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Diarrheal Effects among Children under Five Years of Age on Health Systems Performance in Western Kenya: A Descriptive Cross-Sectional Study

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ABSTRACT

Background: Annually, there are approximately 2.39 billion cases of diarrheal conditions, posing a significant global health issue. Diarrhea has significant effects on health system performance. This study aimed to assess the effects of diarrheal conditions on health systems performance in Migori County, western Kenya, specifically among children under the age of five years.

Methods: A fascinating cross-sectional descriptive study was meticulously carried out. The study involved conducting a detailed descriptive analysis and utilizing the chi-square test of independence to explore the relationship between variables in a univariate analysis. By employing logistic regression, we conducted a bivariate analysis to explore the relationship between independent variables and the outcome. Additionally, we performed a multivariate analysis to account for any potential confounding factors.

Results: Out of the 334 children, majority (58%) were female, with a mean age of 32 months. The predictors which significantly predicted the outcome were; stunting growth (*cOR*=1.47; *p*=0.009, *aOR*=1.53; *p*=0.014), reducing cognitive development (*cOR*=1.42; *p*=0.007, *aOR*=1.49; *p* =0.011) and dehydration (*cOR*=1.51; *p*=0.018, *aOR*=1.59; *p*=0.021). Regression modeling had a significant prediction performance [X^2(5, N=334 = 11.36, *p*=0.005)] and were significantly good predictors of the outcome variable (R^2=0.862).

Conclusion: Diarrheal effects significantly predicted the performance of health systems. Community-based health education about the effects attributed to diarrhea and strengthening diarrheal prevention strategies could significantly reduce pressure exerted on the health systems.

Key words: cognitive, diarrheal, dehydration, effects, stunting

INTRODUCTION

Diarrheal diseases pose a significant challenge to global public health, exerting a substantial impact on both the health service providers and infrastructure, prevalence of illness and the occurrence of death worldwide (WHO, 2017)[1]. There is a correlation between the effects on systems responsible for service delivery and stunting growth for developing children, interference with cognitive status and dehydration (Melese et al., 2019). Globally, it is estimated that approximately 13.5% of cases of stunting can be attributed to diarrheal disease (Akombi et al., 2017). Childhood diarrheal infections affect growth potential due to loss of essential growth nutrients during diarrhea (Mal-Ed Network Investigators, 2017). The occurrence of diarrheal disease during early childhood, particularly when it happens repeatedly and for extended periods, can have significant and lasting effects on a child's physical growth

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and cognitive development (Scharf et al., 2018; Pinkerton et al., 2016). The reason behind this phenomenon lies in the fact that diarrhea not only heightens the body's demand for additional nutrients but also diminishes a child's appetite and reduces their food consumption (Pinkerton et al., 2016). Diarrhea has been found to cause malnutrition, stunted growth, dehydration as well as mental and physical development impairment on children under five years of age (Pinkerton et al., 2016).

The occurrence of diarrhea during childhood has the potential to result in long-term consequences such as stunted physical growth and delayed cognitive development (Rogawski et al., 2017). The long-term cognitive consequences resulting from significant episodes of diarrhea during early childhood are still not fully understood or clearly defined (Fischer Walker et al., 2012). Diarrhea has been found to be positively associated with cognitive scores (Donowitz et al., 2021). The biggest and most clinically important complication of diarrhea is dehydration, which occurs when a child loses more fluid than they take in (WHO, 2017). When this happens, the body doesn't have enough water or electrolytes to carry out its normal function (GBD 2016 Diarrhoeal Disease Collaborators, 2018). In addition to depleting the body of water and electrolytes; acute diarrhea can have significant negative impacts on a child's nutritional well-being (Guerrant et al., 2013).

