Original article

Housing, water and sanitation implications on food insecurity and diet diversity in landslide affected communities: A cross-sectional survey of two districts in Uganda

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SUMMARY

Background: The major landslide of 2010 in Bududa district in Eastern Uganda is the most catastrophic natural disaster in Uganda's recorded history. An estimated 350 people died and some of the affected were resettled in Kiryandongo district. We assessed housing, water and sanitation practises of affected households and controls to establish possible implications on food insecurity and diet diversity.
Methods: This cross-sectional study assessed 1078 affected and control households in Bududa and Kiryandongo districts. The head of the households were either affected, selected from landslide disaster-affected communities, or controls from a random sub-county bordering the affected. Structured interviews were used and entries were tested statistically to report crude estimates based on the Pearson x^2 and ANOVA, while adjusted analysis used multivariate analysis of co-variance (MANCOVA) and Wald's Odds Ratio (OR) of Binary Logistic Regression at the 95% CI.
Results: On adjusting for the disaster and covariates, households who had insufficient access to water scored higher mean (SE) on food insecurity than those who reported sufficient access: 13.1 (0.4) vs. 9.5 (0.3) ($P < 0.01$). Intriguingly, households who owned a toilet and those who reported always using soap to wash hands scored higher food insecurity than their counterparts: 11.1 (0.3) vs. 9.0 (0.6) ($P < 0.01$) and 11.3 (0.3) vs. 9.1 (0.5) ($P < 0.01$), respectively. However, not owning a toilet increased the likelihood of being food insecure (OR 3.43; 95% CI 1.31, 8.97; $P = 0.02$). In Kiryandongo, affected households scored higher food insecurity than controls: 9.5 (0.5) vs. 5.4 (0.5) ($P < 0.01$) and higher diet diversity scores (DDS): 6.7 (0.2) vs. 6.2 (0.2) ($P = 0.04$). Type of housing also predicted food insecurity ($P < 0.01$) and DDS ($P = 0.03$). Like Bududa, households with insufficient water access scored higher food insecurity while those owning toilet scored higher DDS. Uniquely, only number of rooms was linked to a high likelihood of being food insecure (OR 1.60; 95% CI 1.19, 2.15; $P < 0.05$).
Conclusion: Disaster, food security and diet were sensitive to housing, water and sanitation and were integral to an adequate standard of living of victims of this landslide.

1. Background

Access to appropriate housing, water and sanitation services and adequate food are constituents of the right of everyone to a standard of living adequate for health and wellbeing. This is enshrined in the International Bill of Human Rights, specifically in

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Article 25(1) of the Universal Declaration of Human Rights (UDHR) [1] and Article 11(1) of the International Covenant on Economic, Social and Cultural Rights [2]. The nexus of these rights is also exhibited in the context of nutrition where food security, water and sanitation are among the underlying determinants of nutritional status, short of which exposes to poor diet, disease and malnutrition consequences [3]. There is now a global consensus and focus on these phenomena in the Sustainable Development Goals (SDG), especially goals number 2 and 6 on ending hunger and malnutrition, and increasing access to clean water and sanitation, respectively [4,5].

The burden of people living in conditions of inadequate housing, water, sanitation and food insecurity are more pronounced in resource-constrained countries [6]. Estimates from United Nations Human Settlement Programme (UN-Habitat) indicate that about 1.6 billion people will require adequate and affordable housing by 2025, with the vast majority requiring urgent attention in countries of South-East Asia and Sub-Sahara Africa [7]. Water access is also still a challenge. By 2017, an estimated 2.1 billion people lacked access to safely managed drinking water services, while 4.5 billion people lacked safely managed sanitation services with Sub-Saharan Africa posting the least access [8]. On the other hand, the number of undernourished persons has not reduced significantly over the past decade, with an increase from 777 million in 2015 to 815 million in 2016 [9], while 155 million children aged 6–59 months were stunted (a marker of chronic undernutrition) in 2017 [6].

The 2016 Uganda Demographic and Health Survey (UDHS) indicated that stunting levels in children 6–59 months old were reduced minimally, from 33% in 2011 to 29% in 2016 with more than 2.2 million affected children, while anaemia mostly due to iron deficiency, increased from 49% to 53% among children and from 23% to 32% among women of reproductive age [10,11]. A review of Uganda's progress on SDG 2 on ending hunger, improving food security and nutrition, indicated that on average Ugandans were consuming 1860 kcals per capita, below the recommended 2200 kcal, while food insecurity was affecting an estimated 46% of the population [11].

In Uganda, landslides are among the major disaster problems affecting the country, especially around highland and mountainous areas [12–15]. In 2010, a major landslide in the Bududa district left over 350 dead and thousands displaced [12,16]. A number of disaster events had been reported prior to the major event of 2010 [12,13,17–19] and more recently a disaster on 11th October 2018 killed about 50 people and displaced thousands leading to the Government to declare a resettlement plan for all populations in the landslide risk areas around Mount Elgon [20]. In the aftermath of the major 2010 landslide, an assessment of the disaster victims who had been temporary resettled in camps indicated that there were inadequate safe water and sanitation facilities [21]. Subsequently, the camps were closed and some affected households returned to their homes while other were resettled in Kiryandongo district, over 200 km away in Western Uganda [22,23].

