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Effectiveness of Ceramic Filter Water Treatment Method in Improving Drinking Water Quality and Reducing Water-Related Disease: Systematic Review and Meta-Analysis

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Abstract: Lack of access to improved drinking water sources is global problem. Millions of peoples cannot get safe drinking water as defined by the World Health Organization (WHO) Guidelines for Drinking Water Quality. Untreated drinking water has been reported in different studies as one of the major contributors to the human health problem (water related disease) such as cholera, typhoid, viral hepatitis and dysentery, and responsible for death of people in million each year. Middle and low-income countries more affected by the problem. To scope up this problem many of these countries started to use household level water treatment methods like: chlorination, solar disinfection and ceramic water treatment method. The aim of this study is to pool out the available research evidence on the effectiveness of the ceramic filter water treatment method in reducing diarrhea in both children and adults. Searches were conducted in PubMed, Google Scholar databases and references to other studies. The review included RCT studies on both children and adults found anywhere in the world regardless of sex, ethnicity and socioeconomic status, and religion which were published or conducted in English from December 2000 to January 2022. Studies that compared the diarrhea incidence between the intervention groups who were exposed to ceramic filter disinfection water treatment and the control group who were not exposed to such water treatment. Two independent reviewers critically reviewed and appraised the selected studies. Effect sizes were expressed in risk ratio and in their 95% CIs. 9 eligible studies were identified out of total of 14,007 studies pooled from data bases. In all identified studies, ceramic filter water treatment method reduced the risk of diarrhea in both children and adults. The estimated pooled risk ratio of diarrhea among participants who used ceramic filter disinfection water treatment method was 0.49 (0.41, 0.57). The overall pooled results of the study show that using of ceramic disinfection water treatment method had reduced the risk of diarrheal disease by 51%. This study indicates using of ceramic disinfection water treatment method significantly reduced the risk of diarrheal disease both in children and adults.

Keywords: Ceramic Filters, Water-Related Disease, Water Quality, Diarrhea

1. Introduction

More than 2 billion people in the world live without access to safe water for drinking and other use, and millions of people suffer from waterborne pathogenic disease each year [1]. Around 1.8 billion people worldwide drinks contaminated water with fecal pathogenic microorganisms, these results in to 2 million deaths annually which associated to water borne diseases (diarrheal). Particularly, children under the age of five highly affected by water related disease [2]. Study indicates that the major contributors to the human disease burden such as cholera, typhoid, viral hepatitis and dysentery is drinking untreated drinking water. It is responsible for about 1.9 million deaths per year [3]. In Latin America and the Caribbean only around 38 million people lack access to sources of drinking water, as result water-related diseases are one of ten major causes of death every year in this region [4]. According to WHO estimate, in 2008 diarrheal disease claimed the lives of two and half million people. African countries are among developing countries suffering from lack of improved drinking water. Particularly Sub-Saharan Africa (SSA) region is where the number of people living without safe drinking water increased by 23% in end of twenty century and beginning of twenty one (1990–2004) [3]. In this region (SSA) consumption of untreated drinking water increases the risk of diarrheal diseases, and recorded as a major cause of morbidity and mortality in infants as well as in adults children [5]. Lack of access to clean and sufficient water has both direct and indirect impacts on Africa's health and economic development. Direct impacts include waterborne and water related diseases and low agricultural yields, while indirect impacts include impacts on economic activity which directly or indirectly associated with water [3].

Unsafe water directly related to diarrheal diseases and diarrheal disease is one of the leading causes of death. According to (WHO 2017) report, Diarrheal disease is the second leading cause of death among children under five years, and is responsible for death of about 525 000 children every year. Ugboko et al (2020) Report that Childhood diarrhoea affecting children under the age of five accounts for approximately 63% of the global burden [6]. According to Recent meta-analysis study conducted by the World Bank hygiene education and water quality improvements are very effective for reducing the risk of diarrheal disease (42% and 39%, respectively) [7].

Low and middle-income countries are victims of this problem at first stage. To counter the problem several cost-effective water purification methods have been implemented at the household level in these countries [4]. Result of systematic reviews on water quality improvement have shown house hold water treatment source storage (HWTS) to be effective in improving drinking water quality and preventing diarrheal disease. Based on this evidence, the WHO and UNICEF recommend HWTS as part of a comprehensive strategy to prevent diarrheal disease for populations relying on unsafe water [5]. This includes chlorination, boiling and ceramic filter. Ceramic filters remove bacteria and parasites by physical removal and have been reported to effectively reduce bacteria. There is some evidences on it effectiveness in virus removal, but data are variable [8]. It was observed that there is ambiguous epidemiologic evidence about the protective effect of household ceramic filters against hepatitis A virus [9]. Beside improvement in water quality, CWF is ease and simple to use, long life if it properly handed to avoid broking, and relatively low cost due to local production of the material. This method is very important since it is applied to emergencies, especially in the absence of chemical disinfectants method [10, 11].

The effectiveness of CWFs in removing bacterial and protozoa depends on the production quality of the filter. The most appropriate HWTS option for a location depends on different factors: existing water and sanitation conditions, water quality, cultural acceptability, implementation feasibility, availability of HWTS technologies, and other local conditions and factors. Study showed that Water purification in by this method is by the combined effects of physical filtration and chemical disinfection. Filtration can purify up to 30L of water per day [12]. The aim of this systematic review is to pool out the available study evidence showing the extent of effectiveness of CWF method in improving the quality of drinking water and reducing water-related disease and diarrhea. The systematic review question is Does ceramic filter water treatment method improve drinking water quality and reduce water-related disease in children and adult when compared with individual or house hold drinking untreated water?

