sis. Descriptive statistics were run on all variables. Mean, median and SD were reported for continuous variables. Percentages were displayed for discrete ones. Maps of the independent variables aggregated per household cluster were produced to visualise their spatial pattern. For the spatial pattern of categorical variables, the percentage levels were displayed. For continuous variables, such as mothers BMIs, classes of BMI indicating underweight, normal weight, overweight and obesity, were used to visualise the spatial pattern. Correlation between the anthropometric status and the independent variables were ran on all variables to study the linear relationship with height-for-age. A hierarchical stepwise linear regression model was applied to determine the factors that were significant HAZ determinants. Three hierarchical stepwise models were run, with demographic and socio-economic factors that affect height-for-age entered first. The second block consisted of environmental variables and in the third block, the household clusters classification variables, based on the type of market that served each cluster. The independent variables retained in the final model were all significant at the $P \leq 0.05$ level. Given that most regression analyses have been criticised of overlooking or not correcting for the spatial dependence which biases the results of the regression models (Voss *et al.*, 2006; de Sherbinin, 2011), we checked for possible spatial autocorrelation in our analyses. Thus, the results of the final model were validated by visualising the pattern of the residuals in ArcGIS, and running a spatial autocorrelation analysis using Global Moran's *I* to assess the non-spatial clustering of the model residuals. Spatial autocorrelation indicates that the errors in the model are not independent (Voss *et al.*, 2006). When spatial autocorrelation is present, it reduces the standard errors of the estimates, increases the *t*-values and reduces the P-value thereby leading to a bias in the model (Voss *et al.*, 2006). Moran's *I* is similar to Pearson's correlation coefficient, and has values ranging from -1 to 1, with positive values indicating high values surrounded by high values and, negative results showing spatial randomness. A prediction map based on the model predicted height-for-age z-scores per household cluster and per district was produced using natural breaks.

Results

The descriptive characteristics of the study population is presented in Table 2, while Figure 3 displays the spatial variability existing within the demographic and socio-economic variables per cluster. The high percentage of stunting is more common in the North, West and south-eastern part of Rwanda and varies from 0%