In 2012 we performed a survey among affected households and comparable controls in Bududa and Kiryandongo districts. We established that in the Bududa district where the landslide occurred, affected households had lower food insecurity than controls, but higher diet diversity scores (DDS), a proxy for nutritional intake. They also had a higher likelihood of skipping a household meal for a whole day [24]. In addition, household size increased the likelihood of food insecurity and reduced DDS [25]. Moreover, while the Government was pursuing a policy of resettlement, the local population preferred land-related remedies that were sensitive to their own "Bamasaba" culture and food security needs, as well as an opportunity to exercise the right of choice and preference when relief food was distributed [26].

In this study, our objective was to assess type of housing, water and sanitation practises and their implications on household food insecurity and diet diversity. In essence, we attempted to unpack the interaction of key components that constitute the human right to an adequate standard of living within the context of landslide disaster on the basis of the hypothesis that the disaster affected households could be more disadvantaged than their control counterparts. The findings may inform future policy actions, contingency plans and disaster management interventions so as to make them sensitive to the underlying determinants of nutrition and human rights dimensions of an adequate standard of living.

2. Methods

2.1. Study design and selection of participants

This study is part of a research project that involved a cross-sectional and descriptive survey in the aftermath of the major 2010 landslide disaster in Eastern Uganda. The survey involved two sub-counties in each district: Bududa, where the landslide occurred, and Kiryandongo where some of affected households were resettled.

As we have reported in some of the findings from the project [24–26], research clearance was obtained from the Uganda National Council of Science and Technology (reference number SS 2885). The study population was households in the two districts that were hosting victims of the 2010 landslide disaster; Bududa and Kiryandongo. In computing sample size, we used the prevalence of undernutrition [27] as a proxy due to the absence of reliable effect measures of landslides on food insecurity and diet.

As indicated in Fig. 1, the first stage of randomisation involved selection of the control sub-county from a list of sub-counties neighbouring the already known affected sub-county hosting disaster victims. Subsequently the second stage involved listing all the villages and their corresponding number of households in the affected and control areas and randomly assigning them into 25 village units, using probability proportion to size. At the third stage, 12 households in each village were randomly identified and consulted for interviews from the household lists generated during the pre-survey mapping and listing.

2.2. Data collection

Although we preferred to interview women respondents due to deeper involvement in household activities, the head of the household who was available and willing to participate was the one interviewed. The questionnaire was initially pretested and translated into the local commonly used language using trained assistants and pre-test households were excluded. Information on socio-demographic characteristics, housing, water, sanitation, access to food and diversity of food eaten by the household has been considered. Informed consent was written or by right thump ink stamp. Where respondents were unable to read English, a translated version was read to them prior to consent.

2.3. Scoring diet diversity and food insecurity

As we reported elsewhere [24], a total of 12 food groups, with their food varieties were listed to facilitate a retrospective recall by the respondent. Using this information, we computed the diet diversity score (DDS) as the number of food groups reportedly eaten over the recall period of 7 days prior to the interview. Household food insecurity assessment involved use of the Household Food Insecurity Access Scale (HFIAS) [28], child hunger from the
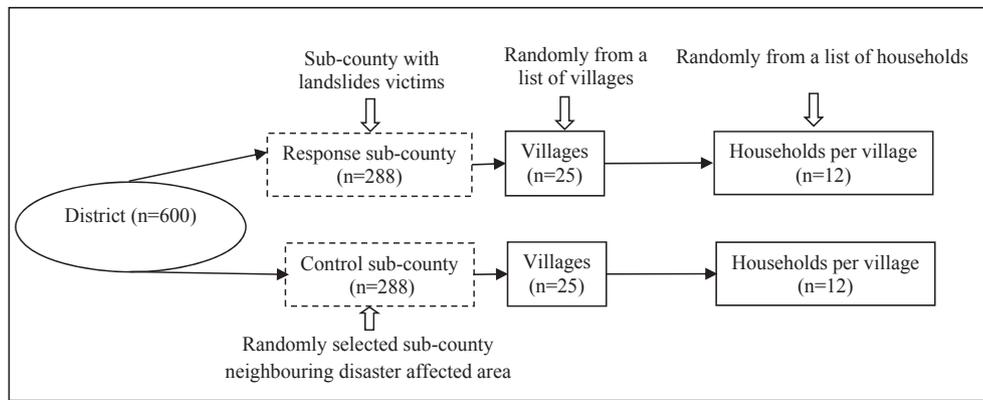
Fig. 1. The three-stage simple random sampling procedure.

Community Childhood Hunger Identification Project (CCHIP) index [29], and food insecurity coping practises from the Coping Strategy Index (CSI) [30,31] given the absence of a gold standard for measuring food insecurity. The tools have been used in East and Southern Africa [29,32—35]. A higher score is linked to more food insecurity experiences.