2. Method

2.1. Protocol Development

This systematic review and meta-analysis has been written based on the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) statement guidelines. The protocol of this systematic review was registered in PROSPERO (NIHR 312780) before conducting the review.

2.2. Data Sources and Search Strategy

In order to identify appropriate peer-reviewed articles that met our inclusion criteria, an electronic database like PubMed/Medline, Google Scholar, and other references (hand searched on journal page and Google) was carried out. A combination of Medical Subject Heading terms and keywords terms used in this review was: (Ceramic filters) AND (water disinfection OR water purification OR water treatment) AND (reduction OR prevention OR control) AND (diarrhea OR water related disease OR water borne Diseases) AND (children OR adults). The searching of the literature was takes place in March 2022. The studies published in English language only included. The result of the search in data base and the detail process for selecting included studies was presented in a flow diagram below (see figure 1).

2.3. Criteria for Consideration of Studies in This Systematic Review

The detail of considered criteria to be included in this review addressed as follow:

2.3.1. Types of Studies

Only randomized controlled trials (RCT) studies that assessed the effectiveness of the ceramic water filter (CWF) water treatment methods for improving drinking water quality and reducing water-related disease and reported or published in English Language, experimental study Articles, RCT study design and both published and unpublished studies which conducted from December 2000 to January 2022 was included.

2.3.2. Participants

The review included all peoples of all age group living anywhere in the world, regardless of ethnicity, sex, culture and socioeconomic status.

2.3.3. Interventions and Comparator

Studies that evaluated the effectiveness of CWF as a water treatment method for improving of drinking water quality and reducing water-related disease /diarrhea were considered. Considered study were the studies that compared the improving drinking water quality and reducing diarrhea occurrence among the intervention group and control group.

2.3.4. Outcome

The outcome of this study was the change observed in diarrhea incidence after CWF applied at house holed level for the purification of drinking water.

2.4. Data Extraction

The extraction of data for included studies was hold using data extraction tool form prepared by two independent reviews. For each study, the authors' name, year of publication, country, sample size, characteristics of interventions, results of the studies, and follow-up duration of the study. Any disagreements that arise between two reviewers were resolved through discussion between two reviewer or with third coo-others.

2.5. Data Management and Selection of Studies

To combine search results as well as to remove duplicate studies Mendeley Desktop reference management software V.1.19.4.0 was used. The screening of included studies conducted by two reviewers. The study found from data base was evaluated for consideration at three levels: by title, by abstract and finally by full text reading. On the point of disagreements regarding including and excluding specific study agreement was reached through were discussion between reviewers. For the screening of studies at the full-text level, rejection of the studies the agreement was reached through was discussion among the reviewers team.

2.6. Methodological Quality (Risk of Bias of Included Studies)

The Risk of bias or methodological quality of included studies were evaluated by two independent reviewer using the effective public health practice project (EPHPP) quality assessment tool for Systematic Reviews. The method classifies bias in the studies as "Strong" or "Moderate" or "Weak" on the presence or absence of: random sequence generation, confounders, study design, data collocation methods, blinding and withdrawals and drops. Disagreements between the two reviewers on rating for each bias criterion on individual studies were discussed among the reviewers to reach a consensus.

2.7. Measures of Treatment Effect

CWF treatment intervention was expected to reduce the risk of diarrhea. Risk ratio (RR) was estimated by the number of participants who experienced diarrhea and the total number of participants in each group. RR less than one shows that intervention of CWF results in greater chance of decreasing diarrhea.

2.8. Missing Data

In selected papers we not faced missing data in order to contact author/s.

2.9. Data Synthesis and Heterogeneity Assessment

Narrative synthesis was conducted first to describe the details of the studies, participant and intervention characteristics and outcomes of all included articles. Meta-analysis was conducted using StataSE 16 Comprehensive Meta-Analysis software and MetaXL. 95% CIs and p-values was calculated for outcome.

To present the pooled estimate value forest plots were generated using MetaXL software. The size of each circle in the forest plot, represent the weight of the study, diamond represents overall effect, whereas the width of the diamond indicate the CI for the overall effect estimate and crossed line refers to a 95% CI. To investigate the possible sources of heterogeneity subgroup analyses was performed using continents, year of the studies and follow-up periods of the studies. The presence and absence of publication bias was examined using a funnel plot test.

2.10. Patient and Involvement

No involvement of patient.

3. Result

3.1. Study Selection

Total records from electronic databases searches were 14,007. Out of these, 472 were identified after removing duplicates and 445 records were excluded out of 472 after the titles reviewed, 10 studies were excluded because of study design, 4 studies were excluded because the study include another treatment methods (not by CWF only), lastly 4 studies were excluded because of outcome. Finally, the remaining 9 studies were included in this systematic review (figure 1).

3.2. Study Characteristics

The detail characteristics of the studies included in this systematic review were summarized in table 1. All the included studies were RCT articles conducted from 2000 to 2022 in six low-income and middle-income countries in three continents (Africa, Asia and South America). Among included nine studies, three studies were conducted in Africa, three studies in Asia, and the remaining three studies were in Latin America. (table 1).

