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User fees removal and community-based management of undernutrition in Burkina Faso: what effects on children's nutritional status?

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Abstract
Objective: To examine the effect of an intervention combining user fees removal with community-based management of undernutrition on the nutrition status in children under 5 years of age in Burkina Faso.
Design: The study was a non-equivalent control group post-test-only design based on household survey data collected 4 years after the intervention onset in the intervention and comparison districts. Additionally, we used propensity score weighting to achieve balance on covariates between the two districts, followed by logistic multilevel modelling.
Setting: Two health districts in the Sahel region.
Participants: Totally, 1116 children under 5 years of age residing in 41 intervention communities and 1305 from 51 control communities.
Results: When comparing children living in the intervention district to children living in a non-intervention district, we determined no differences in terms of stunting (OR = 1·13; 95 % CI 0·83, 1·54) and wasting (OR = 1·21; 95 % CI 0·90, 1·64), nor in severely wasted (OR = 1·27; 95 % CI 0·79, 2·04) and severely stunted (OR = 0·99; 95 % CI 0·76, 1·26). However, we determined that 3 % of the variance of wasting (95 % CI 1·25, 10·42) and 9·4 % of the variance of stunting (95 % CI 6·45, 13·38) were due to systematic differences between communities of residence. The presence of the intervention in the communities explained 2 % of the community-level variance of stunting and 3 % of the community-level variance of wasting.
Conclusions: With the scaling-up of the national free health policy in Africa, we stress the need for rigorous evaluations and the means to measure expected changes in order to better inform health interventions.

Keywords
User fee removal
Community-based management of malnutrition
Financial accessibility
Nutritional status
Stunting
Wasting contextual effect
Burkina Faso

Although progress has been made in improving child nutritional status, undernutrition, in particular wasting and stunting remain public health challenges in Burkina Faso with more than 21·1 % of children under the age of 5 years classified as stunted, and 9 % of them suffering from wasting in 2019[1]. In addition to poor maternal health and nutrition, inadequate infant and young child feeding practices, repeated infections such as malaria, diarrhoea, measles, and acute respiratory infection, food insecurity[2], access to child care and nutrition services represent important factors contributing to a child's poor nutritional status in Burkina Faso. Historically, access to healthcare among children under 5 years was extremely low in Burkina Faso and user fees were identified as the most important barrier to healthcare use[3,4]. User fees lead to reduced use of health services, delayed diagnosis and limited access to appropriate treatment for mothers and their children, which then contributes to increase morbidity and mortality among children under 5 years of age[5–10]. As with other sub-Saharan African countries, Burkina Faso first experimented with user fee removal in September 2008[11] in the Sahel region of the country. User fee removal was coupled with management of malnutrition of children under 5 years of age, which included screening and

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treatment of acute malnutrition and providing free care to reduce exposure to repeated illnesses among children by facilitating access to health services[11,12]. Health workers were trained and equipped to provide quality medical and nutritional care to children and pregnant and lactating women. The intervention also included activities related to health service quality improvement through training and supervision of health workers maternal and child health practices[11,12]. The intervention was implemented by HELP NGO (non-governmental organisation) with the objective to encourage mothers to bring their children for care at the onset of symptoms and to increase utilisation of health facilities by all sick children, including the poorest and those living furthest away[11]. The HELP intervention was integrated into the health system and maintained through a national policy that began in April 2016. Conceptually, user fee removal acts as an enabling factor, allowing users to make choices about their use of public healthcare services[13]. By removing financial barriers to healthcare access and improving the management of malnutrition at the community level, individuals and households will change their health-seeking behaviour as services become more affordable[13,14]. Individuals will use healthcare services more often and more regularly and will seek care promptly[15,16]. Health is then improved through the regular use of health services[13,16–18]. Other individual, community, and environmental-level factors including socio-economic status (SES) and illness severity may also modify the use of free health services[12,17,19]. Therefore, the theory of change is that by removing user fees and strengthening the management of the severe acute malnutrition without complications at the community level, it will increase child health services use which will then contribute to reducing child morbidity through the improvement of health status[11]. Removing user fees have also been shown to have an indirect impact on the underlying proximal determinants of health by reducing catastrophic expenditures, a factor that impoverishes households. By enhancing the financial protection of households[20,21] and thus releasing income, it reduces poverty and thereby contributes to improved food consumption[22]. Improved food consumption should then result in a positive impact on measures of child health status, particularly malnutrition, and generally reduce the risk of more frequent episodes of illness[16]. Previous research in the context of our study concluded that as a public health intervention facilitating the use of health services, the presence of the intervention in the villages of the Sahel region in Burkina Faso resulted, 1 year after its implementation, in a substantial increase of use of health services[12,23] that maintained over time[24]. In addition, the intervention resulted in better financial protection of households against the financial risks associated with poor health[21] and provided an empowering environment for women[25].