2.4. Statistical analysis

Version 21 of IBM SPSS (Statistical Package for Social Scientists) [36] was used to generate a one-way multivariate analysis of covariance (MANCOVA) model to test for univariate and multivariate effects while controlling for the disaster effect, housing, water and sanitation. We excluded socio-demographic covariates of head of the household's gender, age, level of education, household size, main source of livelihood, existence of food security relevant assets and having received relief food since they did not show association with food insecurity and DDS in our previous findings [24]. Binary logistic regression was performed to estimate the associations between exposure (disaster, housing, water and sanitation covariates) and outcomes of food insecurity and DDS based on Wald's test Odds Ratio (OR).

3. Results

3.1. Characteristics of the study population

As we have previously reported [24—26], 1097 household-heads were interviewed and significant differences reported in the mean age and levels of education between affected and controls in both districts. In the current study, significant differences between the affected and control households in both districts were observed in type of housing, whether a household reported access to sufficient water, the main source of water, whether a household had its own toilet, and whether soap was always used when washing hands (Table 1). As shown, whereas houses made of mud walls with iron roof dominated Bududa district, in Kiryandongo most housing was grass thatched. In Bududa, the hygienic practise of using a rack for drying utensils was used by more control households ($P < 0.01$), while on the contrary distance to water source was shorter for affected than control households, with an average of 0.2 km compared to 1.3 km ($P < 0.01$).

In Kiryandongo, the recommended practise to boil drinking water was reported in the affirmative by more of the affected households ($P < 0.01$). On the other hand, the temporary pit latrine was the most commonly used toilet with a higher number of affected than control households using it ($P < 0.01$).

3.2. Housing, water and sanitation links with household access to food and diet

Both districts posted significant differences in household food insecurity scores between affected and controls based on the type of housing and access to sufficient water ($P < 0.01$ in both circumstances). In Bududa alone, crude differences between affected and controls were also exhibited with main water source, the practise of boiling drinking water, the household owning its own toilet and use of soap to wash hands. A weak correlation was observed between household food insecurity scores and number of rooms (r = 0.10, $P = 0.02$) and distance to water source (r = 0.21, $P < 0.01$) in Bududa (Table 2a). Crude differences in DDS between affected and control households in both districts were exhibited in households having a rack for drying utensils and owning its own toilet. However in Kiryandongo only, significant mean differences were observed between affected and controls with type of housing ($P = 0.01$). A weak correlation was also observed between household food insecurity scores and number of rooms (r = 0.19, $P < 0.01$) in Kiryandongo (Table 2b).

On adjusting for the covariates on housing, water and sanitation (Table 3), the multivariate analysis model showed that in Bududa the significant predictors for both household food insecurity and diet diversity were: (i) the disaster effect with those affected posting higher mean (SE) dietary diversity scores than controls: 7.4 (0.2) vs. 5.6 (0.2) ($P < 0.01$); (ii) access to sufficient water ($P < 0.01$) as households with inadequate access to sufficient water posted significantly higher mean (SE) food insecurity scores than those who reported accessing sufficient water: 13.1 (0.4) vs. 9.5 (0.3) ($P < 0.01$); (iii) main water source ($P < 0.01$), with significantly higher food insecurity scores among households who mainly used wells and boreholes: 11.8 (0.4) ($P < 0.01$); (iv) households with their own toilet ($P < 0.01$), with higher food insecurity scores ($P < 0.01$) in households who owned their toilet, 11.1 (0.3) than those who did not own the toilet they used, 9.0 (0.6); and (v) households who reported always using soap to wash their hands ($P < 0.01$), with higher food insecurity scores in households who responded in the affirmative, 11.3 (0.3) vs. 9.1 (0.5) ($P < 0.01$).

In Kiryandongo, the significant predictors for both household food insecurity and diet diversity were: (i) the disaster effect ($P < 0.01$), with significant higher food insecurity ($P < 0.01$) and diet diversity scores ($P = 0.04$) in affected households, 9.5 (0.5) and 6.7 (0.2) than controls, 5.4 (0.5) and 6.2 (0.2) respectively; (ii) type of housing ($P < 0.01$) with higher food insecurity scores among those with banana fibre housing while diet diversity was highest among those with grass thatched housing ($P = 0.03$); (iii) access to sufficient water ($P < 0.01$), with higher food insecurity scores among

Table 1
Housing, water and sanitation characteristics of households.