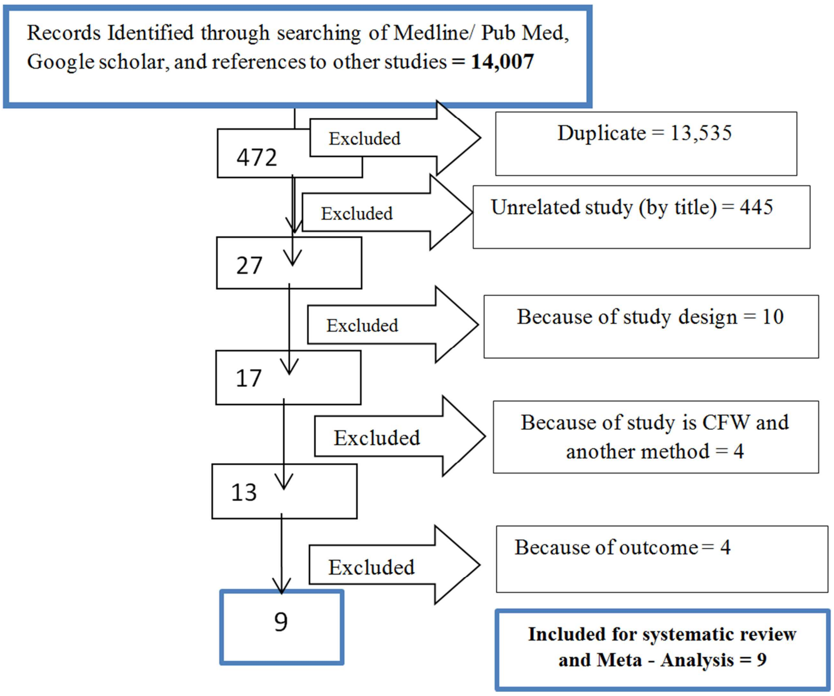

Figure 1. *Diagram showing relevant studies identified by the systematic search strategy for Ceramic Water Filtration.*

3.3. Diarrhea

The results of all included studies indicate that CFW intervention reduced diarrhea. After the intervention of CFW disinfection method, diarrhea was significantly reduced in all studies with a RR ranging 0.23–0.86 at 95% CI. As presented in figure 2. The overall pooled RR of diarrhea for 9 studies was 0.49 (95% CI 0.41 to 0.57). These imply that the intervention of CFWT reduced diarrhea by 51% (figure 2).

3.4. Subgroup Analysis

The results of subgroup analysis were summarized in figures 3–5. Figure 3 showing sub-group analysis pooled risk ratio and corresponding 95% CI CFW treatment to reduce diarrhea by the continents. The study conducted in Asia there is law heterogeneity since the value is lie between 0.51-0.54 (0.51, 0.54 at 95% CI), whereas that of South America shows considerable heterogeneity since the value is lie between 0.40 – 0.70 (.48, 70 at 95% CI), there is high heterogeneity in study conducted in Africa since the value lies between 0.17-.86 (0.15, 0.92 at 95%CI) (figure 3). Based on flow-up period, the level of heterogeneity was not related to follow-up duration in this study, this because there is no evidence that shows sharp trends based on the duration of the follow up (figure 4). Based on the year of the study there is no smooth trend increasing or decreasing in results from 2004-2018. There is also heterogeneity between studies published in the same year as you see figurer 5. High heterogeneity was recorded in between studies published in 2008 (0.17 and 0.51), whereas low heterogeneity recorded in study conducted in 2006 (0.49 and 0.54).

3.5. Sensitivity Analysis

Random-effects model was used to identify the influence of a single study on the overall analysis and a sensitivity analysis was computed. The results of this analysis indicate that the study conducted by Du Preez *et al*., (2008) and Brown and Sobsey (2006) slightly increased the overall RR (See table 3).

3.6. Publication Bias

Publication bias tested using funnel plot. When visually seen it was asymmetrical (figure 6) this asymmetry may be because of true heterogeneity among individual studies or poor methodological quality or publication bias.

Table 1. *Included study detailed characteristics.*

Study	Intervention	Country	Population age group	Type of study design	No. of participants	Outcome
Abebe et al., 2014	ceramic water filter	rural South Africa	People living with the human immune deficiency virus (PLWH).	RCT	74 intervention group 74 control group Finally	Diarrhea
Brown 2007	ceramic water purifier	Cambodia	children, all age groups	RCT	60HH Intervention and 395, 60HHcontrol and 403 individual.	Diarrhea
Brown and	ceramic water	Cambodia	House hold	RCT	79HH intervention	Diarrhea

Study	Intervention	Country	Population age group	Type of study design	No. of participants	Outcome
Sobsey, 2006	purifier				180 HH control Individual 479 (control), 528 (intervention)	
Brown, et al., 2008	ceramic water purifier	Cambodia	Households	RCT	60HH intervention 60 HH control	Diarrhea
Clasen et al., 2004	Ceramic water filters	Rural Bolivia	Children And house hold	RCT	25 HH-intervention 25HH-control	Diarrhea
Clasen et al., 2005	ceramic water filter	Colombia	Household	RCT	70HH intervention 70 HH control	Diarrhea
Clasen et al., 2006	ceramic water filters	Bolivia	House hold	RCT	intervention group (40) HH with 210 participants Control group with107participants	Diarrhea
Du Preez et al., 2008	ceramic water filter	Rural South Africa and Zimbabwe	children 24–36 months	RCT	61 HH intervention 54 HH control	Diarrhea
Morris et al., 2018	Ceramic water filters	Kenya	4-10months old Infants and adults children	RCT	120 HH children intervention 120 HH children control	Diarrhea

