Effectiveness of Health Education Intervention on Water Sanitation and Hygiene Practice among Adolescent Girls in Maiduguri Metropolitan Council, Borno State, Nigeria: A Cluster Randomised Control Trial

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Abstract: Poor water sanitation and hygiene practice can be associated with increased morbidity and mortality. The study aimed to determine the effectiveness of health education intervention using information, motivation and a behavioural skill model on water sanitation and hygiene (WASH) practice among adolescent girls in Maiduguri Metropolitan Council, Borno State, Nigeria. A school-based cluster randomized control trial was conducted among 417 adolescent girls (10 to 19 years old) in four schools. The KoBo collect toolbox was used for data collection from October 2019 to March 2020. The chi-squared test was used to compare the baseline differences between intervention and control groups for WASH practice. A generalized estimating equation was used to assess changes from baseline, post intervention and follow up. There was significant interaction for WASH practice during follow up. Religion, place of residence, monthly income and occupation of mother had a statistically significant effect on WASH practice among adolescent girls. Findings revealed that this health education intervention was effective in improving water sanitation and hygiene practice among adolescent girls. Furthermore, religion, place of residence, monthly income and occupation of mother were found to be associated with water sanitation and hygiene practice.

Keywords: water; sanitation; hygiene; adolescent; KoBo collect; health education; intervention

1. Introduction

The importance of safe, portable drinking water, sanitation and hygiene (WASH) has long been regarded as a general public health concern, especially among children and adolescents [1]. Water, sanitation, and hygiene are subcomponents of child survival and play major roles in the lives of adolescents in all its ramifications [2,3]. Access to safe and portable water, sanitation and hygiene do not only promote good hygiene practice, but they are fundamental components of a healthy family, healthy community and a key impact on nutrition, Moreover, these components become the drivers of achieving the 2030 sustainable development goal on access to safe drinking water including health, nutrition, education and gender equality in general [4–6]. Absence of awareness on hygiene practices, inadequate access to good and portable water, poor sanitation and hygiene practices increases the burden of malnutrition, mortality and morbidity among adolescents [4,7]. Appropriate hand washing practice is one of the most cost effective and cost-efficient means of reducing the spread of infection among humans, especially adolescents, and children in the environment, schools and play grounds. Hygiene practice among adolescent girls is important in reducing the risk of reproductive and urinary tract infection and their related complications [4,7].

Globally in 2015, an estimated 844 million (one in every ten people) lack access to improved portable and safe drinking water [8]. About 2.3 billion (one in every four people) lacked basic sanitation services with 892 million practicing open defecation and 856 million using improved latrine facilities [8]. In Nigeria an estimated 63 million people lack access to an improved source of drinking water, and about 100 million people do not have access to basic facilities for sanitation and hygiene. Moreover, some 12% of the population residing in the urban area practice open defecation [9]. In Borno State, about 3.6 million people lack access to safe and portable water, 1.9 million people do not have access to basic sanitation and 6.2 million people do not practice proper hygiene due to the low rate of hand washing and the high rate of open defecation [10]. Water, sanitation and hygiene intervention promotes the utilization of clean and portable water, enhances facilities for disposal of feces and also promotes frequent hand washing practice in order to reduce the spread of infectious diseases [11].

Addressing the issue of WASH among adolescent girls, especially among the early adolescents, can be a window of opportunity for "catch-up" growth, thereby reducing the burden of malnutrition, infection and mortality. When WASH is taken as a serious public health problem, it will be an important key for breaking the inter-generational cycle of malnutrition. Malnutrition is directly caused by inadequate dietary intake or diseases and it is indirectly related to many factors, including poor safe, portable water, sanitation and hygiene [12]. In order to reduce the burden of malnutrition among adolescents, especially girls, it requires a shift from interventions that focus solely on under-five children, pregnant and lactating mothers to reach out to adolescent girls to improve their nutrition as well as the living environment [13]. Several health education interventions using randomsed control trials with an active control group have been an effective method in improving water, sanitation and hygiene practices among adolescents [14–16].

The authors chose to focus on adolescent girls only because access to safe water, sanitation and hygiene is more dire to girls than boys in the area of sexual and reproduction health, gender equality and malnutrition, thereby contributing to maternal morbidity and mortality. Women and girls bear an unequal burden collecting water for themselves and their families, with consequences for their health and safety where clean water is not easily accessible. Women and girls are both the most likely to be exposed to unsafe water and bear the consequences of lack of access to clean water, adequate sanitation, and wastewater management. Without addressing these linkages, governments' ability to achieve the sustainable development goals will fall short [17].