Diarrhea not only poses a significant threat to performance of general health systems, but also imposes a considerable economic burden on the affected households (Walker et al., 2013). Putting pressure on the health systems, slow down their other routine service delivery so as to respond to the emergency of diarrhea infections (WHO, 2007; Braithwaite et al., 2017). Consequently, substantial resources are allocated towards the treatment and management of diarrhea cases which could have been used for other essential commodities or services (Braithwaite et al., 2017). This unfortunate circumstance places the children at an elevated vulnerability to increased mortality risks which will require health systems to overwork so as to manage the consequences of diarrheal situations (Van Olmen et al., 2010; Brownlee et al., 2017).

Approximately 75% of effects caused by diarrheal diseases was concentrated within a select group of 15 countries burdened by this health issue (Brownlee et al., 2017). It is worth mentioning that among the 15 countries, a remarkable ten are situated in the sub-Saharan region of Africa, with Kenya proudly included among them (Zimmermann et al., 2019). It was established that in all these countries, their health systems strengthening were affected by the occurrences of diarrhea and more resources were required to plan and mitigate on diarrheal outbreaks (Zimmermann et al., 2019; Wardlaw et al., 2010). In Kenya, it was realized that diarrhea had made health systems to stretch beyond its limits in terms of limited resources so as to contain the occurrence and effects associated with diarrhea infections (Brian, 2016). In addition, the households affected experienced overall financial burden associated with diarrheal treatment and management at various levels of healthcare provisions (Mulatya & Ochieng, 2020).

Diarrheal infections have a detrimental impact on the functional stability of health systems, as they give rise to unforeseen expenses due to diarrhea (Baral et al., 2020). These expenses encompass various aspects, such as healthcare costs, costs associated with reduced productivity due to management and treating of diarrhea related consequences (Cannon et al., 2015). The study aimed to investigate the impact of diarrhea on the performance of health systems in Migori County, located in the western region of Kenya, specifically among children under the age of five. The recommendations of the study will enable significant reduction in diarrheal conditions, hence reducing unnecessary pressure or stress exerted on health systems during diarrheal treatment and or management, and consequently it will save resources which could be utilized to improve the health systems so as to deliver more satisfactory healthcare services.

MATERIALS AND METHODS

Study Design

Descriptive cross-sectional study design was employed to effectively depict the existing conditions within a specific population, capturing a snapshot of the situation as it naturally unfolded. The research was conducted at a specific juncture, encompassing a representative sample from the entirety of the population under scrutiny.

Study Setting

The research was conducted in Migori County, a captivating region located in the western part of the Republic of Kenya, nestled within the beautiful geographical boundaries of this diverse country. The participants were drawn from eight distinct administrative units regarded as Sub-Counties, each with its own unique identity and characteristics. These sub-counties are Suna East, Suna West, Uriri, Awendo, Rongo, Nyatike, Kuria West, and Kuria East.

Study Population

Migori County reported about 58,188 cases of diarrhea during the year 2018, whereby 29,704 (51.05%) cases of diarrhea were for children under five years and 28,484 (48.95%) cases were above five years (DHIS, 2018).

Target Population

The study targeted 29,704 (51.05%) children under five years who suffered from diarrheal conditions and had visited a health facility for treatment or management during the completed year 2018.

Sample Size Determination

The determination of the sample size for this study was based on the statistical formula proposed by Fisher et al. (1998).

$$n = \frac{Z^2 p(1-p)}{d^2}$$

Where;
n= required sample size (minimum size for a statistically significant survey)
p = proportion of diarrhea (assumed prevalence value of diarrhea of 28%)
Z= standard score corresponding to 95% confidence level (and is thus equal to 1.96)
d = margin of error acceptable/ measure of precision (estimated at 5% and is thus equal to 0.05).

