	0.26	0.72 (0.39, 1.34)	0.30
No (ref)	1		1		1		1	
Person who feeds the child								
Mother (ref)	1		1		1		1	
Other	0.96 (0.51, 1.80)	0.90	1.06 (0.56, 1.99)	0.86	0.89 (0.44, 1.78)	0.74	1.19 (0.54, 2.61)	0.67
DDS	0.95 (0.84, 1.08)	0.43	0.94 (0.83, 1.07)	0.36	0.95 (0.83, 1.09)	0.46	0.91 (0.78, 1.06)	0.22
Breastfeeding status of child								
Yes	0.70 (0.39, 1.27)	0.24	0.86 (0.48, 1.56)	0.62	0.78 (0.42, 1.45)	0.43	0.64 (0.30, 1.39)	0.26
No (ref)	1		1		1		1	

Values are odds ratios and 95% confidence interval; [1]inlcudes rubbish dump site and surrounding bush; [2]gutter and no drainage; [3]surrounding bush; [4]includes well, river and dam; [5]washing with only water; *statistically significant at 5% level of significance.

Our study was conducted in the rainy season (June) which was assumed to be the peak of diarrhoea prevalence as described in a previous study [36]. In Ghana, the highest peak diarrhoea occurred in the rainy season from May to August [37]. Hence, performing the study in a rainy season may lead to an overestimation of diarrhoea prevalence because there is a strong link between diarrhoeal morbidity and seasonality [38]; this may partially explain our results. However, some studies in developing context also observed high diarrhoea prevalence in dry seasons [39]. Although the prevalence of diarrhoea in the

Table 6: Backward multivariate binary logistic regression of the determinants of diarrhoea and RTI morbidity among the 6–23 months children.

Variable	Diarrhoea		Respiratory tract infection (RTI)		Both diarrhoea and RTI		Either diarrhoea or RTI	
	Odds ratio (95% C.I)	*P*-value	Odds ratio (95% C.I)	*P*-value	Odds ratio (95% C.I)	*P*-value	Odds ratio (95% C.I)	*P*-value
Caregiver washes hands with or without soap after defecating (ref = No)								
Yes			0.29 (0.10, 0.81)	0.02*	0.43 (0.17, 1.05)	0.06		
Caregiver washes hands with soap after defecating (ref = No)								
Yes	0.32 (0.19, 0.52)	<.0001*			0.39 (0.23, 0.67)	0.0006*	0.39 (0.21, 0.72)	0.004*
Caregiver washes hands with soap before feeding (ref = No)								
Yes	0.50 (0.30, 0.84)	0.009*			0.61 (0.35, 1.04)	0.07		
Child's hands washed with or without soap before feeding (ref = No)								
Yes	0.21 (0.04, 1.01)	0.052*						
Child's hands are washed with soap before feeding (ref = No)								
Yes			0.60 (0.37, 0.99)	0.047*				
Household toilet facility								
Public toilet, latrine or WC			0.52 (0.27, 1.02)	0.058			0.50 (0.24,1.07)	0.07
Otherwise (surrounding bush)			1				1	
How garbage is disposed								
Dug pit/burn					1		1	
Otherwise[1]					2.68 (1.10, 6.53)	0.03*		
Where child defecates								0.03*
Chamber pot							1	
Outside the compound							1.78 (0.93, 3.39)	
Other[2]							4.07 (1.15, 14.38)	
Treatment of fruits and vegetables								
Water and salt (saline)							4.07 (1.15, 14.18)	0.03*
Otherwise[3]							1	
Model fit statistics								
Log likelihood ratio	35.61	<.0001	12.84	0.005*	25.54	<.0001	24.40	0.0002
Wald test	30.42	<.0001	12.19	0.007*	25.52	<.0001	23.69	0.0007
Nagelkerke's R^2		0.16	0.06		0.12		0.13	

