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INFLUENCE OF SODIS ON INCIDENCES OF DIARRHEA AMONG CHILDREN UNDER 5 YEARS IN MAKINDYE DIVISION, KAMPALA

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ABSTRACT: *The use of solar energy to disinfect water to meet the basic needs of day to day consumption and supply of safe drinking water goes back to 1990 After the convention on sustainable development at berlin where access to safe drinking water were discovered to have potential alternative sources. The present study examined the use of solar energy (UV-Rays) for disinfect and sanitize water for the consumption of children less than 5yrs of age. Data were collected through interactions with a sample of 100 participants. The study results provide explanations on practices of solar water disinfection (SODIS) acceptance, diarrheal episode reduction and compliance rates of the intervention at household level. The intervention recommends more scientific research to explore the role of SODIS in promoting well-being of children below 5yrs of age and use it to achieve Sustainable Development Goals to ensure access to safe drinking water to communities.*

KEYWORDS: SODIS, Diarrhea, Children, Under 5 Years, Solar Energy, SDGs, Kampala

INTRODUCTION

Water scarcity has been a prevailing event since the evolution of man, there is limited access to clean safe water for drinking. Less than 15% of the world's water bodies are safe for consumption. Africa has been the part of the world affected the most by lack or storage of clean safe drinking water. After the convention on sustainable development at berlin in 1990, there was an adverse improvement on access to clean safe water, more discoveries and sources of clean safe water were evolved (WHO/UNICEF 2014). Since water is required to maintain life, people often have no alternative but to consume contaminated drinking water despite the associated risk of waterborne disease. A Joint Monitoring Programme (JMP) for Water Supply and Sanitation conducted as of 2014, came with a statistic that 748 million people lack access to an improved drinking water source and 547 million of these will not have gained access by 2015 if the trends remain unchanged, showing that it is of paramount importance to evolve in approaches that will reduce the present level of shortage of safe drinking water (WHO/UNICEF, 2014). Furthermore, the progress achieved was mostly in urban areas. Indeed 90% of the population, who are still without access to improved drinking water sources are poor, marginalized and live in rural areas (WHO/UNICEF, 2014). This lack of access to adequate and safe drinking water sources is detrimental to health as waterborne diseases (diarrhea) transpire after consumption of unsafe or contaminated drinking water.

SODIS came into discovery for the first time in 1984 by Aftim Acra in a booklet from UNICEF. After then, the method began to further into investigation using PET bottles and practiced in many countries by a team of researchers from SANDEC (Water and Sanitation in Developing Countries) at EAWAG (Swiss Federal Institute of Aquatic Science and Technology). SODIS is a simple and sustainable way to treat drinking water at a household level. Solar disinfection of bacteria is well documented in literatures and many studies have shown that bacteria are highly sensitive to UV-A and are therefore easily inactivated.

The quality of drinking water is a concern all over the world. According to the World Health Organization (WHO), 1.6 million people die every year due to diarrhea caused by waterborne diseases and 1.1 billion people do not have access to an acceptable source of drinking water (WHO, 2004; 2007). Majority of these deaths are in children under 5 years of age, usually in rural areas. According to a UN Human Development Report, "The most effective vaccine against child death in Africa is a glass of clean water" (WHO, 2006).

Limitations and lack of access to safe drinking water in low-income and rural areas has been of detrimental effect to the health and well-being of children, it opens rooms to outbreak of diseases like cholera, typhoid, dysentery and diarrhea.

As a result of this prevailing effects, there is need to examine the significance, acceptance and adaption of SODIS by the local communities at a household level, as well as measuring the efficiency of SODIS in reduction of diarrheal cases amongst children which has aimed at improving health, safe and well-being in the community. More specifically, this study addresses the following objectives:

1. To access the impacts of SODIS on diarrheal prevalence on children below the age of 5years.
2. To identify the factors that are affecting attitudes and perceptions regarding SODIS method adoption and use by the local communities.

MATERIAL AND METHODS

Research Design

Using a community-based randomized control, a quantitative approach for quantitative data, the nature of this research made use of phenomenological design that investigated participants' response towards the objective. The research study had a little experimental research aspect on water samples collected from different collection points. Interpretive philosophy with positivistic approach was adopted during this research after field data collection.

Study Settings and Population

The study was conducted in Makindye division, Kampala district, Uganda. The site is characterized as a settlement of low-income earners which limited access to clean water. An approximate slum homes of about 450 households by projection. The ratio of male to female inhabitants was almost 1:1, each of households had at least one child under 5 years of age. Almost all households collect water from wells, vandalized pipes and store their drinking-water in Jerry cans and open containers.