Being the first health education intervention on WASH practice among adolescent girls in the state, the study tries to answer the research question on what is the effectiveness of health education intervention on water, sanitation and hygiene practices among adolescent girls in Maiduguri Metropolitan Council (MMC), Borno State, Nigeria. The main objective of the study was to determine the effectiveness of health education intervention on water, sanitation and hygiene practices among adolescent girls in Maiduguri Metropolitan Council (MMC), Borno State, Nigeria using information, motivation and behavioural skill (IMB) model. A cluster randomised control trial was performed.

2. Materials and Methods

2.1. Study Design and Participants

The study location was the state capital, Maiduguri Metropolitan Council (MMC), one of the 27 local government council of Borno state, Nigeria. Borno has a population of about 4,171,104 consisting of 2,163,358 male and 2,007,746 females, Maiduguri has a population of about 540,016 [18–20]. There are eight government secondary schools in MMC, Borno State, Nigeria, which are either mixed (girls and boys) or single girls schools. A random number generating software and an opaque sealed envelope were used for the allocation concealment, out of which the two schools selected were single girls schools, while the remaining two were mixed schools (girls and boys).

This was a cluster randomised control trial carried out from October 2019 to March 2020 among adolescent girls 10 to 19 years old. Simple random sampling was used for the selection of participants in this study. Two populations proportional for sample size, according to the method of Lemeshow and Lwanga, was used to determine the sample size [21], $Z_{1-\alpha/2}$ = 1.96 (95% confidence interval), $Z_{1-\beta}$ = 1.282, proportion of distributing based on attitude p1 (0.938), p2 (0.803) [22], effect size of 1.3, considering non-response rate of 20%, the total sample 'size was 424 (212 for intervention and 212 for the control group). Inclusion criteria were a full secondary school with junior secondary school 1 (JSS) to senior secondary 3 (SS), a mixed school or girl's school only, must be a government school with adolescent girls aged 10 to 19 years old. Private schools, primary schools with universal basic education (UBE) only, schools mixed with married women, schools with boys only and sick adolescent girls were excluded from the study.

2.2. Procedure of the Study

Four schools were randomly selected, randomization and allocation concealment was performed as group one were allocated as the intervention group and group two was allocated as the control group, using opaque sealed envelopes. The eligible participants (424) were given two written informed consent, one for them and the other one for their parents/guardian to sign before enrolment into the study. A total of 417 (208 intervention group, 209 control group) returned the signed consent form. Each participant was then interviewed by a trained enumerator using the KoBo collect software tool at baseline, three months post intervention and at follow up at the sixth month. Single blinding was employed, the participants were not aware of the randomization and allocation process.

2.3. Variables and Instruments

WASH practice consisted of five questions with options to choose one as shown in Table 1 The questionnaire was adapted from a food and agricultural organisation of the United Nation (FAO) [23]. The instrument was field-tested in several countries like Cambodia, Mexico, Malawi and El Salvador to ensure that it was valid, readable, stress-free to administer and was not too much of a burden for the respondents. Correct answers in the questionnaire was scored as a 1 and wrong answers were scored as a zero. The total score for WASH practice was 13. The same questionnaire was used to collect data at baseline, three months post intervention and at follow up at the sixth month. The mean and standard deviation for age of adolescent girls was 15.0 ± 2.0 for the intervention group and 15.0 ± 2.0 for the control group.

Table 1. WASH practice of respondents at baseline.

Items	Response	Intervention n (%)	Control n (%)	Total n (%)	X^2	*p*-Value
What is your current source of drinking water	Tap	32(15.4)	45(21.5)	77(18.5)	4.863	0.433
	Borehole	81(38.9)	80(38.3)	161(38.6)		
	Well	6(2.9)	4(1.9)	10(2.4)		
	Dam	(53925.5)	40(19.1)	93(22.3)		
	Tanker	9(4.3)	12(5.7)	21(5.00)		
	Truck	28(13.4)	27(13.0)	55(13.2)		
Where do you dispose human waste at home	Private latrine	91(43.8)	77(36.8)	168(40.3)	2.083	0.353
	Shared latrine	115(55.3)	130(62.2)	245(58.8)		
	Open defecation	2(1.00)	2(1.0)	4(1.00)		
What are the times when you wash your hands with soap or ash or sand and clean water	After visiting the toilet	187(89.9)	196(93.8)	383(91.8)	2.421	0.298
	Before sleeping	16(7.7)	11(5.3)	27(6.5)		
	Before going to the toilet	5(2.4)	2(1.0)	7(1.7)		

Table 1. *Cont*.