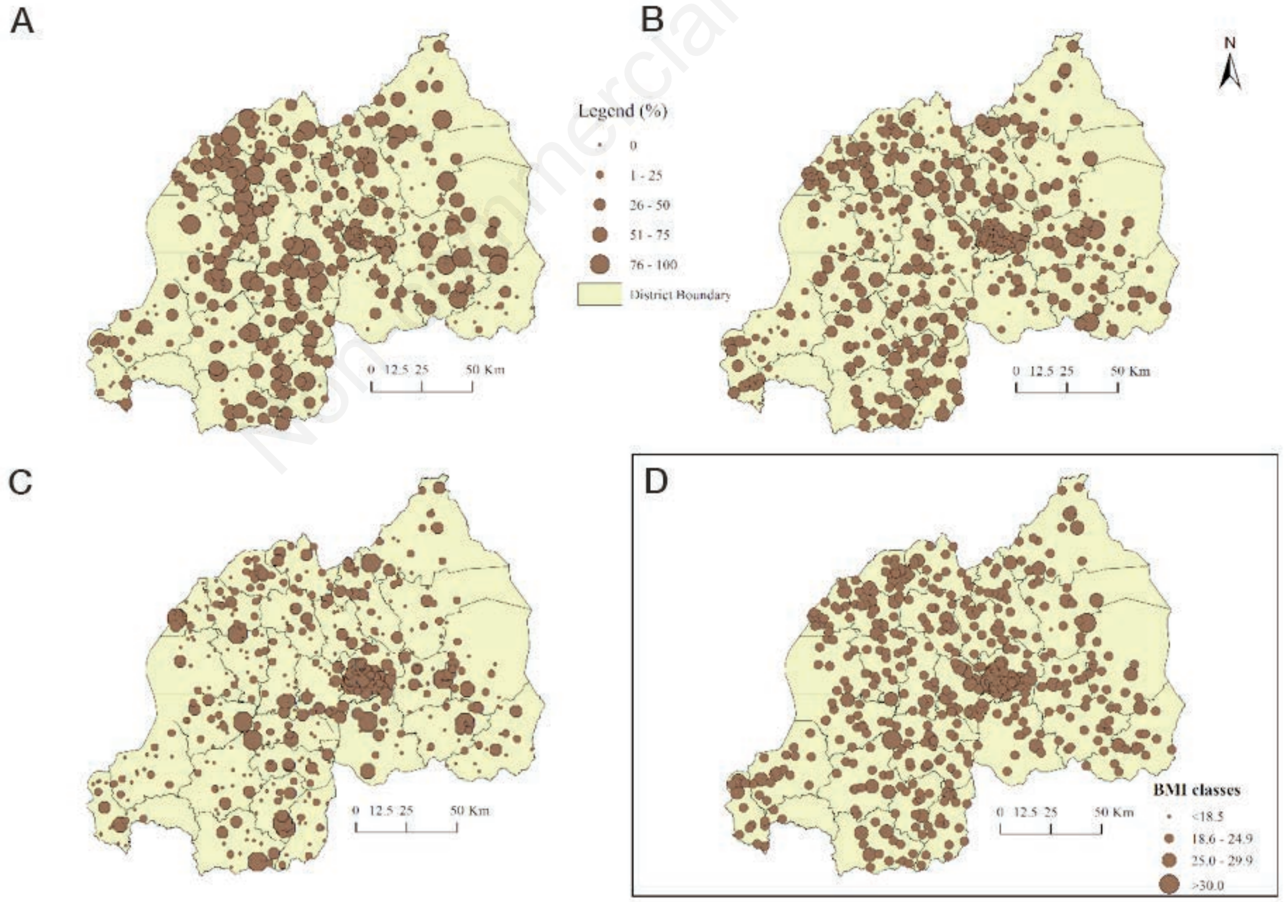

Figure 3. Prevalence rate of Demographic and Health Survey variables per cluster. A) Prevalence rate of stunting; B) percentage of exclusive breastfeeding; C) secondary and other higher education of mother; D) mothers' body mass index (BMI) classes per cluster.

to 100% in some clusters (Figure 3A). Exclusive breastfeeding of children less than six months was generally below 75% (Figure 3B). As expected, mothers with secondary education and higher mostly lived in Kigali (Figure 3C). On the other hand, the BMI of mothers were uniformly spread across the country (Figure 3D).

As shown in Figure 4, the percentage of children receiving deworming tablets in the last six months (Figure 4A) was higher across the country as opposed to the prevalence of diarrhoea (Figure 4B). The use of non-improved water source (Figure 4C) in the households was more pronounced in the East, North and some regions in the South. On the other hand, the use of non-improved sanitation (Figure 4D) was evenly spread across the four provinces of Rwanda.

Table 3 shows the results from the household cluster classification. Household clusters that were served by an urban market within a 5 and a 10-km radius were 21% and 32%, respectively. Household clusters served only by a rural market were 39% and 61% within the 5 and 10 km, respectively. Household clusters served by neither an urban nor a rural market within 5 km were 40% as opposed to 7% within 10 km.

Figure 5 shows the spatial distribution of the household clusters as served by an urban market or a rural market within a 5 km (Figure 5A) and 10 km radius (Figure 5B). The majority of household clusters that were served by a market at the top of the food supply chain were located in urban areas. According to our assumption of increased aflatoxin contamination along the food supply chain, these household clusters were considered as clusters with the least risk of exposure to higher aflatoxin level. Household clusters served by markets at the intermediate level in the food supply chain were mostly located in rural areas; and thus they will be more exposed to aflatoxins compared to clusters located in the urban areas, assuming the rural markets get their supply from the urban markets. Finally, the household clusters neither served by an urban nor a rural market within a 10-km radius, which is the third category, will be potentially the most exposed to higher levels of aflatoxins.

As can be seen in Table 4 showing the results of the hierarchical linear regression model, the child's age, mother's height, secondary education, being male, birth weight was significantly associated with height-for-age. From the biophysical factors, elevation was a significant predictor of height-for-age in children. Being served by a rural market within 10 km radius was negatively associated with the height-for-age in children. The HAZ significantly decreased as a cluster changed from being served by an urban market to being served by a rural market within a 10-km radius. The adjusted R^2 of the final model was 0.27, implying that 27% of the total variability in stunting can be explained by this significant empirical model.

Figure 6 shows the results of the spatial autocorrelation analysis with residuals on the x-axis and the lagged residuals on the y-axis. The lagged residuals represent the sum of weighted residuals of neighbouring household clusters indicating that there is no spatial autocorrelation among residuals, thereby confirming their independence. Figure 7B shows the spatial pattern of the predicted values of HAZ at the cluster-level in Rwanda, based on the model presented in Table 4, with the same mean HAZ aggregated to the district level. Overall, the central region of Rwanda has normal height-for-age values in contrast to the northern and the western regions that have mostly low height-for-age values. The aggregation to the district level, however, overshadows the clusters with higher HAZ, which are surrounded by clusters with lower HAZ. As seen in Figure 7A, the same is observed from the comparison with the commonly reported stunting prevalence per district. Compared with Figure 1, the spatial variability in HAZ is lost due to data aggregation at the district levels.

Table 2. Descriptive statistics of dependent and independent variables used in the study.

Variable	Mean	SD	No. of clusters	%
Continuous				
Height-for-age	-1.2	1.5	1,467	
Child age (months)	11	7.0	1,514	
Child birth weight (kg)	3.3	0.6	1,509	
Mother's BMI (kg/m^2)	23.1	3.5	1,509	
Mother's height (cm)	156.9	6.1	1,509	
Birth index (months)	11.4	6.6	3,122	
Wealth index	-0.1	0.8	3,122	
Elevation (m)	1702	348.0		
Slope (degrees)	11.7	10.9		
Rainfall (mm)	1208	259.0		
Relative humidity	73.9	3.6		
Categorical				
Stunting			1,467	30.2
Sex			3,122	
Female				50.1
Male				49.9
Exclusive breastfeeding			2,972	
Yes				25.3
Mother's education			3,122	
No education				13.3
Primary education				71.8
Secondary education				12.5
Higher				2.4
Improved water source*			3,074	
Yes				72.5
Improved sanitation°			3,074	
Yes				70.2
Deworming tablets use in last six months				3,116
Yes				48.6
Diarrhoea in last two weeks			3,122	
Yes				17.0

Data source: Demographic and Health Survey, Rwanda 2014-2015 and authors' own calculations. SD, standard deviation; BMI, body mass index. *includes piped water, public tap/standpipe, tube well, borehole, protected well, protected spring, rainwater; °includes connection to a piped sewer system, to a septic tank, to a pit latrine, ventilated improved pit latrine, pit latrine with slab, composting toilet. Shared improved facilities are also included.