Variable	Bududa district (n = 555)			P	Kiryandongo district (n = 523)			P
	Affected (n = 285)	Controls (n = 270)	Total (or SD)		Affected (n = 260)	Controls (n = 263)	Total (or SD)	
Housing								
Grass thatched house	3	0	3	<0.01	139	148	287	<0.01
Banana fibre house	89	18	107		6	31	37	
Mud walls with tent roof	4	0	4		29	4	33	
Brick walls with tent roof	1	1	2		9	14	23	
Mud walls with iron roof	110	228	338		13	23	36	
Brick walls with iron roof	78	23	101		64	43	107	
Mean (SD) number of rooms	2.5 (1.0)	2.6 (1.0)	2.6 (1.0)	0.20	1.3 (1.0)	1.3 (1.1)	1.3 (1.1)	0.8
Access to sufficient water								
Yes	201	167	368	0.03	107	141	248	<0.01
No	84	103	187		153	122	275	
Main water source								
Community well or borehole	70	244	314	<0.01	251	209	460	<0.01
Piped water tap	12	10	22		0	1	1	
Vendor	0	10	10		0	5	5	
Stream or river	203	6	209		9	48	57	
Mean (SD) distance in Km	0.2 (0.4)	1.3 (1.7)	0.7 (1.3)	<0.01	1.1 (0.7)	0.9 (0.7)	1.0 (0.7)	0.06
Boil drinking water								
Yes	152	134	286	0.40	180	119	299	<0.01
No	133	136	269		80	144	224	
Availability of a rack for drying utensils								
Yes	131	187	318	<0.01	157	154	311	0.67
No	154	83	237		103	109	212	
Household has its own toilet								
Yes	229	236	465	0.03	195	176	371	0.04
No	56	34	90		65	87	152	
Type of toilet used by the household								
Temporary pit latrine	276	261	537	0.06	234	202	436	<0.01
Improved/modern toilet	7	1	8		19	28	47	
Unknown place/bush (no toilet)	2	8	10		7	33	40	
Always use soap when you wash hands								
Yes	230	192	422	0.01	83	194	277	<0.01
No	55	78	133		177	69	246	

those reporting insufficient access than sufficient access, 8.5 (0.4) vs. 6.3 (0.5) ($P < 0.01$); and (iv) households owning their own toilet ($P < 0.01$), with those with their own having higher dietary diversity scores than those without their own, 6.7 (0.1) vs. 5.8 (0.2) ($P < 0.01$).

The binary logistic regression model showed that only household ownership of the toilet seemed to predict food insecurity in Bududa district when the disaster and covariates on housing, water and sanitation were taken into account (Table 4a): not owning a toilet by a household exhibited a higher likelihood for a household to experience food insecurity (OR 3.43; 95% CI 1.31, 8.97; $P = 0.02$). On the other hand, the disaster affected households had a lower likelihood to score undesirable dietary diversity of less than 6 food groups (OR 0.22; 95% CI 0.12, 0.39; $P = 0.02$) than controls (Table 4b). In Kiryandongo district (Table 4b), an increase in number of rooms increased the likelihood of food insecurity by nearly two times (OR 1.60; 95% CI 1.19, 2.15; $P = 0.02$).

3.3. Multivariate effects on both food insecurity and diet diversity

The MANCOVA model showed that being affected by the disaster, access to water and toilet ownership predicted both outcomes ($P < 0.01$ in both) (Table 3). Distinctively, it was only in Kiryandongo where being affected by the disaster and type of housing could predict both outcomes ($P < 0.01$ on both case). The logistic regression model showed that the disaster had varying effects in the two districts when housing, water and sanitation were controlled. In Bududa, it could significantly predict household food insecurity based on toilet ownership with an overall predictive accuracy of 94% and variance (Negelkerke R^2) of 7.3%, and a low DDS less than six food groups with predictive accuracy of 73% and

variance (Negelkerke R^2) of 20% (Table 4a). In Kiryandongo the model could only predict household food insecurity based on the number of rooms in the house with a predictive accuracy of 78% and 13% variance (Table 4b).

4. Discussion

This study has shown that water, housing and sanitation factors had varying implications on household food insecurity and diet diversity in the affected and control households in the two districts. Apparently, in both districts the disaster affected households scored higher on diet diversity than controls while in Kiryandongo the affected had higher food insecurity scores than controls. Access to sufficient water seemed to safeguard households from higher food insecurity scores in both districts, but it was interesting that in Bududa those with access to sufficient water scored lower on dietary diversity. Whereas toilet ownership was linked to higher diversity scores in both districts, in Bududa it was linked to higher food insecurity and so was always using soap to wash hands. Intriguingly, much as the likelihood to score undesirable diet diversity of less than 6 out of 12 was low among affected households in Bududa, the likelihood of food insecurity was higher in households who did not own their own toilet. In Kiryandongo the likelihood of food insecurity increased with number of rooms in the house in Kiryandongo.

The situation of water, sanitation and hygiene we present here does not differ much from what was reported in 2011 from a rapid assessment performed in the immediate aftermath of the disaster when most of the affected were still in the Bulecheke settlement camp [21]. At that time, the affected households reportedly faced challenges of inadequate access to water and toilet facilities and

Table 2a
Crude differences in food insecurity scores between affected and control households in each district.