Items	Response	Intervention n (%)	Control n (%)	Total n (%)	X²	*p*-Value
I keep my water in a	Clean container	44(21.2)	29(13.9)	73(17.5)	4.009	0.135
	Covered container	52(25.0)	61(29.2)	113(27.1)		
	Clean covered container	112(53.8)	119(56.9)	231(55.4)		
In which of the following ways do you treat your drinking water to make it safe at home	Boil the water	45(21.6)	39(18.7)	84(20.1)	5.007	0.082
	Use a clean cloth to strain the water	91(43.8)	114(54.5)	205(49.2)		
	Allow the dirt to settle at the bottom of the container	72(34.6)	56(26.8)	128(30.7)		

chi-squared = x², * significant level at *p* < 0.05.

2.4. Intervention Strategy

The purpose of health education intervention using IMB was to educate adolescent girls on basic WASH practices. The intervention group received health education on WASH in six sessions (bi-weekly) during the three-month intervention. Each session lasted for one hour thirty minutes consisting of lectures, discussion and hand washing practices. During the health education session, the facilitator covered topics such as sources of drinking water, basic sanitation facilities and hygiene practices as shown in Table 2. The control group received malaria health education intervention by the facilitator. The module was validated by experts and the content validity of health education intervention module was evaluated to confirm its appropriateness, relevance and clarity, taking into account the learning skills to meets the needs of the participants under local conditions [24]. In this study three experts evaluated the content of the module based on four Likert scales ranging from strongly disagree to strongly agree (strongly disagree 1, disagree 2, agree 3 and strongly agree 4). To assess the content of the module, the number of scores filled in by the experts (x), was divided by the actual scores (y), then multiplied by one hundred.

Table 2. Illustration of WASH Health Education Intervention Module by Theory Construct and Content.

Module	Theory Construct	Content	Strategy	Estimated Time
Module 1	Information and behavioural skills	Definition of water, sanitation and hygiene, general sources of water in school and at home, sources of clean water.	Lecture, discussion, brainstorming, role play	1 h 30 min
Module 2	Information and behavioural skills	Water storage	Lectures, brainstorming, and practical's	1 h 30 min
Module 3	Information and behavioural skills	Treatment of drinking water	Lectures, discussion, brainstorming	1 h 30 min
Module 4	Motivation	Prevention of diseases caused by poor WASH practices, participants' experiences and those of other adolescent girls.	Brainstorming, discussion	1 h 30 min
Module 5	Information and behavioural skills	Sanitation, Hygiene, Hand Washing Practical CDC	Lectures, discussion, brainstorming, hand washing practical's	1 h 30 min
Module 6	Motivation	Preventive measures, community norms, and how best they continue with what they have learnt spreading the information to their peers.	Brainstorming, discussion	1 h 30 min

Content validity = (number of scores filled in by the experts (x)/actual scores (y)) $\times$ 100

= (67/72) $\times$ 100

= 93%

A module achieving more than 70% shows that the module has high authenticity, and is considered to achieve a high level of success [25–27].

2.5. Data Analysis

Data collected were transferred from the cloud storage of the KoBo collect toolbox to the statistical package for social sciences software (IBM SPSS) version 25 for analysis produced by SPSS Inc. based in Chicago. Frequency and percentage were used for descriptive analysis on each hygiene item. Mean $\pm$ standard deviation for intervention was 10.34 ± 2.2 and for the control group it was 10.13 ± 2.2 for WASH practice items. The chi-squared was used for categorical bivariate analysis to determine the differences between the intervention and control group for each hygiene item at baseline. The independent *t*-test was used to determine the continuous mean score differences between intervention and control at baseline post intervention and follow up while the paired *t*-test was used to determine the within differences between the baseline and follow up in both intervention and control groups. Multivariate analysis using a generalised estimating equation (GEE) was used to determine changes in WASH practice between intervention and control groups at baseline, immediately after intervention and follow up.