Table 3. Household clusters classification.

Variable	Sample size (%) 5 km	Sample size (%) 10 km
Distance categories		
Household clusters served by an urban market	106 (21)	158 (32)
Household clusters exclusively served by a rural market	90 (39)	300 (61)
Household clusters served by neither an urban nor a rural market	196 (40)	34 (7)

Discussion

We studied the determinants of the spatial pattern of height-for-age at the household cluster level in Rwanda considering demographic, socio-economic variables and environmental variables, with a proxy variable for aflatoxin exposure in children. Stunting prevalence in children in Rwanda was 30.2% which, according to the present stunting prevalence thresholds (de Onis *et al.*, 2019), is considered very high. Factors associated with stunting were the child's age, the mother's height, the mother's education, the child's gender and its birth weight. The direction of the relationship for each covariate was as expected. First, the age of children was negatively associated with height-for-age, a result that aligns with other studies in the sense that as a child becomes older, the risk of stunting increases (Dewey and Huffman, 2009). Second, the mother's height was positively associated with the

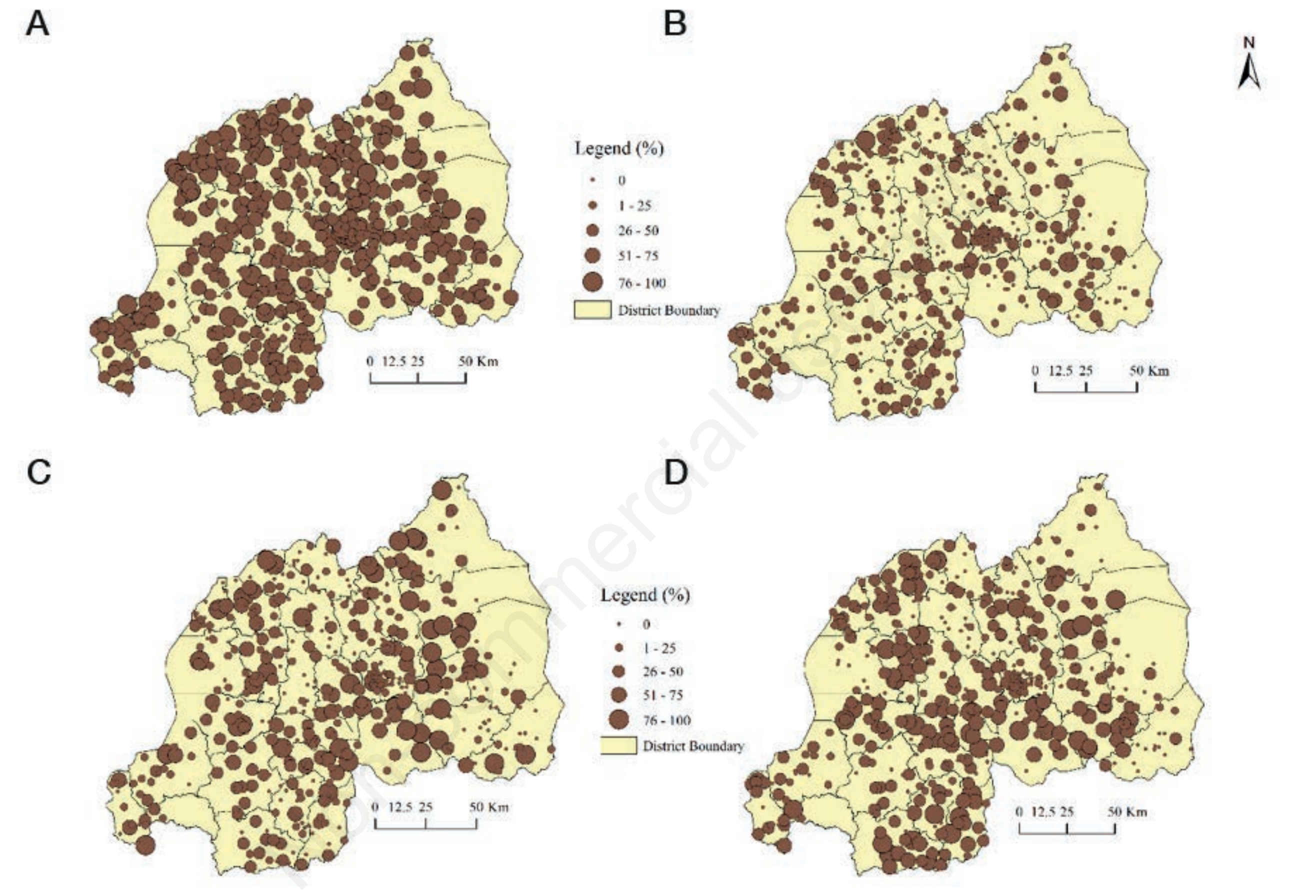

Figure 4. Prevalence rate of Demographic and Health Survey variables per cluster. A) Prevalence rate of using deworming tablets in last six months; B) percentage of diarrhoea in last two weeks; C) non-improved water source in the households; D) non-improved sanitation in household.