Sampling Technique

The collected water samples where gotten from open water sources by the constraint of adapting a Randomized sampling technique, the collection points were selected within Makindye settlements. These points were from locations (Sankara, Kigundu, Kiwempe and Mutesasila) virtually along drainages, one of which is a water shade combining flows from different sources, a vandalized tap water sources, ground water sources(well) and lastly the flowing water channels from the destructed wetland (characterized as the spring).

After selecting four points out of the different collection sources in plastic water bottles, which were then taken to the laboratory at Uganda industrial research institute (UIRI) for water test. These water test involves E.coli test which is the main bacteria causing diarrhea and other waterborne diseases. As part of the preliminaries, this data proves the effectiveness of the practice on inactivating E.coli bacteria which makes the water sample suits the interventional objectives

Procedures

Solar water disinfection is a water purification technology, it is a low cost point-of-use practice of water disinfection system which kills harmful pathogens by exposing PET bottles in to sunlight where the UV-rays increases the temperature of the water(residual water exclusive) which with the reaction between the UV-rays and the PET bottles helps in speeding up the disinfection process. The process takes a minimum of 4hours and maximum of 6-8hours depending on the weather condition during the practice. SODIS depends on the amount of exposure to sunlight.

Adapting procedures from previous researches, the following steps were followed to attain a successful and efficient result of the intervention.

A. Pre-processing stage of providing PET bottles which were given to households.

B. Water collection from the source to be filtered to ensure it clear from residue and filled to the top and closed without allowing air circulation.

C. Providing metallic sheets, concrete or levelled flooring that will allow stable horizontal display of the water bottles direct to the sunlight.

D. Processing stage allowing the displayed bottles for a minimum of 8hours regarding the climatic condition during the practice.

E. Preventing obstructions and unnecessary movements during the process.

After the processes were completed, a record keeping strategy for the incidents of diarrhea per each child consuming the displayed water with the aid of a pen and a dairy were introduced.

The lack of blinding of drinking water quality interventions were common in the areas. The research team were thus encouraged to include a large number of participants and to follow them for a period of time. Census data and local knowledge were accessed to determine the diarrhea morbidity and mortality in children under 5 years and the level of water access in the surrounding areas of Kiwempe was also considered. The areas chosen had different socio-economic development levels and utilizes different types of drinking water sources. The

household were also within reasonable distance and easily accessible for researchers and field workers. Most of the communities involved in the research were peril-urban communities.

Purposive Sampling (Judgment Sampling)

The community selection started early December 2018 and was finalized by the end of April 2019 due to the nature of newly introduced interventions, its acceptance by the communities became very difficult. The sampling technique is characterized by the focus of the researcher's interest. The consideration of individual and community response is also within the investigation scope. Three community health workers were recruited from their local community. They were trained on SODIS procedures and were well aware of the objectives of the study.

The materials were distributed for the start-up and the relevant households were educated and encouraged to participate in SODIS. The researchers also joined the community health workers on many occasions and on unannounced visits to the areas to assist the field workers and familiarize themselves with the problems and progress of the field study.

A 1.5-liter PET bottles were provided to each child in the community. During the training on SODIS, participants were instructed to fill bottle each day and place it in unobscured sunlight for a minimum of 6-8hours for use the following day. Participants were instructed to frequently change water in the bottles with a 24hrs of use which minimized exposure to possible bacterial regrowth. Children were advised to drink directly from the bottle, if possible, to minimize recontamination of SODIS water. Children in the control group were not provided with SODIS bottles and instead were instructed to continue drinking their usual water stored in storage containers in the house.

The main research took place over a 3months period during which diarrheal incidence were recorded daily for both control and intervention children using the daily diarrhea diary that was completed by the parents for each child and collected by community health field workers after that period.

Cluster Sampling

The cluster selection uses the following criteria to suit the interest of the researcher due to the limitations and scope of the study.

(1) The geographical accessibility of cluster areas throughout the research period

(2) Two clusters were identified with children aged under 5 years from 100 households with in the community.

(3) Both clusters (intervention and control) within 50 households each relay only on untreated drinking-water sources, and with prevalence of diarrheal cases incidents.

Follow up, the strategies which supports the households in order to have response in data collection period were implemented. The community health field workers visited the clusters for effective compliance and participation during the period research.

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Data Analysis and Procedures

The data collected were in-put first in to SPSS Software version 16.0 and then transferred into Microsoft excel for data analysis if need maybe. Descriptive statistics were used to determine percentages, means, and standard deviations of the participants. A test was applied to check the uniformity of baseline data between the intervention and control households. An intention-to-treat analysis was used to compare the incidence of diarrhea among children under 5 years of age between intervention and control groups. After analysis, results were presented in tables.

THE RESULTS

The trial had 169 children within 84 households. The number of children with diarrheal incidents after the intervention of SODIS reduced by 38 percent (no incidents/week) and by 41 percent (form above once to once/week). There was not significant sign of reduction from twice to above twice incidents per week.