2.6. Ethical Approval

The study obtained ethical approval from Jawatankuasa Etika Universiti Putra Malaysia UPM UPM/TNCPI/RMC/JKEUPM/1.4.18.2 (JKEUPM). The trial was registered with Pan African Clinical Trials Registry (PACTR201905528313816). An approval letter was also obtained from the ministry of education Maiduguri, Borno State, Nigeria. Signed informed consent was obtained from participants, and their parents/guardian.

3. Results

The response rate at three months post intervention was 203 (97.6%) in the intervention group and 206 (98.6%) in the control group. During follow up at the sixth month, the response rate was 199 (95.6%) for respondents in the intervention group and 204 (97.6%) in the control group. The overall response rate during follow up at the sixth month was 403 (96.6%). Intention to treat was used for the analysis.

There was no significant difference in the baseline sociodemographic characteristics. The age of the adolescent girls ranged from 10 to 19 years old, their ages were grouped into three: early adolescents stage (10–13 years), middle adolescent stage (14–16 years) and late adolescent stage (17–19 years). The mean standard deviation for age was 15.0 ± 2.0 for the intervention and control groups. Fifty-five (26.4%) of respondents in the intervention group and 52 (24.9%) in the control group were in early adolescent stage, 101 (48.6%) in the intervention group and 102 (48.8%) in the control group were in middle adolescent stage, while 52 (25.0%) in the intervention group and 55 (26.3%) in the control group were in late adolescent stage. Religion of respondents: 57 (27.4%) were in the intervention group and 59 (28.2%) in the control group were from Christian religion while 151 (72.6%) in the intervention group and 150 (71.8%) in the control group were from the Islamic religion. Respondents in the intervention group 30 (14.4%) and 41 (19.6%) in the control group resides in rural areas while 178 (85.6%) in the intervention group and 168 (80.4%) in the control group resides in the urban area. Respondents household monthly income of between ₦ 18,000 and ₦ 30,000 in the intervention group was 65 (31.3%) and 69 (33.0%) in the control group. The majority of mothers were housewives, with 69 (33.2%) in the intervention group and 75 (35.9) in the control group.

3.1. WASH Practice of Respondents at Baseline

Table 1 shows the distribution of WASH practice between intervention and control at baseline. The current source of water among respondents was dam 173 (41.5%), 176 (42.2%) of respondents use a shared latrine, 371 (89.0%) wash their hands with soap and water after using the toilet, 242 (58.0%) keep their water in a clean, covered container, while 180 (43.2%) allow the dirt in the water to settle at the bottom of the container. There was no significant difference in WASH practice statements between intervention and control at baseline.

3.2. Evaluation of the Effectiveness of Health Education Intervention on WASH Practice

3.2.1. Comparing Changes from Baseline to Follow Between Intervention and Control Group

Table 3 shows that the mean ± SD for WASH practice score between intervention was 10.34 ± 2.2 and for the control group it was 10.13 ± 2.2 at baseline, and the overall mean ± SD was 10.23 ± 2.2. There was no statistically significant difference between intervention and control groups for WASH practice at baseline ($p = 0.330$). There was a statistically significant change from baseline to post intervention and follow up (post intervention: $p < 0.001$; follow up: $p < 0.001$) respectively.

Table 3. Mean scores of WASH practice from baseline to follow up (3 months after intervention) between intervention and control group.

Variable	Intervention Mean ± SD (*n* = 208)	Control Mean ± SD (*n* = 209)	Overall Sample Mean ± SD (*n* = 417)	*t*	*p*-Value
Hygiene at baseline	10.34 ± 2.2	10.13 ± 2.2	10.23 ± 2.2	−0.976	0.330
Hygiene at post intervention	11.22 ± 2.10	10.46 ± 1.77	10.84 ± 1.97	−3.977	<0.001 *
Hygiene at follow up	11.57 ± 1.89	10.26 ± 2.01	10.91 ± 2.06	−6.855	<0.001 *

t = independent *t*-test, * significant level at $p < 0.05$.

Table 4 shows the evaluation of change in mean score of hygiene practice from baseline to six (6) months follow up. There was a statistically significant change from baseline to follow up (Time 0 vs. Time 2) ($p < 0.001$). The table further reveals that there was no significant change in the control group from baseline to six (6) months follow up after intervention ($p = 0.540$).