Table 1. *Continued.*

Study	Estimate (95% CI)	Main findings
Abebe et al., 2014	Rate ratio is 0.23, with 95% CI: (0.19, 0.27), p< 0.0001.	The result of this study show that intervention of CWFs can significantly improve the quality of household water quality and decrease days of diarrhea for PLWH in rural South Africa.
Brown 2007	Incidence rate ratio 0.57 (0.50-0.65) prevalence rate ratio; 0.51 (0.41-0.63) Children<5years:- Incidence rate ratio; 0.67 (0.54-0.83) Prevalence rate ratio; 0.58 (0.41-0.82)	Finding of this study indicate that: (i) CWPs reduced E. coli up to 99.9999%, with approximate mean reductions of 99% in both laboratory and field testing; (ii) CFW treatment reduced MS2, a viral surrogate, by a average 90-99% in laboratory testing; (iii) CFW intervention reduced diarrheal approximately by 40% (iv) filters maintained effectiveness over long periods, up to 44 months in field use; (v) because of breakages of the ceramic filter elements coupled with limited availability of replacement parts in communities using of CFWT declined. (vi) CFWT in field use susceptible to recontamination due to improper handling.
Brown and Sobsey, 2006	RR: 0.54, 95% CI 0.41-0.71	CFW intervention reduced *E. coli*/100ml counts by a mean 95.1% in treated versus untreated household water, in some cases it is more than 99.99%. (v), even though the CFW was highly effective against microbial indicator organisms but may be subject to recontamination, probably during regular cleaning; and (vi), the was 46% reduction in diarrhea in filter users (RR: 0.54, 95% CI 0.41-0.71).
Brown, et al., 2008	prevalence ratio 0.51 (0.41–0.63)	Finding of the study show that house hold using ceramic water filter significantly record less diarrhea compared to house hold without ceramic filter. Prevalence ratio of CWF 0.51 at 95% CI: (0.41-0.63), CWF –Fe: 0.58 (95%CI: 0.47- 0.71).
Clasen et al., 2004	Children odds ratio 0.83 (0.51−0.94); *P* < 0.001. HH- 0.70 (0.53−0.80); *P* < 0.001	The finding this study show that household-based ceramic gravity water filters intervention is an effective method in improving microbial water quality and reducing diarrheal disease among a susceptible population. Thus, CFW treatment method can be considered as another useful tool in helping people suffering from unsafe drinking water.
Clasen et al., 2005	odds ratio_0.40 (0.25, 0.63), *P* < 0.0001).	The results of this study showed an association between the microbiologic performance of the filters and their health impact on human. The result of this assessment provides evidence of the potential value of household water treatment in the prevention of risk of diarrheal. Furthermore, it shows the range of effectiveness of the interventions.
Clasen et al., 2006	Odds Ratio 95% CI: 0.49 (0.24, 1.01) p=0.05	We assessed the performance of the filters by conducting a five-month randomized controlled trial among all 60 households in the pilot community. Water filters eliminated thermo tolerant (faecal) coliforms from almost all intervention households and significantly reduced turbidity, thereby improving water aesthetics. Most importantly, the filters were associated with a 45.3% reduction in prevalence of diarrhoea among the study population (p¼0.02). After adjustment for household clustering and repeated episodes in individuals and controlling for age and baseline diarrhoea, prevalence of diarrhoea among the intervention group was 51% lower than controls, though the protective effect was only borderline significant (OR 0.49, 95% CI: 0.24, 1.01; p¼0.05). A followup survey conducted approximately 9 months after deployment of the filters found 67% being used regularly, 13% being used intermittently, and 21% not in use. Water samples from all regularly used filters were free of thermo tolerant coliforms.
Du Preez et al., 2008	Blood Rate Ratio 0.20 (0.09–0.43); *P*< 0.001 no blood diarrhea 0.17 (0.08–0.38); *P* < 0.001),	The result of this study show that Ceramic filters water treatment method was effective in reducing risk of bloody and non-bloody diarrhea. CFW treatment method shows higher percentage reduction in diarrheal disease than solar disinfection method. Thus Ceramic gravity filters became an attractive option for households using unsafe water supply and in emergency conditions. Ceramic filters are durable and easy to use, need only short term training to use and they are easily maintained, can offer safe water at the point of use within short time.
Morris et al., 2018	odds ratio or OR: 0.86 [0.64–1.16]), p-value =0.33	Ceramic filter water treatment method can improve water quality. A larger sample size, longer study duration, and increased emphasis on exclusive use of filtered water by study participants may demonstrate more accurately the potential for ceramic water filter (CWF) to prevent or reduce diarrhea disease and specific infections such as cryptosporidiosis.