$$\text{n} = \frac{1.96^2 \text{x } 0.28 \text{ x } 0.72}{0.05^2}$$

= 309 *(add 10% survey non-response and item non-response)*
= 340

Sampling Procedures

The data for the diarrhea cases under five years for the year under study was obtained from the under five health registers of the 282 different categories of health facilities in Migori County. The lead CHVs for respective link health facilities were present to ensure that live cases only were obtained to form the sampling frame. The researcher clustered the County into eight administrative units namely Sub Counties. The samples from each cluster were obtained proportionally to form the required sample size. The researcher developed a sampling frame by listing all cases alive in each cluster by assigning them random numbers. The researcher wrote the random numbers for each cluster on pieces of paper, folded them to ensure the

random numbers are not visible. Thereafter the researcher selected samples for each cluster by placing them in eight different containers representing the eight clusters, shook them and then blindfolded eight different lead community health volunteers who randomly picked the corresponding number of samples for each cluster.

Data Analysis

Quantitative data analysis

The researcher employed Statistical Package for Social Sciences (SPSS Version 25.0) and Microsoft Excel software to conduct data analysis. On univariate analyses the study employed Descriptive and Chi-square goodness of fit fitness test to investigate the interplay between the variables, specifically examining the relationship of frequencies or distribution. A binary logistic regression analysis was performed to examine the relationship between the independent and dependent variables, with a significance level set at less than 0.05. The individuals who demonstrated statistical significance during bivariate analysis and met the necessary requirements and assumptions for multivariate logistic regression were selected to be part of the final logistic regression model.

Qualitative data analysis

The data obtained through qualitative methodologies, namely Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs), were meticulously transcribed in their entirety using the Microsoft Word software. In order to uphold the utmost precision of the transcribed documents, the research team diligently verified the congruity between the transcripts and the corresponding audio recordings. The qualitative data underwent rigorous analysis through the method of content analysis, which allowed for the identification and exploration of emerging themes.

RESULTS

The study yielded an impressive response rate of 98%.Majority of the children (58%) were female with a statistically significant relationship among their sex [X^2 (1, N=334) = 11.04, p = 0.003]. The average age and range for the children were found to be 32 and 50 months respectively with a standard deviation of 0.67 and a coefficient of variation of 2.11%. These suggested a limited range of variation and dispersion in the data, hence indicating a higher level of consistency and predictability in the responses regarding the age. Age distribution analysis revealed that the highest (25%) proportion fell within the range of 35 to 47 months. Conversely, the age group encompassing infants (0 to 11 months) exhibited the lowest percentage (13%). This successfully demonstrated a noteworthy correlation between the ages [X^2 (4, N=334) = 13.61, p = 0.014], revealing a statistically significant relationship. The primary caretakers who participated in the study corresponded to the number of children, as each caretaker exclusively reported on a single child. The demographic characteristics are summarized in Table 1.

As tabulated in Table 2, the majority (66%) of the respondents agreed (M=4.13, SD=0.73) that stunting growth of children under five years had an influence on health systems performance. The relationship among the levels of perception on stunting growth was found to be statistically significant (X^2 = 31.39, p = 0.007). On the reduction of cognitive development's influence on health systems performance, there was a statistical significant relationship (X^2 =46.22, p=0.012) with more than a half (55%) of the respondents strongly agreeing (M =4.43, SD=0.79). Dehydration as an effect of diarrhea, was strongly agreed (M=4.44, SD=0.79) by slightly more than a half (56%) of the respondents to be having an influence on health system performance with a statistical significant relationship (X^2= 63.09, p = 0.020). With a standard deviation (SD) of < 1.0 for the three variables, showed a low variability, translating into a more consistency and predictable responses from the respondents.

As shown in Table 3, stunting growth had a statistically significant association with poor health systems. As stunting growth increases by one unit, the log odds of experiencing poor health systems increased by 47% (COR=1.47; *CI* =1.12, 1.87; *p*=0.009). A robust correlation was observed between reduced cognitive development and the performance of health systems, with statistical significance. For every one unit increase in reduced cognitive development as an effect of diarrhea, the log odds of experiencing poor health systems increased by 0.42 (COR=1.42; *CI* =1.15, 1.79; *p*= 0.008). Dehydration as an effect of diarrhea had a statistically significant association with the performance of health systems. As dehydration increased by one unit, the probability of experiencing poor health systems increased by 51% (*COR* = 1.51; *CI*=1.13, 2.15; *p*=0.018). The study revealed that stunting growth, reduced cognitive development and dehydration as a result of diarrhea were statistically significant risk factors interfering with effectiveness of health systems.