Table 4. Mean scores of WASH practice from baseline to follow up (3 months after intervention) within intervention and control group.

Group	Time Points for Hygiene Practice	Baseline Mean ± SD	Follow up Mean ± SD	Mean Difference	*t*	*p*-Value
Intervention group	Time $_0$ vs. Time $_2$	10.34 ± 2.2	11.57 ± 1.89	−1.23	−5.995	<0.001 *
Control group	Time $_0$ vs. Time $_2$	10.13 ± 2.2	10.26 ± 2.01	−0.13	−0.614	0.540

t = paired *t*-test, * significant level at $p < 0.05$.

Figure 1 reveals changes in WASH practice between the intervention and control groups from baseline to post intervention and follow up. Respondents in the intervention show significant increase in WASH practice from baseline to post intervention and follow up.
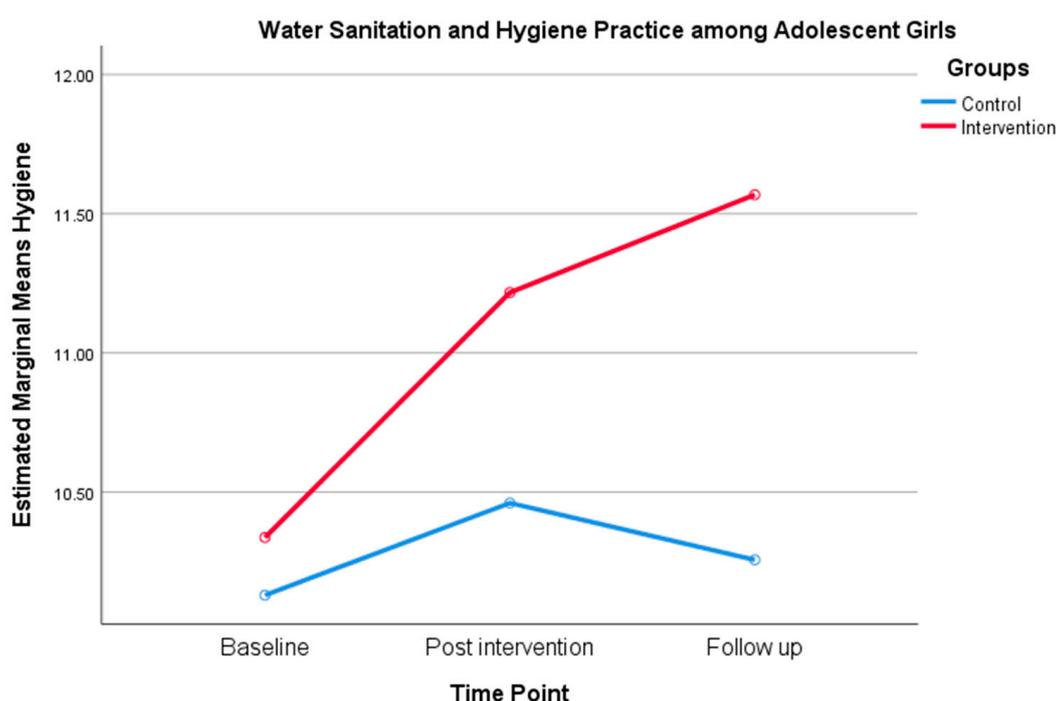
Figure 1. Changes in WASH practice between intervention and control group at three time points.

3.2.2. Factors Associated with WASH Practice

A generalised estimating equation (GEE) was used to assess sociodemographic characteristics, sources of information, information, motivation, behavioural skill level on hygiene practice at univariable analysis. Eight factors were statistically significant including group, time, religion, place of residence, monthly income, education of father, occupation of mother, and information at univariable analysis as shown in Table 5.

Table 5. List of each factor on WASH practice using generalised estimating equation.