Table 2. *Included studies' methodological quality assessment by Effective Public Health Practice Project (EPHPP) assessment tools for Systematic Reviews.*

Studies	**Selection bias**			**Study design**		**Confounders**			**Blinding**		
	Q1	**Q2**	**Rating**	**Q1**	**Rating**	**Q1**	**Q2**	**Rating**	**Q1**	**Q2**	**Rating**
Abebe et al, 2014	1	2	Moderate	1	Strong	2		Strong	1	1	Strong
Brown 2007	1	1	Strong	1	Strong	1	1	Strong	1	1	Strong
Brown and Sobsey, 2006	1	1	Strong	1	Strong	1	1	strong	2	2	Weak
Brown, et al., 2008	1	1	Strong	1	Strong	1	1	Strong	1	1	Strong
Clasen et al, 2004	1	1	Strong	1	Strong	2		Moderate	1	3	Moderate
Clasen et al., 2005	1	1	Strong	1	Strong	1	1	Strong	2	1	Moderate
Clasen et al., 2006	1	1	Strong	1	Strong	1	1	Strong	2	1	Moderate
Du Preez etal., 2008	1	2	Weak	1	Strong	1	1	Strong	1	1	Strong
Morris etal., 2018	1	1	Strong	1	Strong	1	2	Moderate	2	3	Moderate

Table 2. *Continued.*

Studies	**Data collection methods**			**With drawls' and drop outs**			**Global rating**
	Q1	**Q2**	**Rating**	**Q1**	**Q2**	**Rating**	
Abebe et al, 2014	1	1	Strong	1	2	Moderate	Moderate
Brown 2007	1	1	strong	1	1	Strong	Strong
Brown and Sobsey, 2006	1	1	strong	1	1	Strong	Moderate
Brown, et al., 2008	1	1	strong	1	1	Strong	Strong
Clasen et al, 2004	1	1	strong	1	1	Strong	Weak
Clasen et al., 2005	1	1	Strong	1	1	Strong	Moderate
Clasen et al., 2006	1	1	strong	1	1	Strong	Moderate
Du Preez etal., 2008	1	1	strong	1	2	Weak	Weak
Morris etal., 2018	1	1	strong	1	1	Strong	Weak

Table 3. *Sensitivity analysis of the effectiveness of CWF intervention for the reduction of diarrhea.*

Included Studies	***Pooled ES***	***LCI 95%***	***HCL 95%***	***Cochran Q***	***P***	I^2	$I^{2LCI\ 95\%}$	I^2***HCI 95%***
Abebe et al, 2014	*0.548*	*0.455*	*0.659*	*24.917*	*0.001*	*71.907*	*42.255*	*86.333*
Brown 2007	*0.450*	*0.304*	*0.666*	*101.250*	*0.000*	*93.086*	*88.683*	*95.777*
Brown and Sobsey, 2006	*0.455*	*0.324*	*0.638*	*107.511*	*0.000*	*93.489*	*89.434*	*95.988*
Brown, et al., 2008	*0.457*	*0.322*	*0.649*	*107.899*	*0.000*	*93.512*	*89.477*	*96.000*
Clasen et al, 2004	*0.438*	*0.314*	*0.611*	*94.463*	*0.000*	*93.590*	*87.745*	*95.519*
Clasen et al., 2005	*0.473*	*0.342*	*0.654*	*107.411*	*0.000*	*93.483*	*89.423*	*95.989*
Clasen et al., 2006	*0.463*	*0.337*	*0.636*	*108.112*	*0.000*	*93.525*	*89.501*	*96.007*
Du Preez etal., 2008	*0.503*	*0.370*	*0.682*	*101.065*	*0.00*	*93.074*	*88.659*	*95.770*
Morris etal., 2018	*0.429*	*0.314*	*0.587*	*93.135*	*0.000*	*92.484*	*87.545*	*95.465*