Table 4. Regression coefficients of the socio-economic, environmental and accessibility factors on height-for-age.

Variables	Non-standardized coefficients		Standardized coefficients	95% CI
	B	Standard error	Beta	Lower, Upper
Child's age (months)	-0.08**	0.01	-0.328	-0.102, -0.062
Mother's height (cm)	0.06**	0.01	0.223	0.036, 0.078
Secondary education or higher	0.01*	0.00	0.128	0.002, 0.010
Child being male	-0.01*	0.00	-0.132	-0.010, -0.002
Child's birth weight (kg)	0.32*	0.13	0.102	0.065, 0.583
Elevation (m)	-0.00**	0.00	-0.207	-0.001, 0.000
Cluster served by an urban *vs* a rural market	-0.18*	0.09	-0.086	-0.351, -0.007

B, Non-standardized coefficient; Beta, Standardized coefficient; CI, Confidence interval. $^*P \leq 0.05$, $^{**}P \leq 0.001$. Adjusted R^2 of the model is 0.27.

height-for-age of her child, showing the relation between maternal nutrition and anthropometric status of the child. Maternal short stature is a high-risk factor of intra-uterine growth restriction, which has previously been linked to childhood stunting (Black *et al.*, 2013). Third, we found that secondary education or higher of the mother was positively associated with height-for-age. In Uganda, Wamani *et al.* (2007) found similar results. Chopra (2003) and Sakisaka *et al.* (2006) also identified that low maternal education was associated with lower height-for-age of children.

In our study, a child being male was negatively associated with height-for-age. Previous Rwandan DHS surveys (INSR and Macro, 2006; NISR *et al.*, 2010) have shown a similar pattern. The Rwanda DHS of 2010 showed that 47.4% of the boys were stunted compared to 41.4% of the girls. The Rwanda DHS of 2005 identified that 46.3% of the boys were stunted compared to 44.4% of the girls. In a study on sex differences in the nutritional status of HIV-exposed children in Rwanda, Condo *et al.* (2015) found significant differences in stunting status, with male children being more stunted than their female counterparts, although they did not find a significant difference in feeding practices between male and female children. As for birth weight, our findings showed that higher birth weight was positively associated with height-for-age. Black *et al.* (2013) have shown that children with normal birth weight are more protected against infections and have less mortality risk compared to children with a low birth weight.

Although exclusive breastfeeding, use of deworming tablets, access to improved water source and sanitation of the household are known to influence height-for-age (Stewart *et al.*, 2013), our multi-variate analysis did not identify any significant association. Preceding birth interval, mothers' BMI, and type of residence were also not significantly associated with stunting. Households living in areas of higher altitude negatively associated with the height-for-age of children. The robustness of the elevation covariate was consistent throughout the analysis. Similarly, Dang *et al.* (2004) found that children living in mountainous regions have a higher risk of becoming stunted than children brought up in lowlands. Elevation could have a direct effect on height-for-age, but it is more probable that these are more remote areas with higher food insecurity and lower levels of access to health care services. In a comprehensive vulnerability survey conducted in Rwanda in 2015, households at high altitudes were more at risk due to food insecurity, and their children were also found to be more stunted compared to those living in the rest of the country (MINAGRI *et al.*, 2016). On the other hand, in this study we tested the accessibility to health care services, and did not find a significant relationship between distance to health facilities and height-for-age. This is probably because the health care services delivery in Rwanda is well organised with a universal health care system and thus equally accessible to the majority of the population (Binagwaho *et al.*, 2014). We tested other environmental factors such as rainfall, relative humidity and slope. These covariates were not statistically significant. However, this non-significant result might result from the cross-sectional nature of our study. Considering seasonality in future studies might reveal an impact of these factors on the anthropometric status of children. Skoufias and Vinha (2012) analysed the impact of the weather on child height in rural Mexico from 1951 to 1985 and found that after positive rainfall shocks, defined as one or two standard deviations more than the average 1951-1985 rainfall, children were shorter regardless of their location or altitude. Negative temperature shocks, defined as one or two standard deviations less than the average 1951-1985 tempera-