	B	SE	Crude Odd Ratio	Wald Chi-Square	95% CI Lower Bound	95% CI Upper Bound	*p*-Value
Groups							
Control	Ref						
Intervention	0.510	0.112	1.665	20.634	1.336	2.075	<0.001 *
Time points							
Baseline	Ref						
Post intervention	0.571	0.149	1.770	14.728	1.322	2.368	<0.001 *
Follow up	0.729	0.145	2.073	25.356	1.561	2.754	<0.001 *
Age of adolescent girls (Years)							
Early adolescents	−0.049	0.158	0.756	0.096	0.698	1.298	0.756
Middle adolescents	−0.227	0.126	0.797	3.231	0.622	1.021	0.072
Late adolescents	Ref						
Ethnicity							
Bura	Ref						
Kanuri	0.201	0.191	1.222	1.102	0.840	1.778	0.294
Hausa	0.393	0.292	1.482	1.814	0.836	2.625	0.178
Marghi	0.243	0.243	1.275	0.995	0.791	2.053	0.319

Table 5. *Cont.*

	B	SE	Crude Odd Ratio	Wald Chi-Square	95% CI Lower Bound	95% CI Upper Bound	*p*-Value
Shuwa	0.425	0.294	1.529	2.090	0.860	2.719	0.148
Fulani	0.167	0.245	1.182	0.466	0.732	1.909	0.495
Chibok	0.319	0.292	1.376	1.195	0.776	2.440	0.274
Gwoza	−0.226	0.251	0.798	0.807	0.488	1.305	0.369
Other ethnic groups	0.225	0.238	1.253	0.893	0.785	1.999	0.345
Religion							
Christianity	Ref						
Islam	0.348	0.127	1.416	7.493	1.104	1.816	0.006 *
Place of residence							
Rural	Ref						
Urban	−0.414	0.149	0.661	7.703	0.493	0.885	0.006 *
Monthly income							
Less than ₦ 18,000	Ref						
₦ 18,000–₦ 30,000	−0.089	0.153	0.915	0.339	0.677	1.235	0.560
₦ 31,000–₦ 50,000	−0.349	0.178	0.705	3.859	0.498	0.999	0.049 *
₦ 51,000 and above	−0.337	0.162	0.714	4.315	0.520	0.981	0.038 *
Education of father							
No education	Ref						
Informal education	0.047	0.238	1.048	0.039	0.658	1.670	0.843
Primary education	−0.641	0.323	0.527	3.928	0.279	0.993	0.048 *
Secondary education	0.141	0.202	0.868	0.489	0.584	1.291	0.485
Tertiary education	−0.140	0.193	0.869	0.523	0.595	1.270	0.469
Age group of mother (Years)							
≤34	0.013	0.160	0.805	1.835	0.588	1.102	0.932
35 to 44	−0.217	0.156	1.013	0.007	0.746	1.376	0.176
≥45	Ref						
Occupation of mothers							
Civil service	Ref						
Trading/business	0.036	0.147	1.037	0.061	0.777	1.383	0.805
Farming	−0.642	0.231	0.526	7.716	0.335	0.828	0.005 *
House wives	−0.080	0.143	0.923	0.310	0.697	1.223	0.577
Family type							
Monogamy	Ref						
Polygamy	0.177	0.116	1.193	2.333	0.951	1.497	0.127
Information							
Poor information	Ref						
Good information	0.328	0.124	1.389	6.970	1.088	1.772	0.008 *

* significant < 0.05; SE = standard error; CI = confidence interval; Ref = reference category; B = unstandardized beta; BMI = body mass index.

Twelve factors with *p* < 0.25 in univariable analysis were tested in GEE, including group, time, age of adolescent, ethnicity, religion, place of residence, income, education of father, age of mother, occupation of mother, family type, information.

Table 6 shows seven factors had significant main effect on WASH practices. There was a significant interaction at follow up; respondents at follow up were more likely to have good WASH practice compared to respondents in the control group at baseline (Adjusted odd ratio (AOR) = 2.487, 95% CI: 1.383–4.469, *p* = 0.002).

Table 6. Factors associated with WASH practice of respondents using a generalised estimating equation.