While controlling for the confounders as displayed in Table 4, stunting growth at multivariate analysis had a statistically significant association with health systems performance. The adjusted Odds Ratio *(aOR)* was 1.53 (*CI* = 1.27, 1.93; *p*=0.014) from crude Odds Ratio *(cOR)* of 1.47 (CI = 1.12, 1.87; *p*=0.009). The study revealed that for every one unit increase on stunting growth, children were1.53 times more likely to experience poor health systems. The *(aOR)* on reducing cognitive development increased to 1.49(*CI* = 1.18, 1.88; *p*=0.011) from the *(cOR)* of 1.42(*CI* = 1.15, 1.79; *p*= 0.007). The data analysis revealed a strong and meaningful connection, indicating that as cognitive development decreased, the likelihood of encountering poor health systems increased by a factor of 1.49. The association between dehydration and health systems performance was statistically significant. The odds of dehydration were adjusted to 1.59 (*CI*= 1.23, 2.39; *p*=0.021) from 1.51 (*CI* =1.13, 2.15: *p*= 0.018). The study established that for every increase in dehydration, children were 59% more likely to experience poor health systems. The multivariate analysis has shown that at 95% CI, stunting growth, reduced cognitive development and dehydration were statistically significant risk factors for poor health systems.

In reference to Table 5a, the adjusted model was found to be a significant predictor of the outcome with a significant prediction performance of [X^2(4, N=334 = 11.362, *p*=0.005)]. Table 5b illustrates that the strength of association had a large effect on the outcome variable (**Nagelkerke's*R^2 = 0.86) revealing that 86% of the variance in response variable was predicted by the independent variables while 14% of the variance in outcome variable was unexplained by the regression model. Finally as indicated in Table 5c, the model had a good fit (X^2 =12.083, *p* = 0.127), thus the insignificant *p-value* suggests that the model fits the data reasonably well.

Table 1: Socio-demographic characteristics

Variable	Category	(n)%	df.	x^2	*p-value*
Children <60 months					
Sex	Male	(140)42	1	11.04	0.003
	Female	(194)58			
Age (months)	0-11	(43)13	4	13.61	0.014
	12-23	(51)15			
	24 -35	(81)24			
	36 -47	(84)25			
	48- 59	(75)23			
Primary caretakers					
Age (Years)	<20	25(7)	4	18.77	0.021
	20- 29	56(17)			
	30-39	73(22)			
	40-49	82(25)			

	>49	98(29)			
Marital status	Married	241(72)	2	10.59	0.054
	Single	84(25)			
	Others	9(3)			
Highest level of education	No formal education	187(56)	3	14.88	<0.001
	Primary education	96(29)			
	Secondary education	38(12)			
	Tertiary education	13(3)			
Religion	Christians	302(90)	2	11.64	0.073
	Muslim	22(7)			
	Others	10 (3)			
Area of residence	Urban	80(24)	1	9.32	0.004
	Rural	254(76)			
Occupation	House wife	248(74)	4	21.28	0.063
	Privately employed	31(9)			
	Civil servant	41(12)			
	NGO employed	9(3)			
	Others	5(2)			