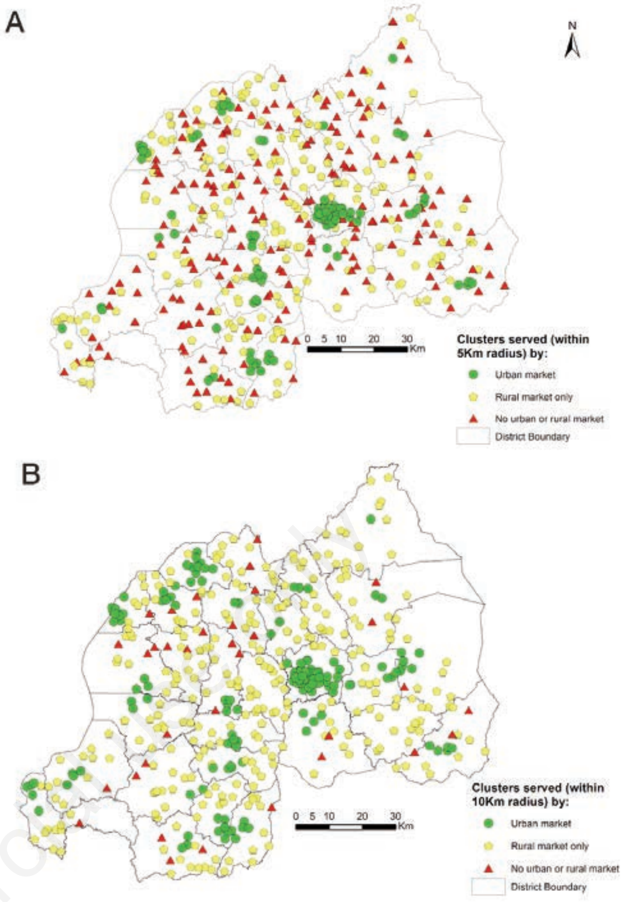

Figure 5. Distribution of household clusters as served by the three categories of markets. A) Within a 5-km distance; and B) a 10-km distance.

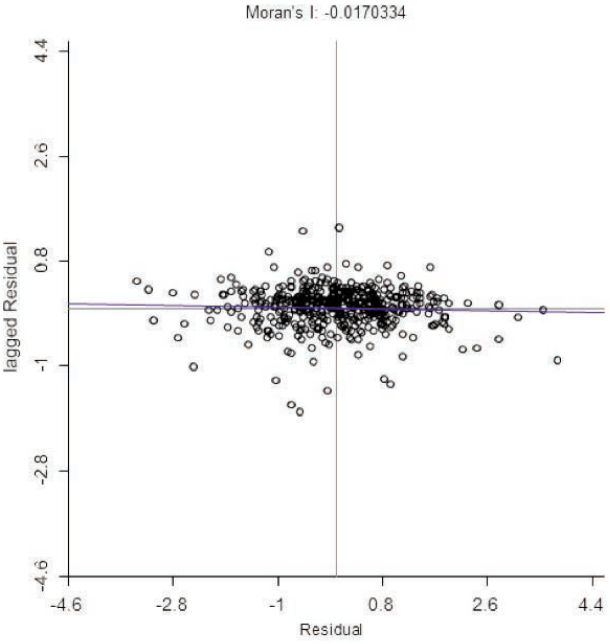

Figure 6. Moran's *I* for the residuals.

ture, also had a negative impact on child's height but only for high altitude areas (Skoufias and Vinha, 2012).

Household clusters that were served by rural markets had a significant negative association with height-for-age compared to clusters that were served by urban markets. This association had the second highest effect on the height-for-age of children after the children's birth weight. This result supports our hypothesis that households that obtain food supplies from markets at the lower end of the food supply chain have a higher risk of aflatoxin exposure. Given that these findings are based on a proxy only, this finding should be treated with caution. Also, in reality, the dynamics of aflatoxin production along the food supply are complex which means that our hypothesis requires further validation by studying the occurrence of this toxin along the food supply chain and quantifying contamination levels. On the other hand, due to the lack of explicit national spatial data on aflatoxins in foods, which is the case in many developing countries, our approach could be applied in other research settings on mycotoxins. Our study revealed that the identified variability in stunting prevalence at the cluster level is lost when stunting levels are aggregated to the district level. This can have considerable implications for stunting reduction policies because a district might be classified as having low stunting and thus not be given priority for programme intervention even if high stunting prevalence could exist at the sub-district or cluster level. To enable more geographically targeted policies and programmes in future, it is important to consider cluster-level variations in stunting prevalence.

The use of the Rwanda DHS 2014-15 data had several strengths and the consideration of biophysical factors and a proxy measure of the exposure to aflatoxins in addition to socio-economic factors rendered the analysis more robust, enabling spatially explicit predictions of stunting occurrence. First, we analysed both child and mother characteristics, further increasing the robustness of the analysis. Second, the DHS survey provided a range of explanatory variables of good quality data. Third, the availability of spatial data enabled us to analyse biophysical factors associated with stunting at the household cluster-level which, to the best of our knowledge, has not been done before in Rwanda. Using the household clusters, we could take into account the spatial variability of the covariates, visualise the spatial distribution of height-for-age at a fine-scale resolution, control for spatial autocorrelation, and finally make a spatial prediction map for height-for-age. Our