User fee removal policies have been extensively evaluated for their impact on access to care[26], demonstrating that exempting children under 5 years of age from user fees increases and maintains the use of healthcare[27] and helps reduce inequities of access in both the short[11] and long term[27]. However, studies on the relationship between user fee removal and child morbidity are scarce with mixed findings[28,29]. To date, the association between user fee removal and child nutritional status has been explored only in one randomised controlled trial in Ghana[22] and no effect on child nutritional status was found. This study used a relatively short follow-up time from the user fee removal (1 year), which is likely too short to have had an effect on child nutritional status. Nutritional status measured by stunting reflects cumulative effects of poverty, poor maternal and early childhood nutrition, and repeated episodes of illness in childhood without access to healthcare[30–32]. Furthermore, as the exposure to user fee removals occur at the population level, logistic regression or simple multilevel analysis are insufficient to appropriately assess contextual effects[33] which are important determinants of effectiveness. Though epidemiologists normally investigate the effect of an intervention as changes in group means, public health interventions may cause a change in the variance of the distribution of health outcomes[34]. In order to provide useful information to policymakers to tailor the implementation of public health intervention across different contexts, it is important to include both measures of variance and means measures of association when performing contextual analyses[34].

Consequently, the rationale of our study is to better understand to what extent a public health intervention, which included user fee removal, quality of care improvement, and malnutrition management, affected the nutritional status of children under 5 years of age and influenced its disparity between communities in Burkina Faso. Specifically, we investigated whether living in intervention communities was associated with decreased likelihood of stunting and wasting among children under 5 years of age. We also investigated if the intervention as a specific community-level characteristic may account for the disparities in stunting and wasting between communities.

Methods

Context and intervention

In the specific context of the Sahel, one of the country's most disadvantaged regions, high levels of morbidity and malnutrition coincide with very low healthcare use or lack of access to health services[35]. In 2008, 20 % of children under 5 years of age were severely anaemic. The rates of stunting (46·1 %) and wasting (17·6 %) were the highest in the country, while vaccination coverage (65 % for all vaccinations) and use of health centres were the lowest

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(only 32 % of children used health services in case of illness). As in the rest of the country, respiratory infections, malaria, and diarrhoea are the leading causes of infant morbidity and mortality. Inequalities in access to care remain substantial. For example, 54 % of children with fever in wealthy families were treated in public health centres, while this proportion was only 22 % for children in poor families[36].

In 2006, as a consequence of a food crisis, humanitarian agencies started piloting a Community-Based Management of Acute Malnutrition (CMAM) approach in the country. The Red Cross of Belgium, an international NGO, in collaboration with the National Red Cross in Burkina Faso, started a CMAM programme in June 2007, and the handover to the Ministry of Health was planned for 2010 in the Sahel region.

In September 2008, based on the UNICEF's conceptual framework on the determinant of malnutrition, the regional health authorities, in collaboration with a German NGO (HELP), implemented an intervention that aimed to improve access to healthcare in order to reduce the burden of malnutrition in this specific context. The promoters of the intervention rely on the assumption that improved access to healthcare services would enable better management of acute malnutrition (wasting) and management of recurrent illness episodes, ultimately resulting in improved outcomes for chronic malnutrition (stunting). With regard with stunting, increased use of maternal and child healthcare may increase uptake of preventive services and curative services, and, to some extent, child immunisation, deworming medication and for severe infectious diseases as malaria, diarrhoea, and acute respiratory infections. In addition, by avoiding perpetuating illnesses over a long period of time due to lack of access to healthcare, nutritional status can be protected. While the intervention does not directly target nutrition, the link between access to curative services and nutritional status is there (even in high-income settings).

The critical intervention activities were user fee removal intervention to improve access to quality child health services (nutrition sensitive) combined with the management of malnutrition for children under-5 years old, which included monitoring the children that were identified as being malnourished (nutrition specific intervention)[11,12]. The intervention also included activities related to social mobilisation, health education, and improvement of service quality.

The principle of the intervention was to make care free of charge for pregnant women and children under 5 years of age and to encourage mothers to have their children treated earlier, as soon as the first symptoms of illness appeared, and thus increase the use of services by all sick children, including the poorest and most deprived. In addition, to achieve more convincing results in the fight against malnutrition, free services have been combined with the medical management of malnutrition in the community. Thus, children suffering from malnutrition are detected, then referred and cared for free of charge in the health centres covered by the intervention. As the intervention is population-based, it systematically reached all the children who use health services less and all the acute malnourished children detected in the community.

