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Malnutrition and morbidity trends in Somalia between 2007 and 2016: results from 291 cross-sectional surveys

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ABSTRACT

Background More than two decades of conflict and natural disasters in Somalia have resulted in one of the longest running humanitarian crises in the world. Nutrition data have been collected over the years despite challenges to inform programmatic action. This paper explores malnutrition and morbidity trends in Somalia during the last decade, disaggregated by geographical zone and livelihood system.

Methods We used data from 291 cross-sectional surveys conducted in children aged 6–59 months between 2007 and 2016 in Somalia. Wasting, morbidity and stunting prevalences over time were analysed by geographic area, livelihood system and season. Logistic regressions were used to test trends.

Results The wasting trends show a striking peak in 2011, more marked in southern and central Somalia and coinciding with the famine declaration. The trend declines slightly thereafter although not consistently across all zones and livelihoods, and it raises again in 2016 especially among internally displaced persons (IDPs). Stunting declined for all groups and in all zones but with more consistent patterns in northern Somalia.
Morbidity also showed a declining trend, although with multiple peaks depicting disease outbreaks.
Pastoralist showed the lowest stunting estimates overall, while agrarian populations showed the lowest prevalence of wasting and morbidity. IDPs were the most affected by all outcomes. Seasonality affected the three outcomes differently by livelihood system. Stunting rates increased after the 2011 famine for all age groups within children under 5 years.

Conclusions Despite the continuous complex situation in Somalia, there has been a sustained decline in stunting and morbidity in the last decade. Wasting trends have remained at very high levels especially in north-east and the south zones of Somalia. The findings support the importance of performing trend analyses disaggregated by zone and livelihood groups within countries to better identify priorities for programme intervention.

Strengths and limitations of this study

- The sample characteristics in terms of size and number of surveys allowed for a high precision in the analysis and for the stratification by livelihood systems, although the so called internally displaced persons' livelihood was over-represented.
- The data collected at village level were aggregated at the operational zone level and stratified by livelihood systems providing a broad perspective relevant for policy analysis and programming.
- Data were collected in field conditions, which may have an impact on the accuracy of measurements, although survey teams were consistently trained and equipment precision regularly monitored to avoid it.
- Accurate age estimation was problematic as there were no accurate records of birth and age determination mostly relied on maternal recall.
- Data quality validation was carried out daily by running the Emergency Nutrition Assessment plausibility checks and after each data collection data vetting was conducted by the Assessment and Information Management Working Group in Somalia.

BACKGROUND

Somalia has been experiencing a long humanitarian crisis for the past two decades. It has suffered protracted war and conflict, political instability, disruption of economy and humanitarian assistance and extreme climatic conditions since collapse of state institutions in 1991, resulting in large-scale food and nutrition security crises. In 2011, the country suffered a famine; more than 250 000 people are estimated to have died of starvation and approximately 53% of the population experienced food crisis. An estimated 200 000 people had also died during a previous famine in 1991/1992.[1]

On top of the two mentioned famines, the rates of acute malnutrition have remained at very high levels since the start of the conflict, and they are among the highest in the world today. The causes of different forms of malnutrition in Somalia are multifactorial and linked to food insecurity and to morbidity and inadequate caring practices, all of them related to the disruption of peoples livelihood, destitution, large-scale

population displacement and the limited access to basic services.[2–4]

Nutrition response programming has been taking place in Somalia for decades in the form of live-saving interventions like distribution of food and cash, treatment of acute malnutrition, targeted supplementary feeding and emergency public health measures during disease outbreaks, as well as in the form of livelihoods recovery and development programmes in agriculture, livestock, water and environment to improve resilience among vulnerable populations.[5] However, effectiveness of humanitarian assistance continues to be constrained by prevailing insecurity which restricts access and delivery of aid to some areas.

The Food Security and Nutritional Analysis Unit (FSNAU) is a project of the United Nations Food and Agriculture Organization (FAO) with the mission to conduct national nutrition surveillance in Somalia since the year 2000 to monitor the nutritional status of the population and inform programme interventions. FSNAU has been collecting data through different surveillance systems including nutrition surveys, rapid Mid-Upper Arm Circumference assessments, passive health facility-based screening and, at some times and places, by sentinel site surveillance.