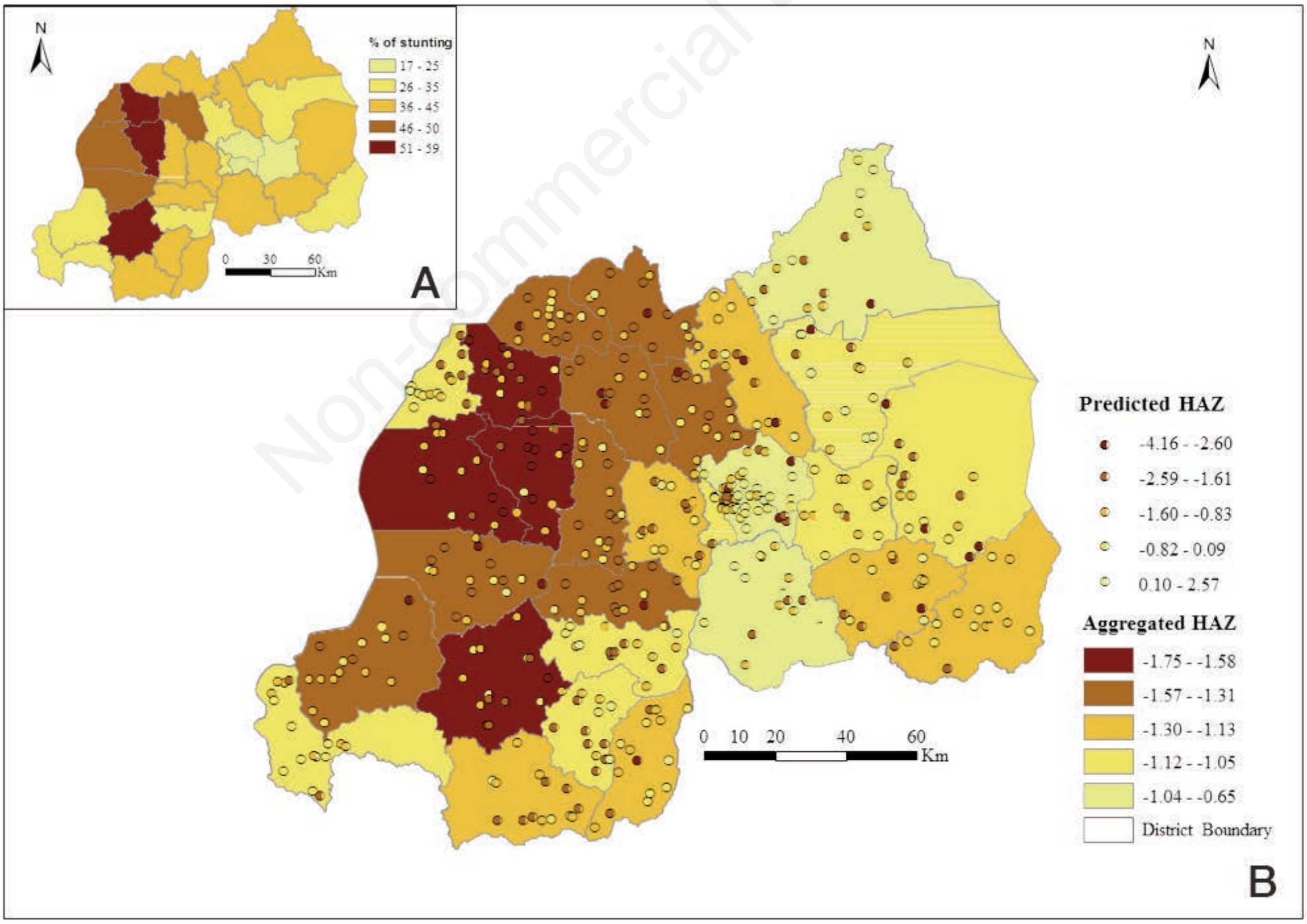

Figure 7. Model-predicted height-for-age z-scores (HAZ) per cluster. Based on Demographic and Health Survey, 2015. A) Per district and B) with the same values shown in the background aggregated at the district level compared to the prevalence of stunting.

study also had limitations. Although for the extraction of environmental factors and the estimation of household exposure to aflatoxins the displacement of the household clusters was taken into account; there will be a margin of error as the true locations of the clusters remain unknown (Burgert *et al.*, 2013). Also, our proxy for aflatoxins exposure via the food supply chain requires further evidence. This is because of the complex interplay of factors leading to aflatoxins produced in food products (Sanchis and Magan, 2004; Sakisaka *et al.*, 2006). Also, our scenario considered only the hierarchy of markets as the source of exposure, which does not take into account the exposure experienced by households that produce and store maize for their own consumption.

Conclusions

Our study confirms not only the usual effect of child and mother factors on height-for-age but also shows the influence of environmental factors in determining the height-of-age of children in Rwanda. Elevation and being supplied by markets at the lower end of the food supply chain were found to be significantly associated with low height-for-age. Thus, an understanding and consideration of the environmental drivers of stunting is crucial in order to produce a holistic approach in addressing low height-for-age in children under five years. Our use of household clusters shows the variability of stunting across the study area. In most published studies, the analysis is generally conducted at the household level with no spatial component considered. Although this approach provides valuable insights into the determinants of stunting on individual and household levels, most governmental interventions are targeted at the regional scale. Future research should focus on studying in depth the clustering observed in the height-for-age measure, to better understand the individual determinants of stunting at a finer scale. Conducting such a research could shed light on overlooked, yet determining correlates of stunting, which would result in better geographically targeted interventions and prioritisation of areas affected. It would also contribute to an examination of the temporal change in hotspots of stunting during the past years, which would lead to a better understanding of the spatial variation in the distribution of stunting. For Africa and Rwanda specifically, there is a need for more interdisciplinary research, incorporating geographical information system applications in understanding the complexity of stunting, to complement the research usually conducted on an individual or household level in the nutrition or social science fields. Finally, there is a tremendous data gap to be filled on the extent of mycotoxin exposure on the national level and how this affects linear growth, not only at the individual level but also at a regional and national scale.