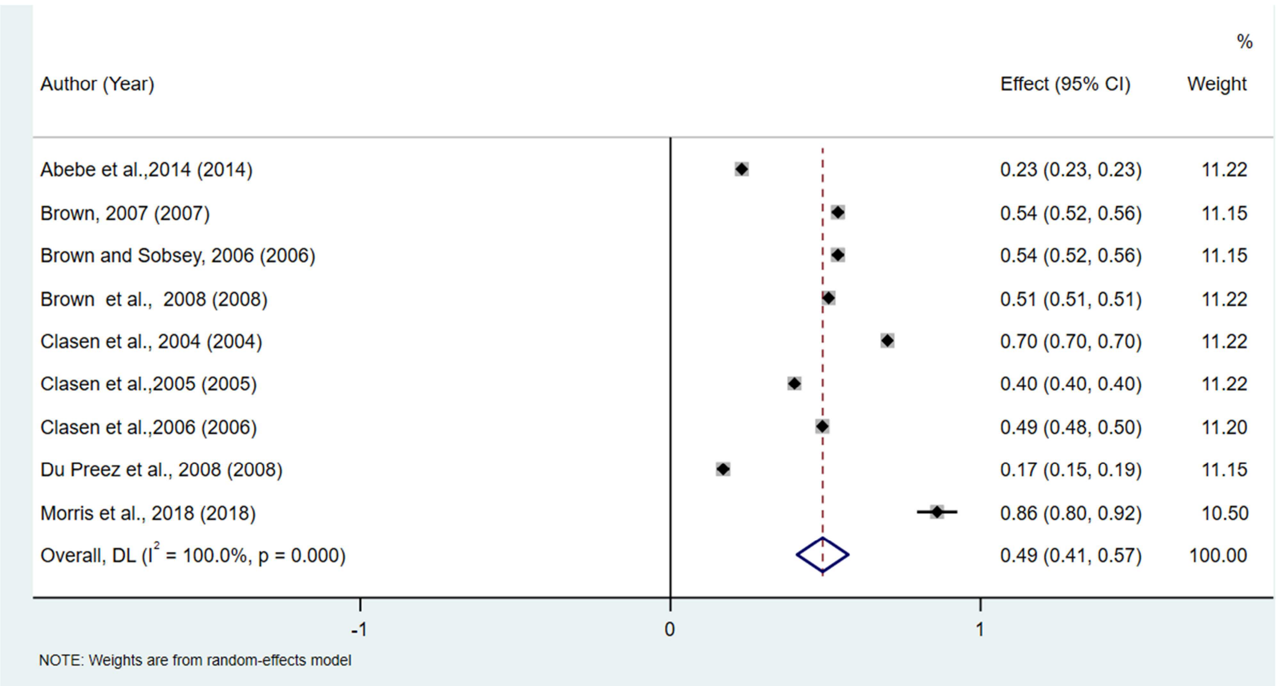

Figure 2. *a, b. Forest plot for pooled risk ratio and corresponding 95% CIs of CFW to reduce diarrhea.*

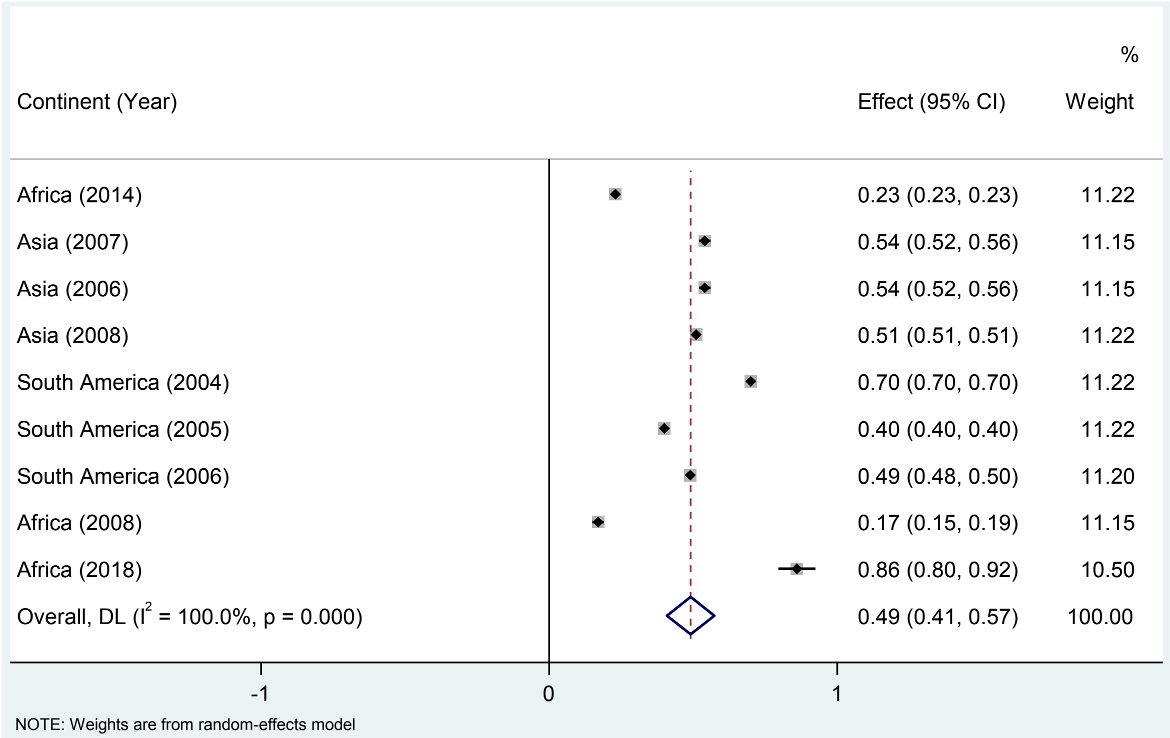

Figure 3. *Forest plot for sub-group analysis pooled risk ratio and corresponding 95% CIs of CFW treatment method to reduce diarrhoea by continents.*