In 2009, FSNAU carried out a meta-analysis study including a systematic review of findings and raw data analysis of surveys conducted by FSNAU and partners in Somalia for the period 2001–2008 focusing on wasting trends and casual factors.[6] In addition, in 2012 World Food Programme released a report analysing trends of food and nutrition insecurity in Somalia for the period 2007–2012.[7] Since then, no other systematic review of the nutrition data collected by FSNAU has been published.

The reports circulated by FSNAU in the 2007–2016 period have been exhaustive in describing the nutrition situation in regular periods (monthly, bimonthly, quarterly or twice yearly depending on the year) and by livelihood zone. They combine results from different data collection methods to assess the overall nutrition situation, as well as to identify malnutrition hotspots and to closely follow-up specific population groups such as internally displaced populations (IDP) or particular livelihood zones.[8] However, these data and results are not compiled and disseminated within the global nutrition reports due to having results aggregated at the livelihood zone level and not by any type of administrative divisions.

The three operational zones of Somalia have been affected differently by the conflict, being the South Central zone (SCZ) historically the most affected one, whereas the North West (NWZ) and the North East zones (NEZ) have been generally more stable, with better governance and institutional capacities. To show the malnutrition outcomes aggregated by operational zone adds to the results provided by FSNAU reports and allows for interpreting the trends within each zone historical context.

On the other hand, the three main livelihood systems present in Somalia are unevenly distributed across the country. Pastoralists are mainly distributed in the north west, east and central parts, while agropastoralists and riverine livelihood systems mostly in the South.[9] The prevailing insecurity has also triggered large-scale displacement of populations, and settlements of IDPs are found all over Somalia but in the SCZ predominantly. According to the latest United Nations High Commissioner for Refugees Forced Displacement report, among the 1.5 million IDPs estimated in 2016, 893 000 were located in the SCZ.[10] Showing malnutrition outcomes and trends by type of livelihood is highly relevant, as the coping strategies to prevent and overcome malnutrition differ depending on the livelihoods and/or displacement situation of populations.

Finally, food security and nutrition outcomes are importantly affected by seasonality in Somalia as well, with annual crop and livestock production dependent on the two main rainy seasons (Gu and Deyr). Seasonality impacts the general availability of food and the rates of infection, among other things. Thus, understanding the typical seasonal fluctuations is useful for predicting changes in malnutrition and morbidity rates.[11]

Assessing the fluctuations in malnutrition by season within the year, over time year to year and differentiated by livelihood group is essential to facilitate interpretation of the situation and target effective interventions, as shown by a similar exercise conducted in the Greater Horn of Africa region.[12]

The aim of this study is to explore and interpret observed trends in malnutrition (wasting and stunting) and morbidity by operational zone, livelihood system and season of analysis for the 2007–2016 period, giving special attention to the effects of the 2011 famine on the malnutrition outcomes for the rest of the period.

METHODS

The data used for this study were obtained from 291 surveys undertaken by FSNAU and partners working in Somalia. All surveys included in this study had similar design (two-stage cross-sectional surveys) and comparable probability sampling methods. They were carried out biannually in the Gu and in the Deyr seasons, from year 2007 to 2016.

There are four main seasons defined by rainfall patterns in Somalia: the Gu, the main rainy season (April–June), the Hagaa, a short and cool dry season (July–September), the Deyr, the short rainy season (October–December) and the long and hot dry season called the Jilaal (January–March).[13] Only surveys conducted in the Gu or in the Deyr seasons were taken into account for the analysis, as data collected in Hagaa or Jilal seasons were only available for years 2007 and 2009. Although the Gu and the Deyr seasons are both rainy seasons, they represent different times of the year and have specific characteristics impacting food and security outcomes, as the Gu is

preceded by the long hot dry season whereas the Deyr follows a short and cool dry one.

Somalia has been divided into three main UN operational zones: Northwest, Northeast and South-Central, with varied social, livelihood and economic structures. These zones generally correspond to current administrative and political designations known, respectively, as Somaliland, Puntland and other Federal Member States of the Federal Government of Somalia. The North West zone is composed of the prewar regions of Woqooyi Galbeed, Awdal, Togdheer, Sool and Sanaag regions; the North East zone includes the prewar regions of Bari and Nugal and the South Central zone comprising Mudug, Galgadud, Hiran, Bakool, Bay, Middle and Lower Shabelle, Middle and Lower Juba, Gedo and Banadir regions.