Values are odds ratios and 95% confidence interval; ref = reference group; [1]inlcudes rubbish dump site and surrounding bush; [2]inside compound, surrounding bush; [3]includes washing with only water; *statistically significant at 5% level of significance.

present study was higher compared to estimates (16%) by the GDHS, the prevalence was even lower compared to estimates by Casals et al. [39] in rural Tanzania (71%) but similar to estimates (6–56%) by Kiulia et al. [40] in Kenya. Osumanu [16] also found a similar prevalence rate (57.5%) of diarrhoea among under-five years children from indigenous residential areas in the Tamale Metropolis of Ghana. Most recently, in the Volta Region of Ghana, diarrhoea prevalence rate of 44.7–59.2% was reported for intervention and control groups in a randomised trial [41]. It is worth noting that our sample was younger than the GDHS sample and younger children are more vulnerable to infections and poor health, which may also be related to poor care and dietary inadequacies and may also partly explain the high diarrhoea prevalence.

Early childhood diarrhoea is independently associated with substantial linear growth retardation that continues even beyond age 6 years and targeted interventions for controlling it may have profound and lasting growth benefits for children [23]. According to Rah et al. [32], improved WASH practices are associated with reduced prevalence of stunting in rural settings. Although not the focus of the present study, our findings may somewhat explain why the northern Region is worst-off in stunting prevalence (33%) among children under-five in Ghana [10]. Unpublished data from the study area among children under five also showed that more than half of children under-five are stunted [43].

The findings of the present study emphasise the importance of handwashing and waste disposal practices in addressing diarrhoea and RTI morbidity among young children. Policies and programmes aimed at addressing morbidity and malnutrition among young children need to consider hand washing and waste disposal practices; thus, shifting the emphasis from nutrition-specific to nutrition-sensitive programming.

Our findings should be interpreted with caution because diarrhoea and RTI prevalence were based on the mother/caregiver's recall which may be influenced by recall bias related to the reliance on the memory of the respondents. Moreover, there may be misclassification of cases if the mother/caregiver wrongly assumes diarrhoea/RTI prevalence during the recall time; nevertheless, to minimise recall bias and misclassification, research assistants were trained to probe further. Although there can be a potential bias in any recall method, this way of data collection is less expensive and relatively fast and is still considered. Mothers/caregivers may also report socially desirable practices which in reality they do not practice; however, we observed that mothers in our study were very motivated and freely answered the questions without hesitancy or intrusions from other people.

A major limitation of our present study is its cross-sectional design as the inference of possible causality is speculative since it is not possible to determine if any of the WASH practices preceded the diarrhoea and or RTI occurrence. As a prospective design would be better equipped to address this problem, we limit the interpretation of our findings to describing associations. Our study population was also limited to 9 rural communities in the Kumbungu District of Ghana; hence, at best, our sample could be considered to be more representative of 6–23 months old rural children in the Northern Region of Ghana.

Notwithstanding the limitations, this study has thrown more light on WASH practices in the rural Northern context of Ghana and the determinants of diarrhoea and RTI prevalence among children 6–23 months. To the best of our knowledge, this study was the first to examine the effect of WASH practices on the prevalence of diarrhoea as well as RTI among 6–23 months children in the rural northern Ghanaian context.