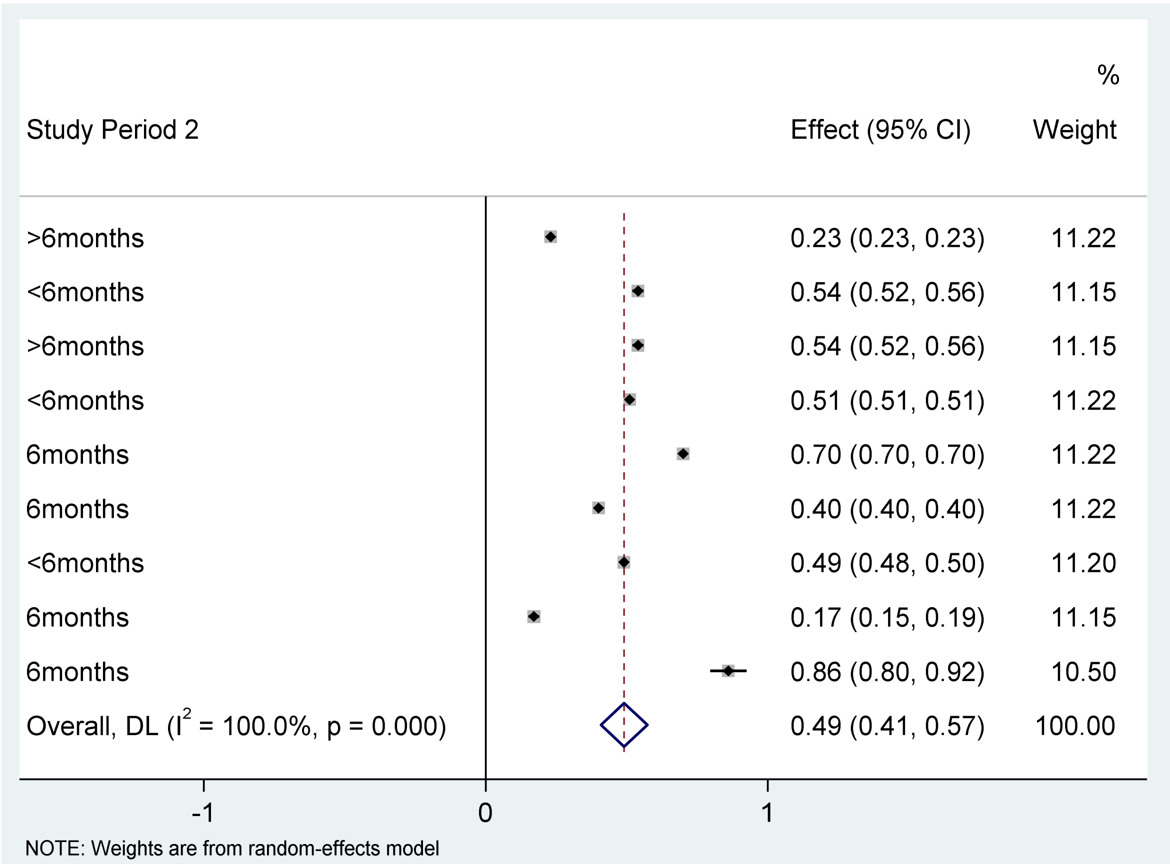

Figure 4. *Forest plot for sub-group analysis pooled risk ratio and corresponding 95% CIs of CFW treatment method to reduce diarrhoea by flow up duration.*

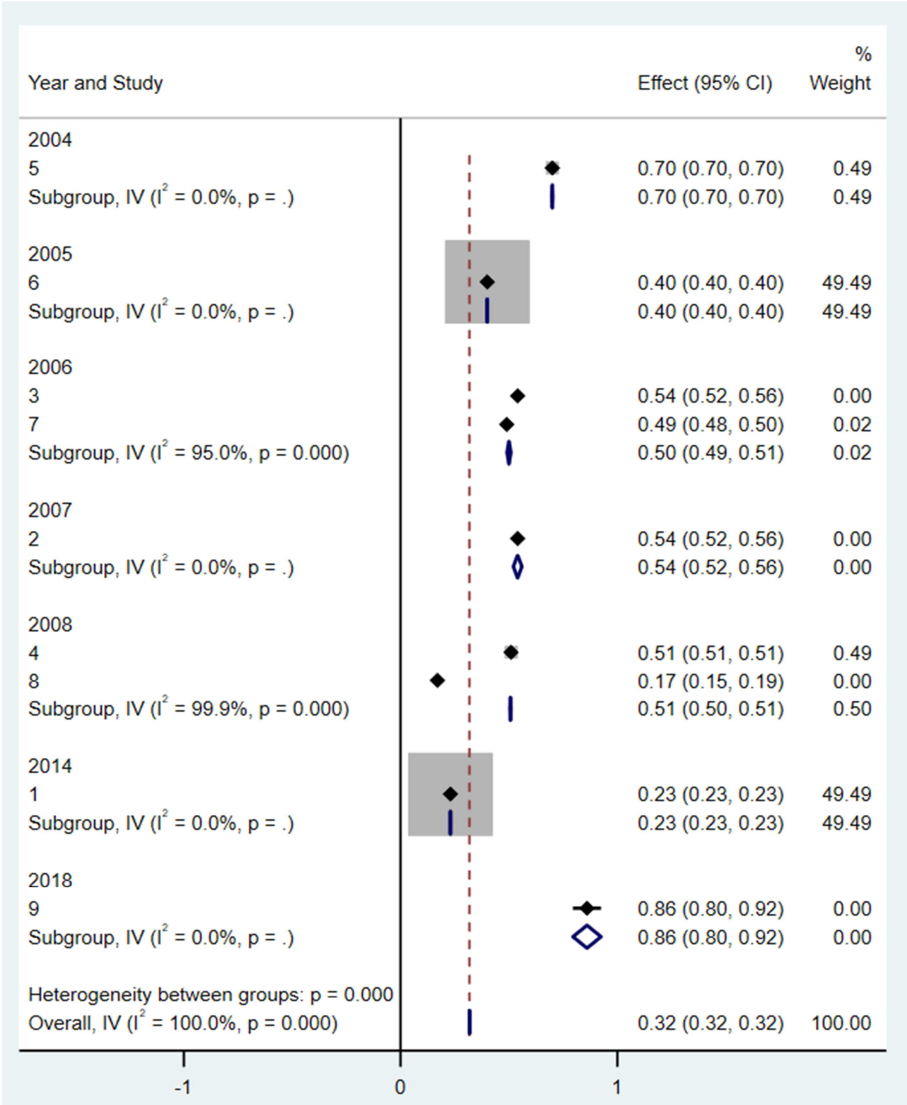

Figure 5. *Forest plot for sub-group analysis pooled risk ratio and corresponding 95% CIs of CFW treatment method to reduce diarrhoea by the year of the study.*