The three main livelihoods in the country are broadly defined by common characteristics of the household's economy: pastoralists rear livestock and are nomadic; agropastoralists practise mixed crop and livestock production and riverine live in the South Central irrigated zones along the Shabelle and Juba rivers and are mainly agrarian.[13] Agropastoralists and riverine livelihoods are classified as Agropastoral in this analysis as both are mainly sedentary and share similar characteristics in terms of their primary dependence on crop cultivation as opposed to reliance on rearing livestock. Because of the presence of a significant proportion of internally displaced population in the country, FSNAU also collects data on IDPs. Surveys of main IDP settlements were included, and these were coded as a further livelihood category, although it does not constitute a livelihood system in sensu stricto. The FSNAU also collects data on selected urban populations (mostly Kismayo and Mogadishu) but not as comprehensively and consistently as on rural and IDP populations, thus, we did not include them in this analysis.

Since 2007 and for both technical and operational purposes, FSNAU has conducted rural livelihood-based surveys as opposed to administrative boundary-based surveys. A livelihood zone map of Somalia was created based on climate, topography, natural resources and local livelihood patterns, resulting into 32 rural livelihood zones. In 2015, the 32 rural livelihood zones were consolidated into 18, reasonably homogeneous rural livelihood zones. Detailed maps can be found at online (http://www.fsnau.org/products/maps/livelihood-maps).[14]

The surveys were conducted at livelihood zone level or main IDP settlement based on multistage cluster sampling with probability proportional to size design covering all livelihood zones that were accessible at the time of the survey. The primary sampling units were the villages (clusters) which were selected randomly from a list of all the villages in each livelihood zone, and the second unit of analysis were the households within the sample villages, which were randomly selected using the Standardized Methodology for Survey in Relief and Transition. All children aged 6–59 months living in the selected household were measured, and the child section of the survey questionnaire administered to the child caregiver or household head. Households and villages were assumed to follow the livelihood of the livelihood zone in which they were located. Sample selection and sizes of the surveys (number of households and number of children) were calculated using the Emergency Nutrition Assessment (ENA) software (version 2011, 9 July 2015). Previous estimations of wasting measured by weight-for-height and crude mortality rates for the surveyed areas were used for the sample size calculations, separately for anthropometry and mortality. The higher of these two sample sizes was used to determine the final sample size as the surveys integrate both anthropometry and mortality. An additional 2%–3% was added to the sample size to allow for dropout or refusal to participate

To show results at the operational zone level, we had to aggregate the data collected at the livelihood zone level and allocate them to the corresponding operational zone based on its location. However, as there are livelihood zones that geographically cross the three operational zones taken into account for this analysis (like Coastal Deeh crossing the SCZ and the NEZ or Hawd Pastoral crossing the SCZ and the NWZ, see maps in http://www.fsnau.org/products/maps/livelihood-maps), we went down to the clusters level to allocate children surveyed to the corresponding operational zone according to the cluster (village) geographical location. In each zone, surveys were aggregated according to the livelihood system of the livelihood zone they represented (example, West Golis Pastoral and Guban Pastoral livelihood zones in the NWZ would be aggregated in the Pastoral subsample of the NWZ, according to 2014 livelihood zone distribution).

Although in most of the time points (season/year) of the study period we had representative data for each livelihood, due to field work restrictions in some specific season/years not all livelihoods systems were covered. Therefore, and to construct the trends for the whole period of analysis, the missing values in-between the trend were imputed. The imputation method we used was logistic regression to calculate the predictions and the residuals. Missing values in the beginning of the trend (year 2007 and 2008) were not imputed. Out of 159 time points analysed, only 24 estimations were imputed. The online supplementary table 1 in annex 1 presents the compiled sample sizes of the population analysed in each time point, disaggregated by livelihood and zone.

Data were collected by FSNAU survey enumerators who are recruited locally from health centres, clinics and so on and are trained for 5 days before every survey as part of FSNAU's quality assurance process. As FSNAU nutrition surveys are conducted regularly (ie, every season), only the best performing enumerators and supervisors are retained, but they still have to undergo the mandatory 5-day training before conducting each survey. FSNAU surveys are coordinated by FSNAU Nutrition Field Analysts and technical experts from the Ministries of Health, and data quality is validated in a daily basis

by running the ENA plausibility checks. At the end of data collection, there is a technical vetting conducted by the Assessment and Information Management Working Group established under the Somalia Nutrition Cluster for data coordination and quality control of nutrition surveys.