Variables	Bududa district (n 555)					P	Kiryandongo district (n 523)					P
	n	Affected (n 285)		Controls (n 270)			n	Affected (n 260)		Controls (n 263)		
		Mean	SD	Mean	SD			Mean	SD	Mean	SD	
Housing												
Grass thatched house	3	3.0	5.2	–	–	<0.01	287	11.0	9.5	5.3	5.4	<0.01
Banana fibre house	107	9.5	5.7	8.7	6.8		37	7.3	4.4	8.3	5.9	
Mud walls with tent roof	4	4.3	1.7	–	–		33	4.1	3.0	4.8	0.5	
Brick walls with tent roof	2	11.0	–	16.0	–		23	11.3	5.5	5.9	5.0	
Mud walls with iron roof	338	7.0	5.3	12.9	5.9		36	7.9	3.2	6.0	4.5	
Brick walls with iron roof	101	12.0	6.1	10.6	5.0		107	7.8	7.4	5.1	5.6	
Access to sufficient water												
Yes	368	7.7	5.6	11.2	6.0	<0.01	248	7.7	7.6	4.9	4.8	<0.01
No	187	12.4	5.6	14.5	5.4		275	10.3	8.7	6.6	6.0	
Main water source												
Community well/borehole	314	12.5	5.5	12.3	6.1	<0.01	460	9.4	8.5	5.5	5.5	0.46
Piped water tap	22	6.3	6.0	12.7	6.2		1	–	–	6.8	–	
Vendor	10	–	–	13.3	2.4		5	–	–	6.0	1.6	
Stream or river	209	17.3	4.7	17.3	4.7		57	5.8	1.3	6.2	5.2	
Boil drinking water												
Yes	286	10.1	5.9	12.9	6.0	<0.01	299	8.8	7.8	6.8	5.5	0.41
No	269	7.9	6.0	12.0	5.9		224	10.1	9.4	4.8	5.2	
Rack for drying utensils available												
Yes	318	9.1	5.5	12.9	5.6	0.13	311	8.7	7.8	5.8	5.7	0.41
No	237	9.0	6.4	11.3	6.6		212	10.1	9.1	5.5	5.1	
Household has its own toilet												
Yes	465	9.5	6.1	13.0	5.6	<0.01	371	8.8	8.1	5.7	5.8	0.27
No	90	7.5	5.5	8.8	7.3		152	10.5	8.8	5.7	4.7	
Type of toilet used by the household												
Temporary pit latrine	537	9.1	6.0	12.6	5.9	0.47	436	9.4	8.5	5.3	5.5	0.43
Improved/modern toilet	8	9.7	5.6	9.6	–		47	7.0	3.4	5.4	5.7	
No toilet/in the bush	10	6.5	6.4	12.4	6.0		40	13.7	11.7	6.5	4.4	
Always use soap to wash hands												
Yes	422	9.7	5.9	13.2	5.6	<0.01	277	10.4	8.1	5.5	5.3	0.42
No	133	6.5	5.7	10.5	6.5		246	8.7	8.4	6.2	5.9	
Pearson correlation												
Number of rooms in the house *vs.* food insecurity scores		r = 0.10				0.02	−0.05					0.31
Distance to water source *vs.* food insecurity scores		r = 0.21				<0.01	−0.06					0.37

poor hygiene among others. It has also been reported that the disaster victims were exposed to food insecurity and poor diet given the nexus of disaster with poverty, incomes and livelihood [18,37,38]. In this study there was a mixed picture: in Bududa, whereas food insecurity affected more of the disaster affected and those with inadequate access to water, the affected households on the contrary reported higher diet diversity than controls in both districts indicating a relatively better diet in proxy terms. This phenomenon could be linked to the relief food that was made available to most of the affected households in the aftermath of the disaster [23,25,26].

Like with nutrition-sensitive interventions that emphasise the integration of water, sanitation and hygiene as part of nutrition interventions [39—41], the Universal Declaration of Human Rights (UDHR) and the International Covenant on Economic, Social and Cultural Rights (ICESCR) consider food, shelter, water and social services as integrated parts of an adequate standard of living [1,2]. This study avers that the same parameters and contexts are paramount in programmes targeting food insecurity mitigation and diet improvement in the context of disaster management. While policy exists in Uganda on disaster preparedness and management [42], on food and nutrition security [43] and an action plan to scale-up nutrition investments that includes mitigating the effects of disasters on nutrition [44], the implementation framework of the existing policies seems incoherent and has not been tested on the extent to which the existing actions are sensitive to housing, water, hygiene and sanitation practises. Moreover the multi-sectoral interventions expected in disaster preparedness and management

and in food and nutrition security remain to be a challenge in resource limited settings especially in Africa where governance system and structures are still evolving [45—48].

Like with our previous study that only considered the disaster and socio-demographic covariates [24], the control households in the Kiryandongo district scored lowest on food insecurity when access to water and practises on hygiene and sanitation were taken into account. This may validate the arguments we made that the resettled landslide-affected victims in the Kiryandongo district were facing more food insecurity challenges than their neighbours in the surroundings. Impliedly, the conditions of resettlement might have been insufficient to guarantee the human right to an adequate standard of living that include decent housing, adequate food and access to water and sanitation practises [24,26]. Moreover, a recent study of 2016 on coping strategies of the same group of those affected indicated that the relocation of victims was unsustainable because people often returned back to the high risk areas in the Bududa district [49].