4. Conclusions

The study showed a high prevalence of diarrhoea and RTI among children aged 6–23 months in the Kumbungu District of Ghana. Caregiver's handwashing with soap after defecation and before feeding as well as hand washing of the child with or without soap before feeding were predictive of diarrhoea prevalence while caregiver handwashing with or without soap after defecation and washing of the child's hands with soap before feeding were predictive of RTI prevalence among the children. Caregiver handwashing with soap after defecation and household garbage disposal were also predictors of diarrhoea and RTI co-morbidity. Moreover, the place where the child defecates, caregiver handwashing with soap after defecation and treatment of fruits and vegetables before eating/cooking were the determining factors of diarrhoea or RTI prevalence. Interventions geared towards improving handwashing and waste disposal should be implemented to avert the high burden of diarrhoea and RTI among the children in Kumbungu District of Ghana.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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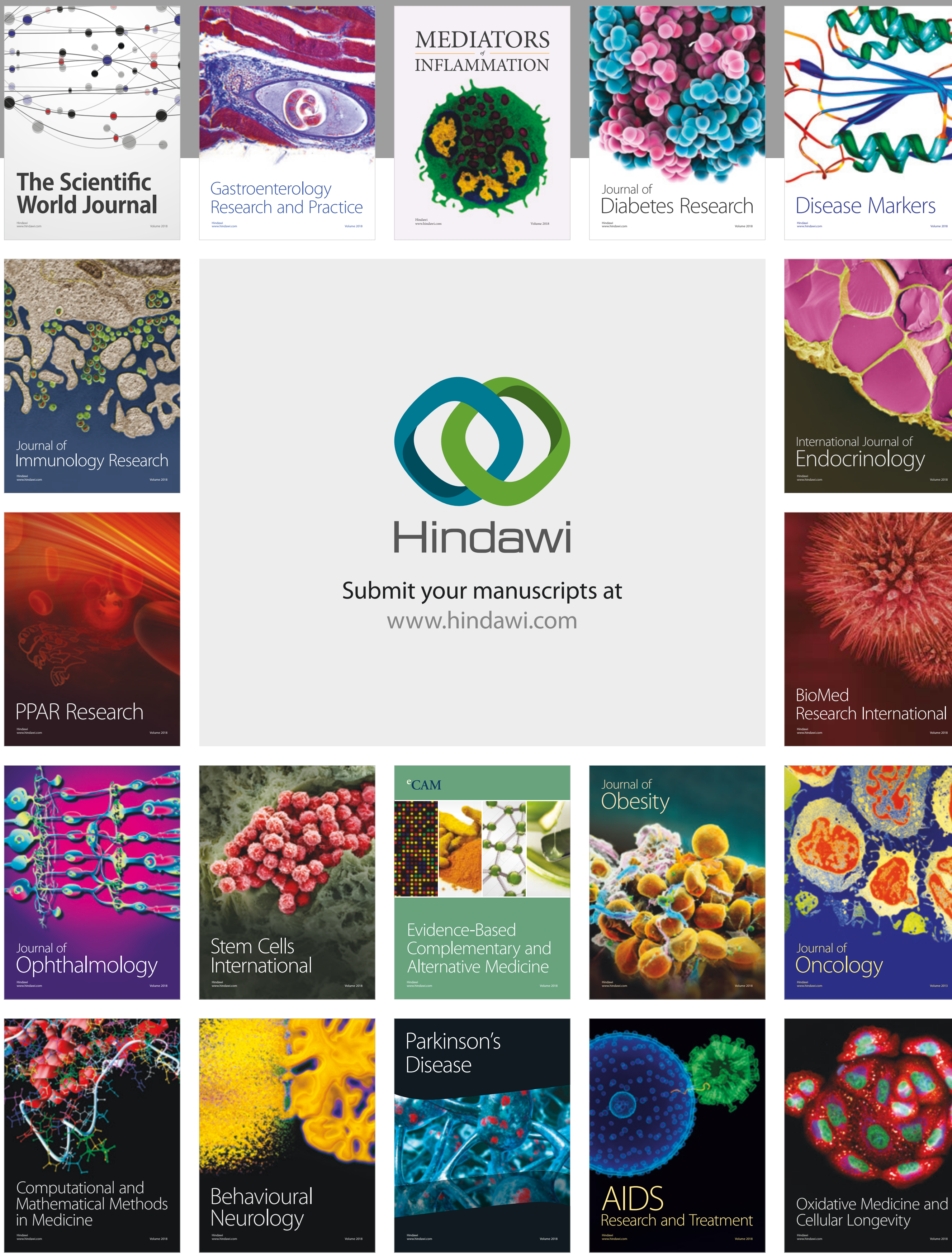

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