Table 2: Effects of diarrhea on health systems performance

Variables	Response	n(%)	Mean(SD)	X^2	*p-value*
Stunting growth	Strongly Disagree	6(2)	4.13(0.73)	31.39	0.007
	Disagree	10(3)			
	Neutral	12(4)			
	Agree	221(66)			
	Strongly agree	85(25)			
Reduce cognitive development	Strongly Disagree	9(3)	4.43(0.79)	46.22	0.012
	Disagree	6(2)			
	Neutral	14(4)			
	Agree	121(36)			
	Strongly agree	183(55)			
Dehydration	Strongly Disagree	6(2)	4.44(0.79)	63.09	0.028
	Disagree	6(2)			
	Neutral	10(3)			
	Agree	125(37)			
	Strongly agree	187(56)			

Table 3: Association between effects of diarrheal and health systems performance

Variable	*p-value*	*cOR*	95% CI for EXP(B)	
			Lower	Upper
Stunting growth	0.009	1.47	1.12	1.87
Constant		1.00		
Reduced cognitive development.	0.007	1.42	1.15	1.79
Constant		1.00		
Dehydration	0.018	1.51	1.13	2.15
Constant		1.00		

Table 4: Association between diarrheal effects and health systems performance

Variable	Bivariate regression (crude Model)			Multivariate regression (adjusted model)		
	cOR	95%CI	*p-value*	aOR	95%CI	*p-value*
Stunting growth	1.47	1.12,1.87	0.009	1.53	1.27,1.93	0.014
Reduce cognitive development	1.42	1.15,1.79	0.007	1.49	1.18,1.88	0.011
Dehydration	1.51	1.13,2.15	0.018	1.59	1.23,2.39	0.021

Table 5: Model significance, strength and goodness of fit

a) Omnibus Tests of Model Coefficients				
Description		**Chi-square**	**df**	**Sig.**
Step 1	Step	11.362	4	0.005
	Block	11.362	4	0.005
	Model	11.362	4	0.005

b) Model summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	24.834	.783	.862

c) Hosmer and Lemeshow goodness of fit test			
Step	**Chi-square**	**df**	**Sig.**
1	12.083	4	.127

Qualitative Results

A comprehensive set of eight (8) Focus Group Discussions (FGDs) and eleven (11) Key Informant Interviews (KIIs) were systematically carried out. The study identified three major effects of diarrhea that had a great influence on the response variable.

Themes

Stunting growth

The study participants were inclined to agree that stunting growth had an influence on health systems performance. A female respondent during the FGD session noted;

"*Stunted children due to diarrhea need medical assistance at health facilities. Essential minerals are lost during diarrhea and they need to be replenished. The hospitals are compelled to procure these nutritional commodities at a cost which was not initially planned for hence affecting the performance of other health services."*

Another respondent added;

"Diarrhea consume extra medical commodities at our hospitals making it uneasy for other patients to receive adequate services leaving the community complaining of poor service delivery"

A key informant stated;

"Stunting growth in children is attributed to loosing growth promoting nutrients through diarrhea. This makes children to fall sick more often and frequently visit health facilities for treatment and management. Finally, it will compel health systems to utilize more resources than anticipated, hence interfering with the general performance of the health systems."

Reduced cognitive development

Respondents also revealed that, health systems could be hindered from realizing their full potential of performance if they are subjected to extraneous pressure due to management or treatment of negative consequences of cognitive development. A key informant stated;

"Repeated diarrhea infections in children leads to growth faltering resulting into stunting, which is associated with decrease in cognitive development. To deal with low cognitive ability, the health systems need to compromise other services and invest in therapies for developmental delays such as physical therapy, occupational therapy, and speech and language therapy. These compromise essential services provision and thus the system will be termed as a poor performer".

Dehydration

The respondents were able to demonstrate that dehydration due to diarrheal needs an urgent medical attention. It has been demonstrated that dehydration disrupts the delicate equilibrium of minerals within the body. Infants, in particular, are highly vulnerable to the negative consequences of dehydration due to their increased need for fluids, greater loss of fluids through evaporation, and their inability to express thirst or actively seek hydration. A gentleman who held the role of a key informant expressed his deep sense of sorrow and regret;

"Dehydration is a dangerous situation that could easily result into death if not urgently attended to. This requires that the health systems inject more resources to cater for such a situation affecting its performance".