Whereas safe water and sanitation are among the drivers with high potential to reduce stunting and other forms of undernutrition [40,50—53], other studies have shown that combined water, sanitation, and handwashing interventions provide no additive benefit to morbidity and other child growth parameters associated with nutrition [54]. The results of this study suggest either that the hypothesis that housing, water and sanitation practises are associated with household food insecurity and diet diversity in Uganda's disaster affected communities is flawed or that it remains valid to the extent that toilet ownership is a predictor for both food

Table 2b
Crude differences in diet diversity scores between affected and control households in each district.

Variable	Bududa district (n 555)					P	Kiryandongo district (n 523)					P
	n	Affected (n 285)		Controls (n 270)			n	Affected (n 260)		Controls (n 263)		
		Mean	SD	Mean	SD			Mean	SD	Mean	SD	
Housing												
Grass thatched house	3	6.0	2.7	–	–	0.86	287	7.1	2.6	6.3	2.2	0.01
Banana fibre house	107	6.9	2.1	6.6	2.2		37	5.3	2.0	5.6	3.1	
Mud walls with tent roof	4	6.8	1.4	–	–		33	6.2	1.5	4.5	1.7	
Brick walls with tent roof	2	6.0	–	9.00	–		23	7.8	2.3	5.1	2.3	
Mud walls with iron roof	338	7.3	1.6	5.9	2.3		36	4.5	1.3	5.8	1.8	
Brick walls with iron roof	101	7.4	2.0	5.3	2.4		107	6.6	2.8	6.6	2.2	
Access sufficient water												
Yes	368	7.1	1.8	5.7	2.2	0.06	248	6.4	2.2	6.2	2.3	0.37
No	187	7.3	2.2	6.2	2.5		275	7.0	2.7	6.0	2.3	
Water source												
Community well/borehole	314	7.5	1.8	5.9	2.3	0.14	460	6.9	2.6	6.2	2.3	0.23
Piped water tap	22	7.0	2.0	5.5	1.8		1	–	–	5.0	–	
Vendor	10	–	–	5.4	1.4		5	–	–	4.8	0.8	
Stream or river	209	7.0	2.0	4.8	2.7		57	4.8	1.0	6.2	2.5	
Boil drinking water												
Yes	286	7.3	1.9	5.7	2.4	0.94	299	7.0	2.7	5.9	2.2	0.36
No	269	7.0	1.9	6.0	2.1		224	6.1	2.2	6.3	2.4	
Rack for drying utensils available												
Yes	318	7.4	2.0	6.0	2.3	0.01	311	7.1	2.5	6.2	2.3	0.02
No	237	6.9	1.8	5.6	2.2		212	6.2	2.5	6.1	2.4	
Household has its own toilet												
Yes	465	7.2	2.0	6.0	2.3	0.01	371	6.9	2.7	6.5	2.3	<0.01
No	90	7.0	1.7	4.7	2.2		152	6.1	2.1	5.5	2.3	
Type of toilet used by the household												
Temporary pit latrine	537	7.1	1.9	5.9	2.3	0.12	436	6.9	2.6	6.3	2.3	0.06
Improved/modern toilet	8	7.7	2.4	8.0	–		47	5.4	2.4	6.8	1.4	
No toilet/in the bush	10	5.5	0.7	5.7	2.5		40	6.0	2.3	5.3	2.4	
Always use soap to wash hands												
Yes	422	7.1	1.9	6.0	2.2	0.94	277	6.7	2.2	6.2	2.3	0.83
No	133	7.5	1.8	5.6	2.4		246	6.7	2.7	6.1	2.5	
Pearson correlation												
Number of rooms in the house *vs.* diet diversity scores		r = 0.10				0.02	0.19					<0.01
Distance to water source *vs.* diet diversity scores		r = −0.19				<0.01	0.10					0.12

insecurity and diet diversity in the landslide disaster prone context of Uganda. Given the higher food insecure scores observed among households who reported owning the toilet they used and always washing hands with soap, the likelihood to be food insecure was higher among those who did not own a toilet in Bududa and this likelihood also increased with number of rooms. In essence, our study outcomes reinforce the notion that food and nutrition security programmes that are sensitive to housing, water, sanitation and hygiene are important if accelerating reductions in undernutrition envisaged in the SDG 2 are to be sustained in the near future.

Methodologically, the observed differences could be linked to the nature of affected and control households who in this case were residing in different sub-counties of two distinct districts. It is possible the differences in food insecurity and diet diversity could arise due to seasonality bias and the socio-cultural and geographical architecture of the independent population groups that were surveyed. This non-homogeneity led to non-pooling of the data hence the two districts were analysed independently. Moreover, as Vakis [55] noted, household food insecurity during disaster can also be exacerbated by often un-investigated and random circumstances, which in this case may have influenced affected households on different scales in the period before, during or after the disaster.

Despite these findings linking housing, water and sanitation to food insecurity and diet, the evidence might be insufficient to explain implication on nutritional status and an adequate standard of living of disaster victims given the nexus of inter-relations between the underlying determinants of malnutrition; food security,

adequate care for vulnerable groups and environmental health aspects of housing, water, sanitation and hygiene among others [3,56–59]. Future studies should investigate the nutritional implications of disaster given evidence that disasters are increasingly the main source of disruption of human, social and economic wellbeing [38,60–65]. Apparently in 2016 estimates showed that an average of 376 natural disasters occurred per year for the period 2006–2015, with the highest annual economic damage recorded at 154 billion United States Dollars [63]. Furthermore, the United Nations estimates put the economic losses associated with natural disasters at averages between USD 250 billion to USD 300 billion every year [66].