The data were cleaned by deleting the records of individual children with any of the following criteria: age <6 months (n=5), age >59 months (n=6) and missing age (n=1137), sex (n=1222), weight (n=1134), height (n=1143) or oedema (n=1802). Weight-for-height z-score (WHZ) and length/height-for-age z-score (HAZ) were calculated using WHO Anthro (V.3.2.2, January 2011) and macros using WHO 2006 growth standards. Extreme biologically implausible values were excluded based on WHO standards with recommended flag limits of WHZ scores below −5 or above +5 (n=545) and HAZ scores below −6 or above +6 (n=824).[15]

Nutritional status indicators used were wasting defined as weight-for-height below −2 Z-scores and/or the presence of nutritional oedema and stunting or chronic malnutrition defined as height-for-age below −2 Z-scores.[16] Severe wasting is defined as WHZ below −3 and/or the presence of nutritional oedema, thus severe wasting is included in the wasting definition. We provide the severe wasting estimates independently in table 1, but the rest of the tables and figures only report wasting which includes both moderate and severe forms.

Child morbidity was assessed based on a 2-week recall of the incidence of diarrhoea, acute respiratory infection and febrile illness and 30 days recall for suspected measles. A new variable called morbidity was created and coded as 1 if the child had a positive response to at least one of the four illnesses and as 0 if the child had a negative response to all of the four illnesses. We calculated the prevalence of wasting, morbidity and stunting for each of the surveys separately and provided the levels of uncertainty in the estimates with the 95% CIs.

We graphed the estimations and CIs of wasting, stunting and morbidity for each year and season disaggregated by livelihood group and geographical zone for the patterns comparison over the 10-year time period.

To analyse the observed trends, we created two differentiated time periods, one before the famine of 2011 (including data from 2007 to 2010) and another one covering the time period after the famine (2012–2016). Logistic regressions were used to test the change of the nutrition and health outcomes with each additional year

Table 1 Characteristics of children 6–59 months in Somalia (n=282 514)

	North West (n=49 585) 17.5%	North East (n=69 275) 24.5%	South Central (n=163 654) 57.9%
Sex			
Male	50.9	50.6	50.8
Female	49.1	49.4	49.2
Age			
<24 months	35.7	34.9	35.8
≥24 months	64.3	65.1	64.2
Wasting			
Weight-for-height <-2 z-scores	12.7	17.0	19.3
Severe wasting			
Weight-for-height <-3 z-scores	2.5	4.0	5.7
Stunting			
Height-for-age <-2 z-scores	7.3	22.1	23.8
Morbidity overall*	24.4	39.2	39.5
Diarrhoea	11.3	14.6	16.4
Acute respiratory infection	8.4	14.1	16.0
Febrile illness	12.9	25.7	22.7
Measles	2.5	4.1	3.9
Livelihood system			
Agropastoralists	12.6	–	26.2
Pastoralists	46.6	33.6	30.7
Riverine	–	–	20.0
Internally displaced persons	40.8	66.4	23.1

*Morbidity variable integrating the diseases described in the table. See the Methods section for details.

in each of the two periods, and to model the association of the outcomes with the Gu and Deyr seasons for the overall period. All analyses were stratified by livelihood system and geographical zone. ORs and CIs were calculated.

To explore the potential impact of the wasting peaks recorded during the 2011 famine on the subsequent stunting estimations, we created six artificial cohorts based on the children's year of birth. We constructed the cohort of 2007 (Cohort07) by selecting children who were 6–12 months in the year 2007, children that were 13–24 months in 2008, 25–36 months in 2009, 37–48 months in 2010 and 49–59 months in 2011. The 2008 cohort (Cohort08) was constructed by selecting children that were 6–12 months in the year 2008, 13–24 months in 2009, 25–36 months in 2010, 37–48 months in 2011 and 49–59 months in 2012. Following the corresponding procedure, we constructed the rest of the cohorts for the years 2009 (Cohort09), 2010 (Cohort10), 2011 (Cohort11) and 2012 (Cohort12), and we graphed the prevalence of stunting (y-axis) for each cohort according to the age of the child (x-axis), highlighting the position of the 2011 famine to facilitate the interpretation of results. Due to data availability, this analysis was restricted to the agropastoral and pastoralists populations of the South Central zone.