References

Amuzie C, Bandyopadhyay R, Bhat RV, Black R, Burger H, Cardwell KF, Gelderblom W, Gong YY, Groopman JD, Kimanya M, Miller JD, Oswald I, Pascale M, Payne GA, Phillips TD, Riley R, Shephard GS, Stoltzfus R, Sugita-Konishi Y, Turner PC, Wogan GN, Wu F, 2016. Mycotoxin control in low- and middle-income countries. Wild CP, Miller D, Groopman JD, Lyon, France.

AUC, NEPAD, 2013. The cost of hunger in Rwanda, social and economic impacts of child undernutrition in Rwanda, implications on national development and vision 2020. African Union Commission (ACU), NEPAD Planning and Coordinating Agency, Economic Commission for Africa (ECA), World Food Programme (WFP), Rwanda.

Binagwaho A, Farmer PE, Nsanzimana S, Karema C, Gasana M, de Dieu Ngirabega J, Ngabo F, Wagner CM, Nutt CT, Nyatanyi T, Gatera M, Kayiteshonga Y, Mugeni C, Mugwaneza P, Shema J, Uwaliraye P, Gaju E, Muhimpundu MA, Dushime T, Senyana F, Mazarati JB, Gaju CM, Tuyisenge L, Mutabazi V, Kyamanywa P, Rusanganwa V, Nyemazi JP, Umutoni A, Kankindi I, Ntizimira C, Ruton H, Mugume N, Nkunda D, Ndenga E, Mubiligi JM, Kakoma JB, Karita E, Sekabaraga C, Rusingiza E, Rich ML, Mukherjee JS, Rhatigan J, Cancedda C, Bertrand-Farmer D, Bukhman G, Stulac SN, Tapela NM, van der Hoof Holstein C, Shulman LN, Habinshuti A, Bonds MH, Wilkes MS, Lu C, Smith-Fawzi MC, Swain JD, Murphy MP, Ricks A, Kerry VB, Bush BP, Siegler RW, Stern CS, Sliney A, Nuthulaganti T, Karangwa I, Pegurri E, Dahl O, Drobac PC, 2014. Rwanda 20 years on: investing in life. Lancet 384:371-5.

Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J, Maternal, Child Undernutrition Study G, 2008. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 371:243-60.

Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, Ezzati M, Grantham-McGregor S, Katz J, Martorell R, Uauy R, Maternal, Child Nutrition Study G, 2013. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 382:427-51.

Burgert CR, Colston J, Roy T, Zachary B, 2013. Geographic displacement procedure and georeferenced data release policy for the Demographic and Health Surveys. DHS Spatial Analysis Reports No. 7. ICF International, Calverton, Maryland, USA.

Chopra M, 2003. Risk factors for undernutrition of young children in a rural area of South Africa. Public Health Nutr 6:645-52.

Condo JU, Gage A, Mock N, Rice J, Greiner T, 2015. Sex differences in nutritional status of HIV-exposed children in Rwanda: a longitudinal study. Trop Med Int Health 20:17-23.

Cotty PJ, Jaime-Garcia R, 2007. Influences of climate on aflatoxin producing fungi and aflatoxin contamination. Int J Food Microbiol 119:109-15.

Dang S, Yan H, Yamamoto S, Wang X, Zeng L, 2004. Poor nutritional status of younger Tibetan children living at high altitudes. Eur J Clin Nutr 58:938-46.

de Onis M, Borghi E, Arimond M, Webb P, Croft T, Saha K, De-Regil LM, Thuita F, Heidkamp R, Krasevec J, Hayashi C, Flores-Ayala R, 2019. Prevalence thresholds for wasting, overweight and stunting in children under 5 years. Public Health Nutr 22:175-9.

de Onis M, Branca F, 2016. Childhood stunting: a global perspective. Matern Child Nutr 12:12-26.

de Sherbinin A, 2011. The biophysical and geographical correlates of child malnutrition in Africa. Popul Space Place 17:27-46.

Dewey KG, Begum K, 2011. Long-term consequences of stunting in early life. Matern Child Nutr 7:5-18.

Dewey KG, Huffman SL, 2009. Maternal, infant, and young child nutrition: combining efforts to maximize impacts on child growth and micronutrient status. Food Nutr Bull 30:S187-9.

FAO, IFAD, UNICEF, WHFP, WHO, 2017. The State of Food Security and Nutrition in the World 2017. Building resilience for peace and food security. FAO, Rome, Italy.

Gbashi S, Madala NE, Adekoya I, Adebo O, De Saeger S, De Boevre M, Njobeh PB, 2018. The socio-economic impact of mycotoxin contamination in Africa. In Njobeh PB, ed. Fungi and mycotoxins - their occurrence, impact on health and the economy as well as pre- and postharvest management strategies. Available from: https://www.intechopen.com/books/mycotoxins-impact-and-management-strategies/the-socio-economic-impact-of-mycotoxin-contamination-in-africa

Hell K, Mutegi C, 2011. Aflatoxin control and prevention strategies in key crops of Sub-Saharan Africa. Afr J Microbiol Res 5:459-66.