The NGO focused its efforts on two of the region's four districts, Dori (290 000 inhabitants, 18 health centres in 2009) and Sebba (180 000 inhabitants, 11 health centres in 2009). The intervention was established to improve access to health services by subsidising 100 % of the care for children under 5 years of age, for pregnant women, and for nursing mothers. Prior to the intervention, patients visiting a health centre had to pay for the consultation ($0·20 USD), for drugs (varying costs depending on the prescription), and for care under observation ($0·60/d USD) if they were hospitalised in the primary health centre[11].

Study design

We conducted a non-equivalent control group post-test-only design[37,38]. A representative cross-sectional household survey was conducted 4 years after the intervention onset. The study group comprised households from 41 communities from intervention district (Dori) in which the intervention was ongoing for 4 years. The control group comprised of households from 51 communities from neighbouring district (Gorom) in which the intervention had not been implemented. Dori and Gorom were chosen as intervention and comparison districts respectively given the similarities of their contexts and in terms of public health intervention except for the presence of HELP intervention in Dori district. In particular, two studies on the effects of the user fee removal intervention on the use of child health services[24] and assisted childbirth[39] showed similar patterns of service utilisation in both groups before the onset of the intervention. However, data from the national health information system and the 2009 nutrition survey show that among the four districts in the region, the district of Dori and the district of Gorom-Gorom showed a slight difference the nutrition outcomes[40]. Indeed, the rate of stunting was estimated at 45·8 % in Gorom-Gorom (95 % CI 40·6, 51·2) and 46·3 % in Dori (95 % CI 41 0, 51·6), while 13·8 % of children suffered from wasting in Gorom-Gorom (95 % CI 10·8, 17·5) compared to 15·6 % in Dori (95 % CI: 12·1, 19, 8)[41].

Sampling and data collection

We collected cross-sectional data on household demographic characteristics as well as on a wide range of health-seeking behaviours and health outcomes for children under 5 years of age. The sampling strategy was a stratified two-stage random probability sampling approach following the WHO's Expanded Program on Immunization (EPI) Cluster Survey Design[12]. The primary sampling unit was defined as census enumeration areas, based on the 1998 census. We use the term 'community' to describe these small areas. During the first sampling stage, we randomly selected communities in the two districts for

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inclusion in the study with the probability of selection proportional to their population size. During the second stage, households were enumerated in each community and between 30 and 40 households were randomly selected[42]. All children who were 6 to 59 months present in each selected household were systematically included.

Mothers or primary caregivers were interviewed to obtain information on details on the occurrence of illness episodes and related health service utilisation in the last 30 d. In addition, we obtained information on household socio-economic and demographic characteristics, as well as on nutritional and health factors.

We used trained nurses as interviewers and proven measurement techniques to collect anthropometric data and objective measures of anaemia and malaria in the intervention and control groups. We took anthropometric measurements (age, weight, height, mid-upper arm circumference) for children under 5 years of age (6–59 months). We measured recumbent length for children less than 2 years old and standing height for children age for 2 years and older. We used digital scale for weight measurement while height and length was measured using a wooden measuring board as is done in Demographic and Health Surveys (DHS) and as recommended by UNICEF[43]. We defined anaemia status according to the level of Hb concentration; the presence of anaemia was defined as lower or equal to 110 g/l or upper and measured by a Hemocue photometer as recommended[44]. All children were tested for malaria, using a rapid diagnostic test (CareStart™ Malaria HRP2/pLDH (Pf/PAN). A child was diagnosed with malaria when the rapid diagnostic test was positive and body temperature was above 37°C.

As communities were selected based on probability proportional to the size of the population, households within communities were then selected with approximately equal probability, and all eligible children in a household were systematically selected, the overall probability of any child having been selected was approximately equal. This resulted in a self-weighting approach with no further weighting being later required at the stage of analysis[42].

Outcomes

As childhood wasting and stunting are the most common form of undernutrition in the study setting and because the intervention was designed to help improve child nutritional status, we used the anthropometric *Z*-score to capture stunting status.

We first calculated the anthropometric *Z*-score using Stata ZSCORE06 module on the basis of the WHO growth standards[45]. We then considered stunting and wasting in their severe and non-severe forms. Stunting and wasting were expressed as a *Z*-score of height for age and weight for height, less than 2 SD, while severe stunting and severe wasting were defined for the values of a *Z*-score of height for age and weight for height less than three standard deviations[45]. *Z*-scores of greater than 6 SD above or below the reference mean were removed from the sample[46] as they were regarded as implausible values (data entry or measurement errors).

Exposure

As a population intervention, the intervention with all its components was deployed in all primary health facilities within each community in the same manner, so that all children under 5 years of age who are identified malnourished or those who actually use health services systematically benefit from the intervention.