Stata V.15 (StataCorp) was used for statistical analysis.

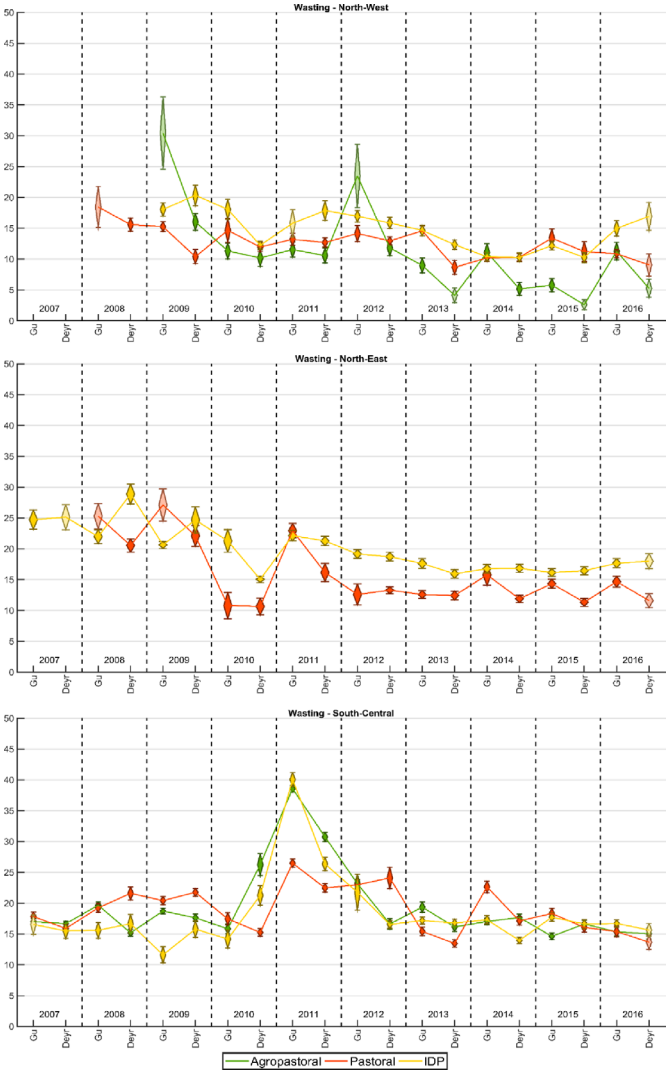

Figure 1 Wasting estimates and CIs at 95% (diamond shapes) by year and season of analysis for each livelihood and disaggregated in the three operational zones (NWZ, NEZ and SCZ). Diamond shapes in lighter colour depict estimations that were imputed. NEZ, North East zone; NWZ, North West Zone; SCZ, South Central zone.

Public and patient involvement

Not patients were involved in the study. Results of the nutrition and mortality surveys conducted in Somalia are used for programmatic actions targeting the study participants (children under 5 years of age), but due to the characteristics of the study population, there is no specific action planned to disseminate results directly to them.

Access to survey sites was agreed with local authorities and community leaders in the districts where the clusters were sampled. Verbal consent for all caregivers of the sampled children was sought before administration of the questionnaire. Children who were found as severely malnourished or with any other medical problem during the survey were referred to the nearest health facility for medical attention and appropriate treatment using referral form.

Subsequent survey plans and protocols were presented and discussed with MOH and partners prior to the conduct of each seasonal assessment.

RESULTS

A total of 282 514 measurements of children aged 6–59 months from 291 surveys were examined from 2007 to 2016. The North West and North East zones of the country were mainly composed of pastoral livelihood zones with a large proportion of IDPs. The South Central zone, in addition to pastoralists and IDPs, also included agropastoral and riverine livelihoods (table 1).

Of the children surveyed, 69 275 (24%) children were located in the North East zone, 49 585 (18%) in the North East zone and 163 654 (58%) in the South Central zone of Somalia. The online supplementary table 1 in annex 2 summarises the survey data by zone, season and period of analysis. The assessments were equally distributed in relation to the Gu (50.7%) and the Deyr (49.3%) seasons. Around 36% of the children were surveyed before the 2011 year of famine, and 64% after year 2011.