Another key informant added;

"Dehydration put health systems into a stressful situation as it struggles to manage the dehydration cases and thus affect the quality of healthcare services provision on other health conditions".

A male key informant emphasized that;

"Diarrhea cases in our facilities are always prioritized due to their consequences. Clients seeking healthcare services get delayed and thus complain of poor services".

DISCUSSION

The salient variables for the study were; stunting growth, reduced cognitive development and dehydration. Stunting growth at multivariable analysis had a statistically significant association with the outcome variable. The study revealed that for every unit increase on stunting growth, result into a more likely experience of poor health systems. Stunting growth of children results into various consequences such as poor development, hindrance in capacity to learn, high chances of acquiring infections among other conditions. All these conditions will require medical interventions from health facilities which will make the facilities to experience unnecessary pressure exerted on them as it handles these conditions. To cope with all these, the system will need extra resources in terms of human capital, time, infrastructures and medical equipment, financial capacity among others. If the extra required resources will not be availed, the system will fail to address the problem effectively and in this context, the system will be referred to as poor health system. This is an indication that indeed stunting growth caused by diarrhea is a risk factor for poor health system. Concurrence exists here with UNICEF (2016), whose study found out diarrhea to cause physical development impairment. Sean et al. (2010) also established that prolonged diarrhea cause severity in stunted-growth than acute diarrhea.

Reducing cognitive development had a statistically significant association with the outcome variable. The study revealed that for every unit decrease in cognitive development was likely to cause poor health system. Poor school performance is associated with poor development of the cognitive abilities and this is indeed a negative consequence of diarrhea which in turn causes poor health systems. This was in concurrence with a study by World Bank (2016), which showed that, diarrhea in children, will interfere with cognitive development. In order to prevent cognitive impairment as an effect of diarrhea, the health system should deal with the root cause such as addressing nutritional related issues at childhood through various

health interventions. This calls for extra efforts and resources on health systems so as to address it effectively, thus putting more pressure on the health system. The study therefore indicated poor development in cognitive status as being a statistically significant risk factor for poor health systems.

The study realized that dehydration had an association with the response variable. It was established that for every increase in dehydration, there was a likely of experiencing poor health systems. Dehydration is mainly caused by diarrheal and entails getting rid of water from the body and this can cause someone to feel thirsty, headaches, lethargy, having dark yellow and strong-smelling pee, sunken eyes, dry mouth, lips and tongue among others. Dehydration needs management to reverse the situation, which is rehydrating the body. Rehydration involves the intervention of embracing ORS (Oral Rehydration Solutions), continuous feeding as well as increased fluids for mild diarrhea. For severe diarrhea the patient will have to receive intravenous rehydration. All these management and treatment interventions will subject the health system into unanticipated strenuous situation thus interfering with its functions and goals. This is in concurrence with a study by El-Khoury et al. (2016), which looked at treating diarrhea and its associated progress in Ghanaian region. The study revealed that diarrhea treatment improves substantially where ORS is applied. Furthermore, it is worth noting that a study conducted by Larson et al. (2012) reached a similar conclusion, further supporting the notion that dehydration poses a significant risk to overall health and well-being within the healthcare systems.

CONCLUSION

It has been established that indeed stunting growth, reduced cognitive development and dehydration does exert pressure on health systems performance which result into poor health systems. Reducing these diarrheal effects is imperative in maintaining or improving health systems performance. With increase in the mentioned effects of diarrhea, the affected household members will be compelled to seek health interventions, thus causing unnecessary pressure on the health systems performance. There is therefore an urgent need to identify the effects relating to diarrhea conditions and effectively address them in specificity. This calls for community health interventions through community health promoters who should be equipped with knowledge and skills on the control and prevention of diarrhea at community level so as to prevent the effects associated with diarrhea that has proved to contribute to poor health systems.

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