However, due the high risk of recall and misclassification bias, it was not accurate to prospectively measure the intensity of exposure to the intervention for children under 5 years to distinguish those who continuously benefit from the intervention from those who did not. Our analysis aims to estimate the effect of a real-life programme to improve the use of child health and nutrition services in which some children in the intervention group may have not received the intervention and some would have using health services even in the absence of the programme.

Therefore, we defined exposure according to the geographical location of residence and it was considering an ecological-level exposure[47,48].Thus, the exposure was defined by living or not in the intervention communities. As a matter of fact, social epidemiologists consider the place as a source of exposure at the global level[49], and several studies in the field of public health have considered residence in communities that have benefited from an intervention to assess its impact on health outcomes[50–53].

Individual- and household-level predictors

Based on the intervention theory[11], the framework developed by WHO[2] and UNICEF[32], we developed the potential pathways of impact for the intervention (Fig. 1) in order to select potential individual and household-level covariates relevant for the analysis.

We constructed bivariate relationships to examine the association of stunting across levels of categorical variables and we retained any variable whose univariable test had a *P*-value less than 0·20 along with all variables of known importance as identified by the literature[54–57]. As a result, the following variables were included in the regression models: child age (from 6–11 months to 48–59 months), sex, mother's education (if attended school or not), recent report of one of the following illness episodes: fever, cough or diarrhoea in the previous 30 d (yes/no), or anaemia (yes/no). In our conceptual framework (Fig. 1), we hypothesised an association between anaemia and stunting, and between stunting and the use of health services[58]. We also included household SES, type of residential area (rural or semi-urban), and community-level SES and

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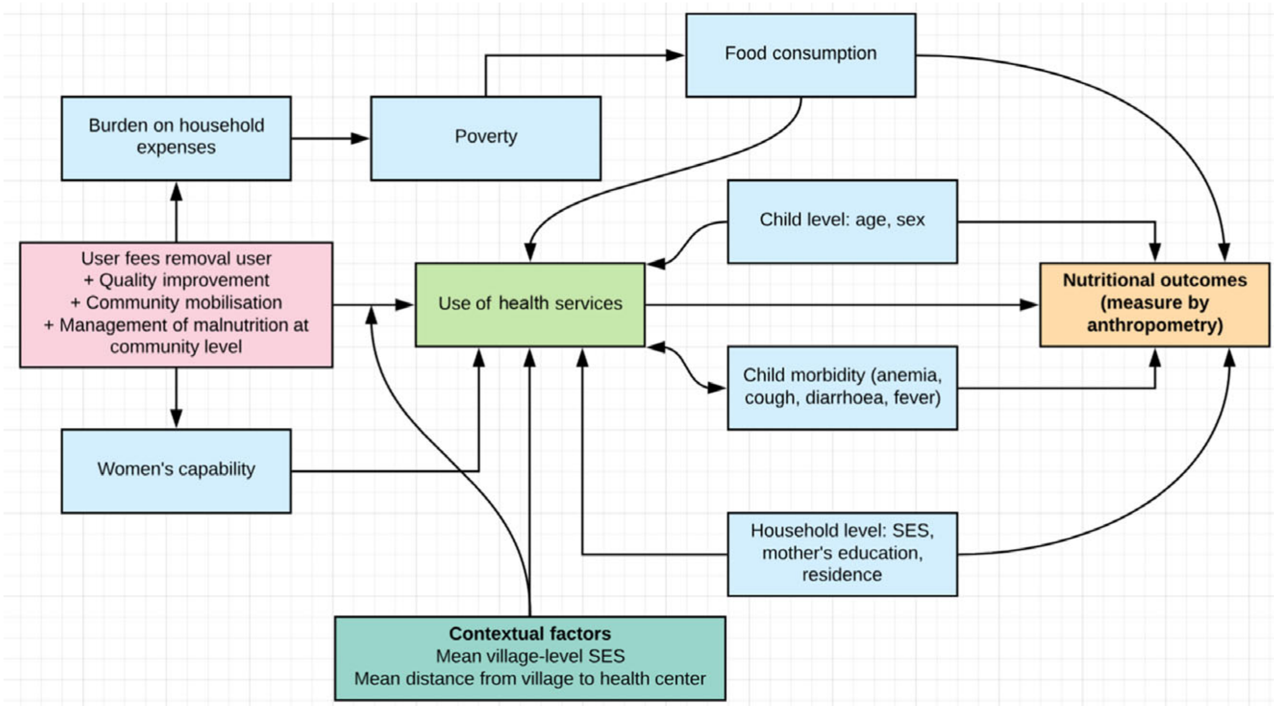

Fig. 1 (colour online) Potential pathways of impact for HELP intervention. SES, socio-economic status

measure of the distance. For the household distance measure, it represented the mean distance between each household and the health facility within a community. Indeed, in some communities, there were more households located more than 5 km away than households located less than 5 km away. Therefore, the impact of the distance may not be the same from one community to another. This implies that the average distance is a contextual factor that may differentially influence the use of health services and nutritional status.