INSR, Macro O, 2006. Rwanda Demographic and Health Survey 2005. Institut National de la Statistique du Rwanda (INSR), ORC Macro, Calverton, Maryland, USA.

Kamika I, Ngbolua KTN, Tekere M, 2016. Occurrence of aflatoxin contamination in maize throughout the supply chain in the Democratic Republic of Congo. Food Control 69:292-6.

Khlangwiset P, Shephard GS, Wu F, 2011. Aflatoxins and growth impairment: a review. Crit Rev Toxicol 41:740-55.

Lu C, Mejia-Guevara I, Hill K, Farmer P, Subramanian SV, Binagwaho A, 2016. Community-based health financing and child stunting in rural Rwanda. Am J Public Health 106:49-55.

Mendelsohn J, Jarvis A, Robertson T, Nyiratuza M, 2016. Rwanda: the measure of a land. Vital Signs, Kigali, Rwanda.

MIGEPROF, 2018. Rwanda Country Strategic Review of Food and Nutrition Security. Ministry of Gender and Family Promotion, Kigali, Rwanda.

MINAGRI, NISR, WFP, 2016. Rwanda 2015-Comprehensive food security and vulnerability analysis. MINAGRI, NISR, WFP, Kigali, Rwanda.

MINALOC, MOH, MINAGRI, 2014. National Food and Nutrition Strategic Plan 2013-2018. MINALOC, MOH, MINAGRI, Rwanda.

Nikoi E, Anthamatten P, 2013. An examination of environmental correlates with childhood height-for-age in Ghana. Public Health Nutr 16:46-53.

NISR, MINECOFIN, 2012. Fourth Rwanda Population and Housing Census (2012 RPHC) Census Atlas. National Institute of Statistics, Ministry of Finance and Economic Planning, Rwanda.

NISR, MOH, ICF, 2010. Rwanda Demographic and Health Survey 2010. National Institute of Statistics of Rwanda (NISR), Ministry of Health (MOH), ICF International, Calverton, Maryland, USA.

NISR, MOH, ICF, 2015. Rwanda Demographic and Health Survey 2014-15. National Institute of Statistics of Rwanda (NISR), Ministry of Health (MOH), ICF International, Rockville, Maryland, USA.

Nyandwi E, Veldkamp T, Amer S, 2016. Regional climate sensitivity of wetland environments in Rwanda: the need for a location-specific approach. Reg Environ Change 16:1635-47.

Onis M, 2007. WHO Child Growth Standards based on length/height, weight and age. Acta Paediatr 95:76-85.

Pitt JI, 2000. Toxigenic fungi and mycotoxins. Br Med Bull 56:184-92.

Rutstein SO, Rojas G, 2006. Guide to DHS Statistics Demographic and Health Surveys Methodology. Measure DHS/ICF International, Calverton, Maryland, USA.

Sakisaka K, Wakai S, Kuroiwa C, Flores LC, Kai I, Mercedes Arago'n M, Hanada K, 2006. Nutritional status and associated factors in children aged 0–23 months in Granada, Nicaragua. Public Health 120:400-11.

Sanchis V, Magan N, 2004. 8 - Environmental conditions affecting mycotoxins. In: Magan N, Olsen M, eds. Mycotoxins in food. Woodhead Publishing, Cambridge, UK. pp 174-189.

Shephard GS, 2008. Impact of mycotoxins on human health in developing countries. Food Addit Contam Part A Chem Anal Control Expo Risk Assess 25:146-51.

Skoufias E, Vinha K, 2012. Climate variability and child height in rural Mexico. Econ Hum Biol 10:54-73.

Stewart CP, Iannotti L, Dewey KG, Michaelsen KF, Onyango AW, 2013. Contextualising complementary feeding in a broader framework for stunting prevention. Matern Child Nutr 9:27-45.

Udomkun P, Wiredu AN, Nagle M, Bandyopadhyay R, Muller J, Vanlauwe B, 2017. Mycotoxins in Sub-Saharan Africa: Present situation, socio-economic impact, awareness, and outlook. Food Control 72:110-22.

Uwiringiyimana V, Ocke MC, Amer S, Veldkamp A, 2018. Predictors of stunting with particular focus on complementary feeding practices: A cross-sectional study in the northern province of Rwanda. Nutrition 60:11-8.

Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, Sachdev HS, Maternal, Child Undernutrition Study G, 2008. Maternal and child undernutrition: consequences for adult health and human capital. Lancet 371:340-57.

Victora CG, de Onis M, Hallal PC, Blossner M, Shrimpton R, 2010. Worldwide timing of growth faltering: revisiting implications for interventions. Pediatrics 125:e473-80.

Vilcins D, Sly PD, Jagals P, 2018. Environmental risk factors associated with child stunting: a systematic review of the literature. Ann Global Health 84:551.

Voss PR, Long DD, Hammer RB, Friedman S, 2006. County child poverty rates in the US: a spatial regression approach. Popul Res Policy Rev 25:369-91.

Wamani H, Åstrøm AN, Peterson S, Tumwine JK, Tylleskär T, 2007. Predictors of poor anthropometric status among children under 2 years of age in rural Uganda. Public Health Nutr 9:320-6.

Wild CP, Gong YY, 2010. Mycotoxins and human disease: a largely ignored global health issue. Carcinogenesis 31:71-82.