In table 1, the children's characteristics by zone are summarised.

Trends in wasting

The mean prevalence of wasting for the overall period of study was 13%, 17% and 19% for the NWZ, NEZ and SCZ, respectively.

Figure 1 shows in the first graph, for the NWZ, a steady decline in wasting estimates for all livelihoods and periods of analysis. Agropastorals' estimates declined to

Table 2 Trend analysis on wasting per period of analysis and season

	Agropastoral	Pastoral	IDPs
North West Zone			
Trend per year			
2007–2010	0.59 (0.42–0.84)	0.87 (0.78–0.97)	1.10 (1.0–1.5)
2012–2016	0.90 (0.81–1.01)	0.91 (0.87–0.95)	0.98 (0.95–1.0)
Season			
Deyr (October–December)	Reference	Reference	Reference
Gu (April–June)	1.06 (0.88–1.26)	1.15 (1.06–1.24)	1.23 (1.16–1.29)
North East Zone			
Trend per year			
2007–2010		0.75 (0.66–0.86)	0.80 (0.75–0.84)
2012–2016		1.00 (0.96–1.03)	0.96 (0.94–0.99)
Season			
Deyr (October–December)	–	Reference	Reference
Gu (April–June)	–	1.26 (1.16–1.36)	0.96 (0.95–0.97)
South Central Zone			
Trend per year			
2007–2010	1.03 (1.0–1.06)	1.00 (0.98–1.04)	1.07 (1.00–1.15)
2012–2016	0.93 (0.91–0.96)	0.94 (0.92–0.97)	0.98 (0.95–1.00)
Season			
Deyr (October–December)	Reference	Reference	Reference
Gu (April–June)	1.07 (1.01–1.13)	1.15 (1.1–1.2)	1.23 (1.17–1.30)

IDPs, internally displaced populations.

around 5% at the end the period, although with a steep increase above 10% in Gu 2016. Wasting among IDPs also increased sharply in 2016 in this particular zone.

In the NEZ, there was an important decrease in wasting estimates for each additional year until 2010 (OR=0.75 and OR=0.80 for pastorals and IDPs, respectively) see table 2, although estimates raised at above 20% in 2011. Since 2012, wasting prevalence has remained above 10% among pastoralists and above 15% among IDPs (second graph of figure 1).

The third graph of figure 1 shows the wasting estimates for the SCZ above 15% for the three livelihoods in most of the years, and the peak of wasting prevalence above 35% in year 2011 for agropastorals and IDPs. This peak was less pronounced among pastoralists, although it was sustained longer in time. In the second period of analysis, starting in 2012, there was a slight decrease on wasting for each additional year (table 2).

In all zones, wasting was higher during the Gu seasonal analysis for all livelihoods, although the difference was more marked for pastoralists and IDPs.

Trends in stunting

For the first period of analysis (2007–2010) the stunting estimates have decreased significantly for each additional year in the three zones and all livelihoods (figure 2 and table 3) although in the NWZ there was a peak for pastoralists observed in Gu 2010 and for all livelihoods in Deyr 2008 in the other two zones (NEZ and SCZ).

During the second period of analysis, there was a small peak of stunting in year 2012 in the NWZ for all livelihoods but ever since estimates have been declining steadily in this zone, reaching estimates below 5% at the end of the period. In the NEZ, the peak was observed for all livelihoods at the end of 2011 and early 2012, with a subsequent decrease thereafter reaching a prevalence around 5% for pastoralists and 15% among IDPs (figure 2). The stunting estimates among pastoralists are approximately a third of the IDPs in this zone during the whole period of analysis.

Stunting trends in the SCZ increased sharply in 2011, and then again in 2013 for agropastorals and IDPs only. After that, rates decreased to below 5% for pastoralists, below 10% for agropastorals and only slightly, to around 25% for IDPs in 2016. Pastoralists show the lower stunting rates overall.

Stunting rates were consistently higher in the Gu season except for the NEZ pattern.