We used an asset index as a proxy of household SES. This was computed using principal component analysis combining ownership of specific assets (cows, poultry, bicycle, motorbike and radio) and characteristics of the dwelling (type of source water, sanitation facilities and materials used for housing construction)[59]. Households were categorised as belonging to the lowest SES (< first quintile), middle SES (second to fourth quintiles) and highest SES (>fifth quintile).

Statistical analyses

Propensity score weighting

As the intervention was not randomly assigned; characteristics of communities, households and children living in the intervention district were likely to be different from those in the comparison district. We relied on generalised boosting modelling (GBM) propensity scores methods[60] to achieve balance in the distributions of selected covariates between the intervention and control groups. GBM is a non-parametric technique that allowed us to estimate the propensity score for the binary treatment indicator using a flexible estimation method that can adjust for a large number of pre-treatment covariates and complex functional forms[60,61]. In practice, for each child in the intervention district, the propensity score was defined as the predicted probability of living in intervention communities as a function of individual, household and community-level confounders[52,62]. We fit the GBM using the package gbm, which was developed for the R statistical environment[60,61]. All covariates which potentially related to the exposure and outcomes variables were included in the boosting models[61]. We ran the GBM algorithm using the standardized mean difference stopping rule to identify the iteration that minimises the average standardised mean differences[60]. The minimum acceptable difference suggested in the literature ranges from 0·1 to 0·25 SD[61,63,64].

Investigation of the contextual effect of the intervention

To assess the relationship between intervention and nutritional status, we performed descriptive statistics and calculated the prevalence of individual nutritional status using the STATA statistical software package version 15.0 (StataCorp.). Given the multilevel structure of the data with children nested within households and households nested within communities, we used multilevel logistic regression analysis approach for our categorical outcomes. We used stabilisation procedures[65] to correct for the influence from children with extreme weights by multiplying inverse probability of treatment weights by a constant, equal to the expected value of receiving the treatment relative to what the child actually received[65]. As recommended[61], we incorporated the estimated propensity score as inverse probability of treatment weights into the two-level random intercept logistic regression model[61] to assess the association between intervention and child nutritional status.

Multilevel analysis of disparities in stunting and wasting
We applied a two-step analytical strategy to distinguish the influence of the community context as a whole from the influence of the intervention as a specific contextual characteristic[34].

We began by fitting a multilevel logistic regression including only the individual-level predictors and predicted the probability of stunting as function of individual characteristics[33] and by incorporating community of residence as a random intercept. By quantifying the intra-class correlation (ICC)[33], this model provides information on the proportion of the total individual variance in the propensity of stunting or wasting that can be found at the community level. We calculated the ICC using the latent variable method:

$$ICC = \left[\frac{\sigma^2}{\sigma^2 + \frac{\pi^2}{3}}\right] * 100,$$

where σ^2 is between-community variance and $\pi^2/3$ is the variance of the of standard logistic distribution.

In the second step of the analysis, we examined specific contextual effects of the intervention[33] by addressing the question of whether living in an intervention community was associated with a reduced probability of stunting or wasting and to what extent the disparities in nutritional status were explained by the intervention. This helps with understanding the mechanism behind the observed general contextual effects. For this purpose, we included the exposure variable (living or not in communities which implemented user fee removal intervention) and calculated the adjusted ICC and the community-level variance explained by the presence of the intervention. The proportional change in variance defined as the proportion of the community-level variance was explained by adding the specific community effect (i.e. user fee removal) in the regression model[33]. A large proportional change in variance would inform us as to what extent the general contextual effect was substantially attributable to the community exposure to the user fee removal intervention combined with management of the malnutrition at the community level. We also estimated the Akaike information criterion to assess the goodness of fit of the different models. We reported estimated regression coefficients and OR by exponentiating the estimated regression coefficients as well as reporting model fit, Akaike information criterion and proportional change in variance. We also reported the estimates of the variance of the distribution of the random effects and statistical significance testing was conducted at the level of $\alpha = 0{\cdot}05$[33].

Results

Propensity score weighting

Table 1 presents results of the test of balance in observables characteristics between intervention and comparison communities. Before weighting, the standardised mean differences were greater than 0·15 for 7 variables. After weighting, the values of the standardised mean difference were attenuated and fall to almost null for all covariates with values lower than 0·03, showing that the propensity score weighting successfully balanced intervention and comparison on observed covariates.