Table 1: Shows the Overall Summary of the Records for the Different Diarrheal Incidents Measured During the Trial. Generally, a Greater Percentages Episode were Recorded for Incidents after SODIS than that of the Incidents before SODIS Averagely.

Diarrheal episodes	Before SODIS	After SODIS
No incident/week	23.8	38.0
Once/week	28.5	41.6
Twice/week	30.9	10.7
Thrice/week	13.0	9.5
Above thrice	3.5	0

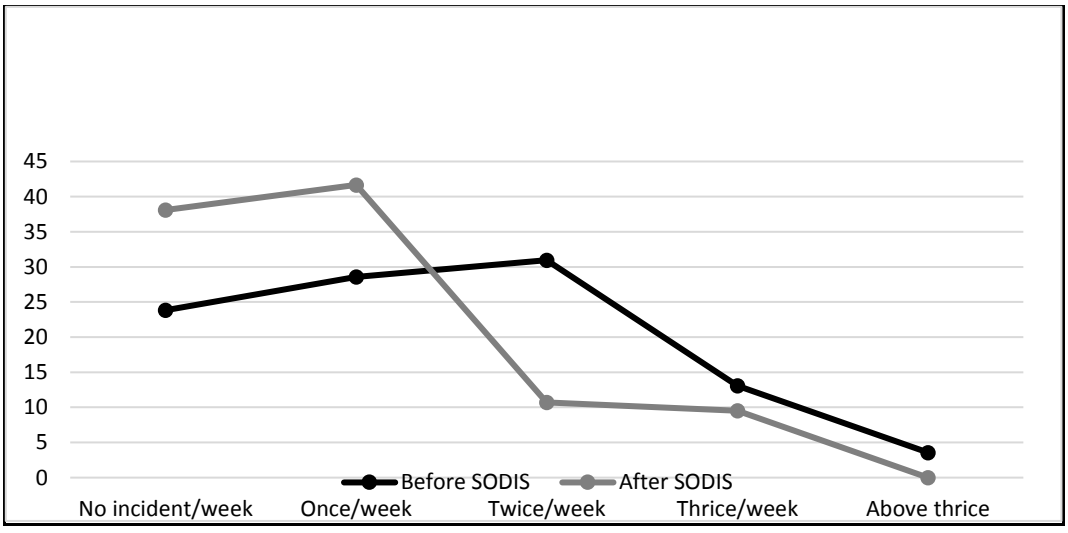

Figure 1: Graph Showing the Decrease in Diarrheal Incidences after SODIS.

The graphical representation particularized more on the decrease in diarrheal incidents especially form the point between twice/week to once/week. By indication from it is believed that from above thrice/week, the percentage of incident reduction rate highlights a significant decrease form 3.5 percent to 0 percent at the incidents before SODIS to after SODIS. Comparing the incident rates from thrice/week to once/week (3.5% & 41.6%) denotes that the decrease in diarrheal incidents on participants that experience incidents above thrice/week had reduced extensively to once/week by 38.1 percent. The efficacy of this practices has been proven once again by the achievement of this great margin. SODIS intervention is effective in reducing diarrhea in children under 5 years.

Perception and Practice of SODIS

During this study, it was discovered that participants what were able to partake in the intervention consider to be described tin four categories as illustrated in table 2 below. The participants approach to the practice was on a minimum level of 1.2 percent and maximum of 61.9 percent. Based on regularity and irregularity in practice, those whom consider the SODIS ease and at the same time practice was ease were with the maximum percentage (61.9%). 8.3 percent of the participants regarded SODIS as difficult to practice and couldn't practice it on a regular basis.

Table 2: Perception and Practice Regarding SODIS

Variables	Frequency	Percentage
Easy and Regular	52	61.9
Easy and Irregular	24	28.6
Difficult and Regular	1	1.2
Difficult and Irregular	7	8.3
Total	**84**	**100.0**

Acceptance Of SODIS

Very large households showed a willingness to adopt SODIS at the end of the main field study. Assessment of post study compliance was determined by interviewing 84 households who used SODIS bottles during the main study. The questionnaires were administered by the previously trained field workers with supervision of the field coordinator. A summary of the questions asked and the percentage responses received from the participants are shown in below.

The table 3 below shows the compliance rate in percentages of the intervention. More than percent of the participants corresponded to the adoption of the intervention and considered it highly recommendable due to its simplicity in practice and affordability to all irrespective of their income levels.

Table 3: SODIS Compliance Rate During Study.