From a public health and development policy perspective, the findings seem to concur with observations suggesting that the negative effects of disasters on nutrition and health are a complex and protracted outcome that may be mediated through the dynamic aspects in the household's social environment [58,67]. Sustainable mitigation in the long term may require that deliberate efforts are instituted to amplify the integration of housing, water, sanitation and hygiene interventions in disaster management and other cross-cutting national programmes on food and nutrition security. It is also important for actors in disaster preparedness and management to ensure dignified remedy and recourse measures in form of housing, access to water, and services of hygiene and sanitation that can be pursued to meet human rights standards envisaged in the human right to an adequate standard of living specified in Article 25(1) of the UDHR, Article 11(1) of the ICESCR, General Comment Number 12 on the human

Table 3
Adjusted differences in household food insecurity and diet diversity scores.

Variables	Bududa district									Kiryandongo district								
	n	ANCOVA[a]						MANCOVA[d]		n	ANCOVA[a]						MANCOVA[d]
		Food insecurity[b]			Diet diversity[c]						Food insecurity[b]			Diet diversity[c]			
		Mean	SE	P	Mean	SE	P	P			Mean	SE	P	Mean	SE	P	P
Disaster																	
Affected	285	10.1	0.4	0.09	7.4	0.2	<0.01	<0.01		260	9.5	0.5	<0.01	6.7	0.2	0.04	<0.01
Controls	270	11.3	0.4		5.6	0.2				263	5.4	0.5		6.2	0.2		
Housing																	
Grass thatched	3	5.1	3.9	0.36	3.8	1.5	0.43	0.40		287	8.1	0.4	<0.01	6.7	0.2	0.03	<0.01
Banana fibre	107	10.5	0.6		6.4	0.2				37	9.6	1.2		5.9	0.4		
Mud with tent	4	6.6	2.8		6.2	1.1				33	2.6	1.2		5.9	0.4		
Brick with tent	2	12.3	3.9		7.1	1.5				23	8.4	1.4		6.3	0.5		
Mud and iron roof	338	10.7	0.3		6.6	0.1				36	7.5	1.4		5.3	0.5		
Brick and iron roof	101	11.3	0.6		6.3	0.2				107	6.3	0.7		6.5	0.2		
Access sufficient water																	
Yes	368	9.5	0.3	<0.01	6.4	0.1	0.13	<0.01		248	6.3	0.5	<0.01	6.4	0.2	0.51	<0.01
No	187	13.1	0.4		6.7	0.2				275	8.5	0.4		6.5	0.2		
Water source																	
Well/borehole	314	11.8	0.4	<0.01	6.7	0.2	0.14	<0.01		460	7.2	0.3	0.31	6.5	0.1	0.58	0.43
Piped water tap	22	7.5	2.0		7.3	0.8				1	8.5	2.0		4.7	2.4		
Vendor	10	10.4	1.8		6.0	0.7				5	8.7	3.2		5.8	1.1		
Stream or river	209	9.1	0.5		6.2	0.2				57	8.7	1.0		6.4	0.4		
Have rack for utensils																	
Yes	318	10.8	0.3	0.81	6.7	0.1	0.07	0.18		311	7.4	0.4	0.80	6.6	0.1	0.13	0.30
No	237	10.7	0.4		6.3	0.1				212	7.5	0.5		6.2	0.2		
Boiled drinking water																	
Yes	286	10.9	0.3	0.35	6.5	0.1	0.50	0.53		299	7.7	0.4	0.38	6.5	0.1	0.33	0.45
No	269	10.5	0.3		6.6	0.1				224	7.1	0.5		6.3	0.2		
Household has its own toilet																	
Yes	465	11.1	0.3	<0.01	6.6	0.1	0.06	<0.01		371	7.3	0.4	0.38	6.7	0.1	<0.01	<0.01
No	90	9.0	0.6		6.1	0.2				152	7.9	0.6		5.8	0.2		
Use soap to wash hands																	
Yes	422	11.3	0.3	<0.01	6.5	0.1	0.58	<0.01		277	7.8	0.5	0.26	6.5	0.2	0.51	0.45
No	133	9.1	0.5		6.6	0.2				246	7.0	0.5		6.3	0.2		

[a] Test for univariate effect of each variable on the outcome after adjusting for covariates.
[b] Covariates in the model included whether a household was affected by the disaster, type of housing, whether household accesses sufficient water, type of water source, availability of a utensils rack and whether soap was always used to wash hands and diet diversity.
[c] Covariates in the model included whether a household was affected by the disaster, type of housing, whether household accesses sufficient water, type of water source, availability of a utensils rack and whether soap was always used to wash hands and food insecurity.
[d] Test for multivariate effect of each variable on both outcomes after adjusting for covariates. Given two dependent variables in the model, Hotelling's Trace value is reported.