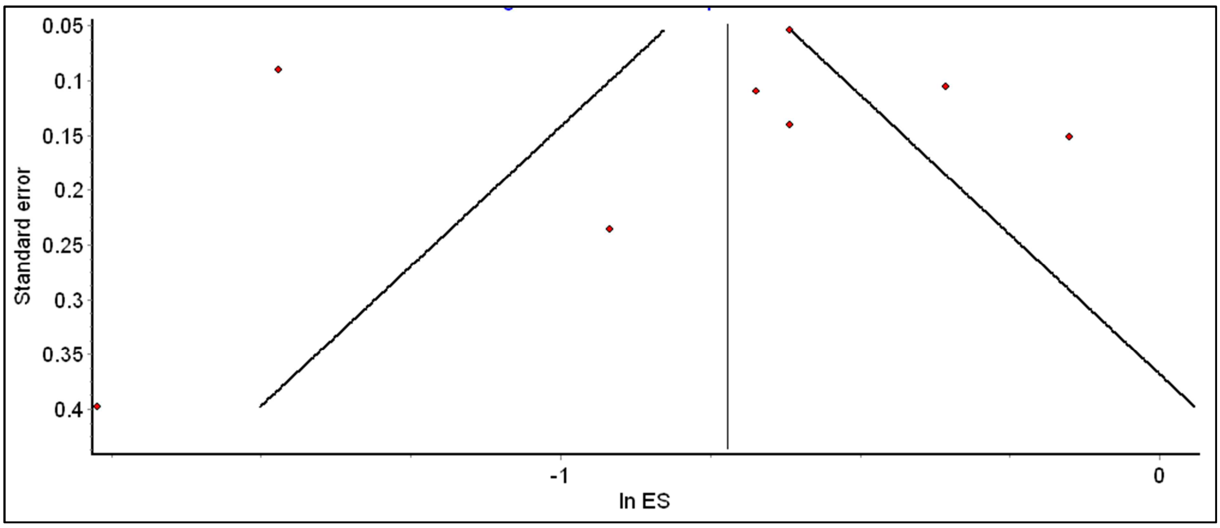

Figure 6. *Plot of included studies in the analysis of the effectiveness of CFW treatment method for the reduction of diarrhea.*

4. Discussion

The result and analysis of this review shows the effectiveness of the CFW treatment method for the prevention and reduction of diarrhea. The overall pooled RR of diarrhea reported by the 9 studies was 0.49 (95% CI 0.41 to 0.57). These imply that diarrhea was reduced by 51% using the CFW water treatment method. If this result compared with another treatment method, we can say that this method is very effective. For example, overall pooled RR of systematic review on solar disinfection (SODIS) water treatment methods indicated a 38% reduction of diarrhea [11]. A systematic review conducted by Arnold and Colford [13] for improving water quality intervention of diarrhea by chlorination shows improvement of water quality by 29% only. Similarly, when we compare with another diarrheal reduction method, we see more effectiveness of CFW disinfection in preventing or reducing diarrheal diseases. A systematic review on the impact of drinking water, hygiene and sanitation interventions to reduce childhood diarrhea conducted by Fewtrell *et a*l. [14] showed a reduction of diarrhea by 37% or 0·63 (95% CI 0·52–0·77) and 25% or 0·75 (95% CI 0·62–0·91) respectably.

All studies identified as eligible for this review shows effectiveness of CFW treatment method in water-related or diarrheal diseases. The pooled RRs for the subgroup analysis based on the continent where the study conducted in Asia there is law heterogeneity since the value is lie between 0.51-0.54 (0.51, 0.54 at 95% CI), whereas that of South America shows considerable heterogeneity since the value is lie between 0.40 – 0.70 (.48, 70 at 95% CI). The high heterogeneity was observed in study conducted in Africa since the value lies between 0.17-.86 (0.15, 0.92 at 95% CI). The level of heterogeneity was not related to follow-up period and the year of the study in this study, this because there is no evidence that shows sharp trends based on these.

Methodological Quality assessment of included studies using Effective Public Health Practice Project (EPHPP) assessment tools for Systematic Reviews Global rating shows two studies strong, four moderate and three weak. Publication bias was tested by the funnel plot. It was asymmetrical when visually inspected. This funnel plot asymmetry may be due to true heterogeneity or poor methodological quality or publication bias. Even though different studies result show effectiveness of ceramic filters in improving drinking water quality, as well as water related disease, long-term and large-scale studies are needed to ensure that ceramic filters interventions can provide consistent, reliable, and low-cost access to safe drinking water [15].

5. Conclusion

Even though lack access to safe drinking water in law and middle income countries, these countries takes different simple, low cost and locally available technologies to solve or reduce this problem. One of these local technologies is ceramic filter water treatment method. This study aim to pool out available evidence on the effectiveness of Ceramic filter method in solving or reducing water related disease or diarrhea. The result of this systematic review shows that the intervention of ceramic filter disinfection water treatment method significantly reduced the risk of diarrheal disease both in children and adults. The use of ceramic filter disinfection water treatment method is advisable for peoples have no access safe drinking water. PROSPERO registration number for the protocol of this review was (NIHR 312780).

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