Variables	B	SE	Adjusted Odd Ratio	Wald Chi-Square	95% CI Lower Bound	Upper Bound	*p*-Value
Intercepts	−0.012	0.258					
Groups							
Control	Ref						
Intervention	0.118	0.205	1.125	0.330	0.753	1.680	0.566
Time points							
Baseline	Ref						
Post intervention	0.380	0.212	1.462	3.217	0.965	2.214	0.073
Follow up	0.301	0.197	1.351	2.334	0.918	1.988	0.127
Interaction							
Control *baseline	Ref						
Intervention *post intervention	0.396	0.301	1.486	1.734	0.824	2.680	0.188
Intervention *follow up	0.911	0.299	2.487	9.273	1.383	4.469	0.002 *
Religion							
Christianity	Ref						
Islam	0.339	0.129	1.404	6.972	1.091	1.806	0.008 *
Place of residence							
Rural	Ref						
Urban	−0.458	0.159	0.632	8.283	0.463	0.864	0.004 *
Monthly income							
Less than ₦ 18,000	Ref						
₦ 18,000–₦ 30,000	−0.222	0.159	0.801	1.945	0.587	1.094	0.163
₦ 31,000–₦ 50,000	−0.339	0.181	0.712	3.533	0.500	1.015	0.060
₦ 51,000 and above	−0.352	0.163	0.703	4.646	0.511	0.969	0.031 *
Occupation of mothers							
Civil service	Ref						
Trading/business	−0.012	0.145	1.012	0.006	0.761	1.345	0.936
Farming	−0.627	0.212	0.534	6.736	0.333	0.858	0.009 *
House wives	−0.108	0.141	0.897	0.590	0681	1.183	0.442

* significant < 0.05; SE = standard error; CI = confidence interval; Ref = reference category; B = unstandardized beta; Quasi-likelihood under Independence Model Criterion (QIC) = 1671.102; Corrected Quasi-likelihood under Independence Model Criterion (QICC) = 1672.608.

Respondents from the Islam religion were more likely to have good WASH practice compared to respondents from the Christian religion (AOR = 1.404, 95% CI: 1.091–1.806, *p* = 0.008). Respondents from an urban area were less likely to have good WASH practice compared to respondents from a rural area (AOR = 0.632, 95% CI: 0.463–0.864, *p* = 0.004). Respondents whose monthly income was ₦ 51,000 and above were less likely to have good WASH practice compared to respondents with monthly income less than ₦ 18,000 (AOR = 0.703, 95% CI: 0.511–0.969, *p* = 0.031). Respondents whose mother's occupation was farming were less likely to have good WASH practice compared to respondents whose mothers were civil servants (AOR = 0.534, 95% CI: 0.333–0.858, *p* = 0.001).

4. Discussion

To the best of our knowledge, this is the first study to evaluate the effectiveness of health education intervention on water sanitation and hygiene practices among adolescent girls in Maiduguri Metropolitan Council, Borno State, Nigeria. This study is the first intervention study among adolescents in the region and the state, and the study has an active control group. Baseline characteristics of the schools studied in this research were similar and theory was used in this study, in order to achieve the objective of the study.

Interventions involving WASH have a potential contribution in making the general health and welfare of children and adolescents better [28]. Improvement in WASH has fundamental importance in promoting the health and nutrition of children and adolescents globally. Scarcity of water or lack of improved portable water, inadequate access to im-

proved sanitation and hygiene contribute immensely to a high burden of health conditions such as infectious diseases, worms and malnutrition among others. WASH related illnesses further contribute to the vicious cycle of poverty, disease and even malnutrition, thereby creating negative impact on the performance and productivity of children and adolescents within the family and community [28–31].

The evaluation of changes between and within intervention and control groups from baseline to post intervention and follow up was statistically significant in line with a study in Bangaluru, Zimbabwe, Cambodia, Indonesia, Kenya, Philippines, Nepal and Bangladesh [15,28,32–36]. Even though the mean score change was small (mean score change = 1.23), it is equivalent to 15.38% significant changes in WASH practice compared to baseline, which showed that the health education intervention module had significant impact among adolescent girls. This reveals a practical suggestion to stakeholders in prioritizing improvement in WASH practice as an area of concern among adolescents. And in line with this, sustainable development goals cannot be achieved without addressing the issue WASH and mainstreaming it into all aspects of multi-sectoral interventions for better health and betterment of adolescent girls and humanity by 2030 [5,17]. To ease the interpretation of WASH practice outcomes, wash practice score was converted to a binary dependent variable for further analysis, scores < median were considered poor hygiene, while scores ≥ median score were considered good hygiene.