Sample characteristics

The study population consisted of 2421 children (aged 6 months to 59 months) from 92 communities (13 from semi-urban and 79 from rural areas), with an average of 30 children per community for a total of 1116 children from intervention communities and 1305 from control communities.

Table 2 shows the bivariate associations between the intervention, nutritional status, anaemia, illness episodes and the use of health services. Results shows that moderated stunted children were commonly from the intervention group ($P < 0{\cdot}03$), whereas no difference was found in the prevalence of wasting between the two groups ($P = 0{\cdot}301$). Additionally, the proportion of children who suffer from anaemia or illness episodes ($P < 0{\cdot}01$) or had used health services ($P < 0{\cdot}001$) is significantly higher in the intervention group compared to those in the comparison group ($P < 0{\cdot}001$).

Effect of the intervention group on wasting and stunting

Table 3 shows the results of the mixed effects logistic regression model on the relationship between living in the intervention group and nutritional status. The results show that older children and those who experienced an illness episode and who suffer from anaemia are more likely to have poor nutritional status. In addition, the likelihood of stunting and wasting tend to reduce with the level of SES status. Finally, children from an educated mother and those from semi-urban areas are less likely to experience stunting compared to children living in rural areas or compared to those whose mothers are not educated. However, this relationship is not statistically significant for wasting.

In addition, the results also show for children under 5 years of age, living in an intervention community was not associated with a reduced likelihood of stunting (OR = 1·13; 95 % CI 0·83, 1·54) nor with reduced likelihood of child wasting (OR = 1·21; 95 % CI 0·90, 1·64), while

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Table 1 Characteristics of children in the intervention and comparison group before and after balancing by propensity score

	Before weighting				After weighting			
	Intervention	Comparison	std,eff,sz*	*P*-value	Intervention	Comparison	std,eff,sz	*P*-value
Age								
6–11 months	13·08	11·34	0·05	0·000	12·38	12·07	0·01	0·995
12–23 months	23·03	21·07	0·05		22·03	21·44	0·01	
24–35 months	18·46	22·22	−0·10		20·51	20·75	−0·01	
36–48 months	27·06	20·54	0·15		23·5	23·69	0·00	
48–5 months	18·37	24·83	−0·17		21·59	22·04	−0·01	
Sex								
Male	53·49	50·19	0·07	0·105	51·9	51·23	0·01	0·758
Female	46·51	49·81	−0·07		48·1	48·77	−0·01	
Residence area								
Rural	89·61	90·57	−0·03	0·426	90·02	90·03	0·00	0·991
Urban	10·39	9·43	0·03		9·98	9·97	0·00	
Household distance to health centre								
0–5 km	46·06	42·76	0·07	0·002	43·74	44·22	−0·01	0·949
5–10 km	33·24	30·42	0·06		32·15	31·5	0·01	
10–15 km	20·70	26·82	−0·15		24·11	24·28	0·00	
SES								
Poor	26·61	19·54	0·16	0·000	22·56	22·28	0·01	0·939
Middle	54·03	63·6	−0·19		59·76	60·48	−0·01	
Wealthiest	19·35	16·86	0·06		17·69	17·24	0·01	
Number of children								
1 child	18·28	25·29	−0·18	0·000	22·37	22·59	−0·01	0·961
2 children	37·37	48·66	−0·23		43·03	43·39	−0·01	
3 children+	44·35	26·05	0·37		34·6	34·02	0·01	
Mother attended school								
No	90·59	91·88	−0·04	0·264	91·82	91·63	0·01	0·873
Yes	9·41	8·12	0·04		8·18	8·37	−0·01	
Slept under bednet last night								
No	13·71	14·18	−0·01	0·741	14·12	14·21	0·00	0·955
Yes	86·29	85·82	0·01		85·88	85·79	0·00	
Access to potable water								
No	61·02	76·63	−0·32	0·000	69·1	70·31	−0·03	0·788
Yes	38·98	22·37	0·32		29·89	28·69	0·03	
Mean distance to health centre								
0–5 km	53·14	48·74	0·09	0·010	50·44	50·4	0·00	0·991
5–10 km	31·00	30·73	0·01		30·96	31·18	0·00	
> 10 km	15·86	20·54	−0·13		18·6	18·42	0·00	
Village level SES								
Poor	8·06	9·43	−0·05	0·020	7·63	8·64	−0·04	0·545
Middle	80·38	82·22	−0·05		82·69	82·61	0·00	
Wealthiest	11·56	8·35	0·10		9·68	8·75	0·03	

*std,eff,sz represents standardised effect size.

controlling for child and household-level characteristics. In addition, when comparing children living in the intervention district to children living in a non-intervention district in terms of severity (Table 4), we determined no differences in terms severely wasted (OR = 1·27; 95 % CI 0·79, 2·04) nor in severely stunted (OR = 0·99; 95 % CI 0·76, 1·26).