Responses	Frequency	%	Cumulative %
Compliance	68	81.0	81.0
non-compliance	16	19.0	19.0
Total	84	100.0	100.0

Challenges and Reason for Non-Exposure

During the study, the practice level has encountered series of challenges and unforeseen circumstances. The challenges encountered include low sunlight, time consuming and difficult procedures. These challenges in one way or the other affected the compliance rate, reduced motivation, disrupted the main elements of practice and reducing the effectiveness of the practice as well. The frequencies detected that out of 84 households, more than 41 percent of the study group were affected by the flood incidence. The seasonal changes resulted to un-controlled challenges like low sunlight, having high frequency. Below is the representations of the series of challenges and reason for non-exposure.

Table: 4 Challenges and reasons for non-exposure

Issues	Responses	Frequency	Percentage
Challenges	Low sunlight	41	48.81
	Time consuming	36	42.86
	Difficult procedure	7	8.33
Reasons for Non-exposure	Negligence	21	25.00
	Bottle lost	46	54.76
	Boiling	17	20.24

DISCUSSION

The overall objective of the study relayed primarily on the effectiveness of using solar disinfection in respect of compliance and associated reduction of waterborne diseases resulting to diarrhea. The study used the incidence of diarrhea in children under 5 years of age as indicators of effectiveness. As secondary objectives, the study also intended to create a better understanding of the role of SODIS method in reducing diarrhea and as an alternative which was accepted by the targeted community.

The four communities chosen for the field studies, namely Sankara, Kigundu, Kiwempe and Mutesasila, had both similarities and differences. The communities study sites consisted of urban slums areas with a very low socio-economic status. People have inadequate access to free water in their households. The water provided is of significantly low quality and diarrhea incidences in the areas were reasonably high. People paid for water provided at standpipes, while having a number of other water sources mainly untreated which are predominantly available to the community. Most of People lived under circumstances of poverty and sub-standard housing conditions. The outcomes of the field studies in each community were much more fundamentally determined by events outside the control of the project team. These

resulted to the serious participatory and financial problems. The study group suffered a severe flood outbreak during the trial period which caused for relocation.

SODIS and Compliance

During the trial, the degree to which participants adhered to complete the questionnaires required from the study group, was used as a substitution of motivation to participation. This measure allowed calculation of motivation for households and also used to determine both the incidence of diarrhea and the level of compliance in the community. Our data showed that more than three quarter of the households falls under this measure with 81% compliance rate within 3months of trial. The decision to use questionnaires to fill-in as a substitution for adherence to the SODIS protocol came in the way with significant doubt that was cast upon whether the community health workers have effectively explained, monitored, supervised or distributed the materials to the participatory communities.

Despite an intensive health promotion intervention in 11 communities, compliance with SODIS was very low (32%), and the SODIS group did not show a statistically significant reduction in incidence of diarrhea. The reason for the failure of the trial was unclear as it could either have been a failure of SODIS to reduce risk, or a failure of the intervention to generate sufficient compliance with SODIS to achieve a reduction in risk as pointed out by Bhutta (2009). Compliance was measured using "four different subjective and objective indicators" (Maüsezahl et al., 2009). The authors state that "Judgments criteria for this main compliance indicator study included observing regular SODIS practice and bottles exposed to sun or ready to drink in the kitchen and being offered SODIS-treated water upon request." It is, therefore, unclear as to what their stated compliance rate of 32% could have been attributed to. However, it is notable that their compliance indicator was not correlated with risk of diarrhea, suggesting that either (a) it was too imprecise a measure of compliance to show a graded association or (b) that even the most compliant households failed to comply sufficiently to show any effect on disease. However, the finding highlights the importance of understanding the role of participant motivation in the effectiveness of SODIS. Previous reports have attempted to measure compliance with SODIS as a determinant of effectiveness by noting, for example, if SODIS bottles are in place in the sunlight when a field worker makes an unannounced visit (Rose et al., 2006) as well as self-reporting by careers and being offered a drink of SODIS water on request (Maüsezahl et al., 2009).

However, the research encountered series of setbacks. The lack of adequate follow ups strategies lead to the absence of participation of the majority of the households. The completion of diarrheal diaries as a substitution for compliance to SODIS became unfeasible for data analysis because the amount of diary data recorded were insignificant during the main study period. A reference indicating the participation of a few were noticed but not documented in this report.

CONCLUSION

SODIS has been proven to be a low-cost simple point-of-use alternative water disinfection method that supports inactivation of enteric pathogens in drinking water and subsequently reducing risk of diarrheal diseases in humans. The SODIS health impact assressment undertaken during this study confirmed its ability to reduce diarrhea among children under 5

years of age. Importantly, the effectiveness of SODIS could be confirmed by the percentage of reduction on diarrheal incidences reported by respondents based on the intervention. In our view these are important findings for the low-income household water treatment (HWT) interventions, and could also offer an alternative to the unsafe tap, spring, well and borehole water sources available to the residents of Makindye division in Kampala.

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