Although the result from this study shows statistical significance, the result reveals the positive direction of the impact of the intervention. The outcome of WASH practice intervention in this study can go a long way in preventing the spread of infectious diseases among these age groups and beyond, that is caused by poor water sanitation and hygiene practices, as these infectious diseases have a synergistic effect with malnutrition. Poor access to safe and adequate WASH can further predict growth and malnutrition among children and adolescents. Furthermore, sustaining this intervention will reduce the fecal-oral transmission of micro-organism through the provision of improved water supply, household water treatment and safety storage, improved sanitation facilities and best hygiene practices such as hand washing after the use of toilet and before the preparation of food. Behavioural influences are significant in determining the adoption of sustainable WASH practices and are highly efficient, though its effectiveness depends on the context and behavioural changes that is possible through the transfer of knowledge and hygiene promotion. In general, this intervention tends to reduce the spread of infectious diseases, severity and impact of malnutrition, promote dignity and enhance safety mostly among girls. The presence of a safe clean water supply and functioning latrine/toilet facilities will greatly promote school attendance due to their improved health and nutritional status, reduce school dropout among girls and encourage continuity of education as WASH intervention can aid in beginning a lifetime of better health for all children and adolescents [1,12,37–39].

The overall response rate during follow up concurs with a study in Cambodia, Indonesia and Lao PDR [28]. There was no significant difference in WASH statements between intervention and control at baseline. The intervention and control groups were comparable at baseline in WASH practice statement and overall WASH practice score.

However, there was a statistically significant interaction at follow up; respondents at follow up were more likely to have good WASH practice compared to respondents in the control group at baseline. The finding was similar to studies in North Bengaluru, Ghana and Kenya that reported significant changes in follow up [32,40,41]. Religion plays a major role in shaping individual lives, as many individuals depend on religious practices for guidance into experiences and behavioural practices in life where they can find hope and social support [42,43]. Regarding the place of residence, adolescents residing in urban areas are more likely to receive more information on WASH facilities, where they learn about issues related to daily living in order to prevent harm and promote individual care in addressing WASH as a public health concern. In the urban area there was a high level of acceptance of some of the national initiatives like global hand washing day,

better infrastructure/basic amenities with more government investment [4,44]. Household monthly income may be applicable to improvement in WASH, as inadequate or low income is considered the primary cause of poor WASH practice, as social inequality has greater influence on hygiene practice [41,45]. The occupation of the mother had significant effect on the WASH practice of respondents. The occupation of mothers gives more strength to the socialization function of the family and the integration of good WASH practice among children and adolescents, thereby increasing their hygiene activities [45]. Water, sanitation and hygiene among adolescent girls focuses on the development of their skills to influence their hygiene practice positively on themselves, in their homes, and the community at large, to reduce the burden of disease [42,43].

In this study, this health education intervention has significantly improved WASH practice among adolescent girls in the intervention group compared to the control group. The strength of this study includes a cluster randomized control trial which is a goal standard, large sample size and the use of effect size, the frequency of contact during the intervention (bi-monthly intense health education intervention), the duration of intervention (three months intervention), follow up after three months intervention, single blinding, the use of opaque envelopes during randomization and allocation concealment, the use of theory-based intervention, applying intention to treat in the analysis (once randomised always analysed), overall high retention rate of greater than 90% during follow up data collection, and the control group received malaria health education intervention. Rigorous training of both facilitator and enumerators and the use of KoBo Collect Toolbox software for data collection were also strengths of the study.

There might be possible response bias from the respondents as some of the respondents may tend to portray their water sanitation and hygiene practice in line with the safety WASH practice. Future study should target adolescent girls attending private secondary schools, school drop outs and those not attending any school at all. Future studies should explore the use of mass media and social media such as reality shows involving adolescents in the initiative. The result from this study shows poor WASH practice among adolescent girls at baseline. Since this is the first study in the state with great improvement in the respondents WASH practices, the module can be adapted by stakeholders and make it available for all age groups to benefit from it. School administrators and the ministry of health and education should place more emphasis on basic hygiene practices to reduce the burden of infectious diseases. Broader research on the WASH practice is highly recommended. School-based health and nutrition education intervention should be part of the comprehensive school health program to reach out to both adolescents and their potential family members.

5. Conclusions

Findings from this study reveal that the intervention study designed to improve practices on WASH have increasing beneficial effect on the growth and development of adolescent girls. the study reveals that there was no significant difference between the intervention and control groups at baseline. Furthermore, health education intervention has improved the WASH practice of adolescent girls in Maiduguri Metropolitan Council, Borno State. More so, the study further reveals that there was a significant interaction at follow up as respondents at follow up were more likely to have good WASH practice compared to respondents in the control group at baseline. Religion, place of residence, income and occupation of the mother were statistically associated with WASH practice.

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