The analysis of the proportion of the variance explained by the context in general level and individual characteristics shows that 3 % of the variance of wasting (95 % CI 1·25, 10·42) and 9·4 % of the variance of stunting (95 % CI 6·45, 13·38) were due to systematic differences between communities of residence, while the remaining 90·6 % of the variance of stunting (95 % CI 86·6, 93·55) and 96·30 % of the variance of wasting (95 % CI 89·58, 98·75) was due to individual differences. This implies that the vast majority of the variance of stunting and mostly of wasting in children occurs at the individual level. Finally, in terms of influence of the intervention on the disparities of nutritional status, the results showed that presence of the intervention in the communities explains a very small proportion of a community's level variance of stunting (2 %) and community's level variance of wasting (3 %).

Discussion

We examined the contextual effects of a user fee removal intervention combined with healthcare quality improvement and malnutrition interventions, on child nutritional status and its variance at the community level. In our study, when comparing children living in the intervention district to children living in a non-intervention district, 4 years after the start of the intervention we found no statistically significant differences in terms of stunting and wasting, nor on their severity. We also determined that variance in stunting and

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Table 2 Bivariate associations between the intervention, nutritional status, anaemia, illness episode and the use of health services

	Comparison (*n* 1305)		Intervention (*n* 1116)			Total (*n* 2421)	
	n	%	*n*	%	*P*-value	*n*	%
Stunted							
None	756	57·93	591	52·96	0·03	1347	55·64
Moderate	298	22·84	300	26·88		598	24·70
Severe	251	19·23	225	20·16		476	19·66
Wasted							
None	1151	88·20	961	86·11	0·301	2112	87·24
Moderate	111	8·51	110	9·86		221	9·13
Severe	43	3·30	45	4·03		88	3·63
Anaemia							
None	539	41·30	332	29·75	<0·001	871	35·98
Mild	333	25·52	260	23·30		1550	64·02
Moderate	370	28·35	452	40·50		822	33·5
Severe	63	4·83	72	6·45		135	5·58
Illness episode							
No	1039	79·62	836	74·91	<0·01	1875	77·45
Yes	266	20·38	280	25·09		546	22·55
Severe illness episode							
No	1115	85·44	929	83·24	0·137	2044	84·43
Yes	190	14·56	187	16·766		377	15·57
Use of health services							
No	1,25	95·79	995	89·16	<0·001	2245	92·73
Yes	55	4·21	121	10·84		176	7·27

Table 3 Multilevel logistic regression analysis of wasting stunting status in the children under 5 years of age

	Wasting		Stunting	
	OR	95 % CI	OR	95 % CI
Individual level				
Age				
6–11 months (Reference)				
12–24 months	0·75	0·51, 1·10	2·88	1·99, 4·17
24–59 months	0·32	0·22, 0·46	3·85	2·79, 5·33
Sex				
Male (reference)				
Female	0·80	0·62, 1·02	0·84	0·69, 1·01
Mother went to school				
No (reference)				
Yes	0·92	0·52, 1·62	0·86	0·56, 1·32
SES				
Poor (reference)				
Middle	1·01	0·73, 1·42	1·34	1·03, 1·75
Wealthiest	0·89	0·56, 1·43	1·29	0·91, 1·84
Illness episode in last month				
No (reference)				
Yes	1·73	1·23, 2·42	1·31	1·01, 1·71
Anaemia				
No (reference)				
Yes	1·46	1·10, 1·95	1·81	1·44, 2·27
Residential area				
Rural (reference)				
Semi-urban	1·45	0·91, 2·32	0·40	0·25, 0·65
Communities level				
Control (reference)				
Intervention	1·21	0·90, 1·64	1·13	0·83, 1·54

Table 4 Relationship between intervention and the severity of wasting and stunting*,†,‡

	Intervention district	Comparaison district	OR	95 % CI
Severely wasted	4·03*	3·30*	1·27	0·79, 2·04
Severely stunted	20·16*	19·23*	0·99	0·76, 1·26

*Values for the comparison and intervention district are prevalence for severely stunted and severely wasted.
†We used a multilevel logistic regression analysis approach.
‡All regressions include child age, sex, mother education level, SES, illness episodes in last month, anaemia, residential area and exposure to the intervention.

wasting largely occurred at the individual level and only 2 % of the community-level variance of stunting and 3 % of the community-level variance of wasting was explained by the presence of the intervention in the communities.