Table 4a
Binary logistic regression on the households' likelihood to experience food insecurity and undesirable diet diversity in Bududa district.

Variable	Food insecurity					Undesirable diet diversity		
	n	%	OR	95% CI	P	OR	95% CI	P
Disaster effect								
Controls	270		1			1		
Affect	285		0.86	0.30, 2.50	0.78	0.22	0.12, 0.39	<0.01
Type of housing								
Brick house with iron roof	101		1			1		
Others	454		0.57	0.19, 1.69	0.31	0.71	0.36, 1.40	0.32
Main water source								
Tapped water	22		1			1		
Others	533		—	—	1.00	—	—	1.00
Household has its own toilet								
Yes	465		1			1		
No	90		3.43	1.31, 8.97	0.02	1.78	0.93, 3.39	0.08
Always wash hands with soap								
Yes	422		1			1		
No	133		1.71	0.67, 4.35	0.26	1.00	0.57, 1.75	0.99
Number of rooms in the house	555		0.95	0.58, 1.55	0.83	1.06	0.81, 1.39	0.67
Distance to water source	555		0.87	0.63, 1.21	0.42	0.84	0.68, 1.03	0.10
Diet diversity scores	555		0.94	0.76, 1.18	0.60			
Food insecurity scores	555					1.02	0.98, 1.07	0.31
Hosmer and lemeshow test (P)					0.79			0.02
Nagelkerke R²			0.07	7.3		0.20	20	
Overall predictive accuracy %		94				73		

Table 4b
Binary logistic regression on the households' likelihood to experience food insecurity and undesirable diet diversity in Kiryandongo district.

Variable	Food insecurity					Undesirable diet diversity		
	n	%	OR	95% CI	P	OR	95% CI	P
Disaster effect								
Controls	263		1			1		
Affected	260		1.40	0.67, 2.93	0.37	1.30	0.71, 2.40	0.40
Type of housing								
Brick walls and iron roof			1			1		
Others			1.86	0.87, 3.98	0.12	1.25	0.64, 2.46	0.52
Access to sufficient water								
Yes			1			1		
No			−	−	1.00	2.15	0.19, 24.57	0.54
Have rack for drying utensils								
Yes			1			1		
No			0.86	0.45, 1.64	0.64	1.36	0.79, 2.34	0.26
Always wash hands with soap								
Yes			1			1		
No			0.61	0.29, 1.26	0.18	1.04	0.58, 1.89	0.89
Number of rooms in the house	555		1.60	1.19, 2.15	<0.01	1.18	0.92, 1.52	0.20
Distance to water source	555		1.15	0.73, 1.82	0.54	1.23	0.84, 1.81	0.30
Food insecurity scores	555		1.00	0.87, 1.15	0.99	1.03	0.98, 1.07	0.27
Hosmer and lemeshow test (P)					0.18			0.11
Nagelkerke R^2	0.13	13				0.08	7.8	
Overall predictive accuracy %		78				56		

right to adequate food of 1999 and other provisions relevant to nutrition and the human right to adequate food enshrined in instruments to which Uganda is a state party.

5. Conclusion

The evidence presented herein reinforces the known facts that housing, water and sanitation practises are linked to food and nutrition security related outcomes. Duty bearers involved in disaster management, food security and diet interventions should be sensitive to housing, water and sanitation as integral components of the right to an adequate standard of living and nutritional health. Progress towards achieving the SDGs linked to food and nutrition security and other aspirations set in national, regional and international human rights instruments and policy frameworks will require a multi-prone and cross-sectoral approach that looks at the integrating social determinants underlying exposure to malnutrition, especially housing, water and sanitation, which have often been negated as costly long term priorities that are secondary and indirect in food and nutrition security interventions. If well harnessed, such an approach that encompasses human rights obligations may strengthen the State's capacity to deal with its human rights obligation to protect at-risk households against disaster-related deprivation and effects on household food security and diet.

Availability of data and materials

All datasets and materials supporting our findings are available from the corresponding author on agreement with the co-authors upon considered request.

Competing interest

We declare no competing interest.

Authors contributions

All authors participated in the planning and design of the study. PMR implemented the data collection, BR, BAA and POI supervised the survey and data management. All authors were active in the analysis, writings and approval of the final manuscript.

Consent to publication

Not applicable.

Ethics approval and consent to participate

Ethical approval and research clearance were obtained before data was collected. The research clearance was obtained from the Uganda National Council of Science and Technology (reference number SS 2885 of 20th July 2012). Informed written consent was obtained from the head of the household. Where respondents were unable to read English, a translated version was read to them and consent obtained by the right hand thumb ink stamp.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnesp.2019.07.010.

Abbreviations

UDHR	Universal Declaration of Human Rights
SDG	Sustainable Development Goals
UDHS	Uganda Demographic and Health Survey

DDS   Diet Diversity Scores
HFIAS   Household Food Insecurity Access Scale
CCHIP   Community Childhood Hunger Identification Project
CSI   Coping Strategy Index
SPSS   Statistical Package for Social Scientists
OR   Odds Ratio
SE   Standard Error

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