A previous study determined that the intervention increased the use of services over the 4 years following the onset of the intervention[24]. Despite this trend, this study estimated that the intervention was not associated with a reduction in the prevalence of chronic malnutrition among the children when compared to children living in non-intervention communities and also when compared to early intervention levels[41]. This finding is in accordance with the results of a randomised controlled trial in Ghana[22], which found that introducing free primary healthcare increased the use of healthcare but did not lead to measurable differences in any health outcome including children's nutritional status after 1 year of follow-up.

Importantly, although we did not find a significant difference in nutritional status between the two groups, this does not mean that the intervention did not influence nutritional status. Despite the mean effect of the intervention being non-significant, the intervention affected the variance in nutritional status, which suggests the intervention may have had a positive impact on children's nutritional status

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in some communities that our study design did not allow us to identify. In addition, it is worth noting that the CMAM has several components and the implementation of its various components may vary according to geography and implementers. While the intervention under study is being implemented in both groups, it is possible that CMAM may be effective in reducing the rate of undernutrition at the community level in both intervention and control communities, thus masking or reducing the impact of the other intervention components.

Furthermore, the lack of effect could be related to the study design and the difficulty to prospectively measure the intensity of exposure to the intervention for children under 5 years to distinguish those who continuously benefit from the intervention from those who did not.

While studies on determinants associated with child nutrition have traditionally focused on individual-level factors[66,67]; our research demonstrates the importance of considering the influence of the community environment and the influence of the intervention as specific community-level factor on the distribution of nutritional status among children under 5 years of age. Our results are consistent with studies in Nigeria[55] and Bangladesh[57] that differentiated between contextual and individual effects on the likelihood of stunting and wasting. These studies found that 8·5 % of the variance of height for age in Bangladesh and 8·7 % of stunting in Nigeria, respectively, were influenced by residential contexts[55,57,68] that included context-specific public health and many other ecological-level exposures[47,48]. Those effects can be dissociated from the effect of the general residential context. Thus, we also estimated that 2 % of the variance of stunting and 3 % of the variance of wasting in communities were associated with the presence of the intervention in those communities. Though epidemiologists normally investigate effect of intervention as changes in group means[34], our results show that the presence of the intervention was associated to some extent with the variance of the distribution of wasting and stunting in the communities. From a public health perspective, this result provides important information about the potential effect of the intervention combining free care with the management of undernutrition in community level on nutritional status.

Despite the use of advanced epidemiological analysis methods and anthropometric measurement tools recommended by UNICEF and WHO[43], our study has several limitations that must be considered when interpreting the results. The lack of effect of nutritional status could be explained by an insufficient study design, the propensity score adjustment, or from measurement error. With regard with measurement error, specifically given the nature of the intervention as the exposure variable was based on an ecological measure, which may have led to misclassification of exposure of individuals as we defined the area of residence. However, social epidemiologists often consider the site to be a source of exposure at the global level and several studies in the public health field have considered residence in intervention communities to assess the impact of public health interventions[50–53]. Secondly, we were unable to account for the prevalence of illnesses and height of the mother, as these variables were not collected. These data exclusion has likely resulted in residual confounding and would have diluted the intervention effects[69]. Thirdly, we were not able to collect baseline data from the two districts given the rapidity of the intervention implementation. Our cross-sectional study design does not allow for the evaluation of secular trends and pre-existing differences in child nutritional status. A difference-in-difference or regression discontinuity analysis using the data over a longer period is the next natural step, using regularly collected data such as the DHS data. Finally, in this study, we did not show whether the intervention was associated with the increase in the use of the healthy service at community level, nor did we analyse the trend of nutritional status before the intervention onset. This perspective of simultaneous evaluation of the effect of the intervention on health service utilisation and nutritional status would require the use of complex analytical methods, such as mediation analyses[70] or structural equations modelling[71] with longitudinal data, but unfortunately the data we collected do not lend itself to such analyses.

Conclusion

Our study was not able to conclude that living in the intervention group was significantly associated with a reduced likelihood of stunting and wasting among children under 5 years of age in the Sahel region in Burkina Faso. However, combining free care with community-based management of undernutrition affects the variance of children's nutritional status suggesting the intervention may have improved nutritional status in some communities. With the scaling-up of the national free health policy in Burkina Faso in June 2016, our study has shown the relevance of an intervention combining user fee removal interventions and management of malnutrition at the community level to increase the use of health services. However, as the intervention affected the variance of nutritional status at community level and given that the vast majority of the variance of stunting and wasting in children occurs at the individual level, if combined with tailored nutrition-specific interventions that target the proximal determinants of malnutrition, user fees removal intervention could act as an important contextual factor catalysing the impact of nutrition-specific interventions. The scaling-up of the national free health policy offers an exceptional opportunity to evaluate the effects of the user fee removal intervention more than 10 years after its initial introduction. This evaluation would provide decisions-markers further information to inform nutrition-specific interventions.

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