Figure 3 represents the growth patterns based on height for age, showing the stunting rates by age group for the six self-constructed cohorts in the agropastoral and pastoral livelihoods of the SCZ (see the Methods section for details). In both livelihoods and all cohorts,

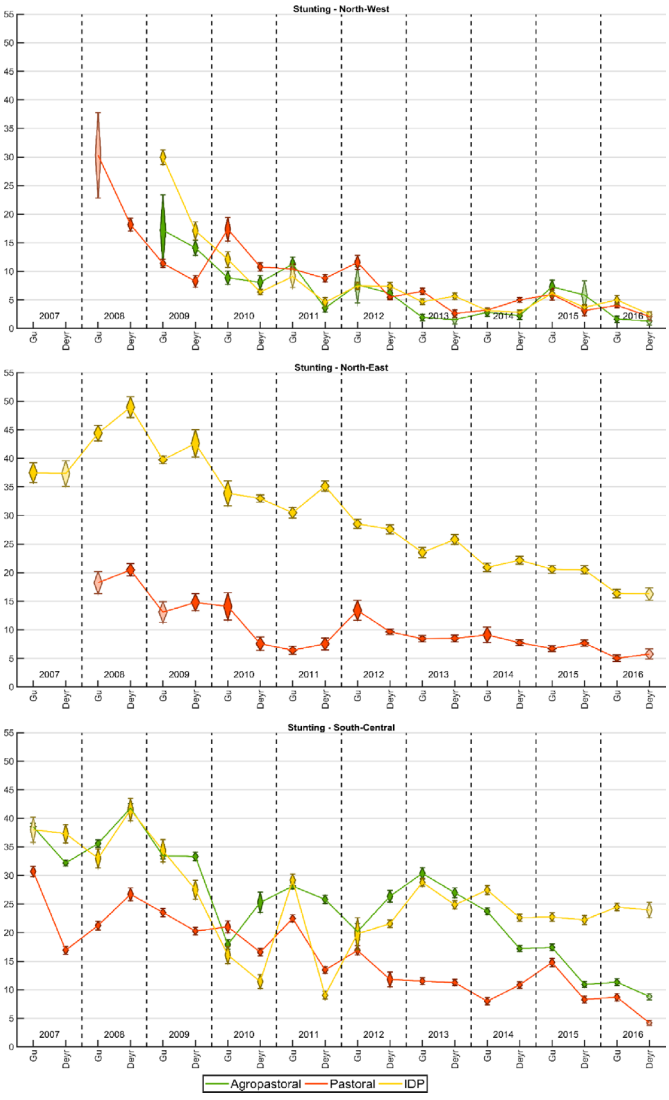

Figure 2 Stunting estimates and CIs at 95% (diamond shapes) by year and season of analysis for each livelihood and disaggregated in the three operational zones (NWZ, NEZ and SCZ). Diamond shapes in lighter colour depict estimations that were imputed. NEZ, North East zone; NWZ, North West zone; SCZ, South Central zone.

we observe a peak in stunting at 24 months of age, which declines thereafter in most of the cohorts. Exceptions to this pattern are, among the agropastoralists, the Coh2009 and the Coh2010 which experience an increase in stunting prevalence after the initial peak at 24 months and the Coh2008 which despite initial decline after the 24 months' peak experience a later increase among the children 49–59 months of age. Among the pastoralists exceptions to the observed pattern were the Coh07 and the Coh09 for which the stunting prevalence increased or decreased only slightly respectively after the first 24 months' peak.

The cohort of children born in 2012 (Coh12) showed the growth patterns with sharper declines in stunting prevalence after initial peak at 13–24 months of age and throughout all the older age groups.

Trends in morbidity

The mean prevalence of reported morbidity for the overall period of analysis was 24.4% in the NWZ, 39.2% in the NEZ and 39.5% in the SCZ.

In figure 4, we observe the jagged patterns of morbidity estimations, with peaks over 50% in several time points (season/year) for the pastoralists and IDP populations.

Pastoralists showed in the NWZ a significant increase in morbidity for each additional year until 2010 (table 4) and two important peaks in the Deyr seasons of 2015 and 2016, while in the NEZ, values for pastoralists have been steadily between 30% and 40% since Deyr 2012. In the SCZ, however, there was a significant decrease of morbidity during the whole period of analysis for pastoralists, more marked during the second period (0.8 decrease per each additional year; table 4), although with a steep rise at the end of the period, in year 2016.

Agropastorals on the other hand, showed a decreasing trend in the two periods and zones where they are present, although with a marked increase in year 2016 as well.

Among IDPS, morbidity has been decreasing significantly since 2012 both in the North West and South Central zones but remaining stagnant at levels around 40% in the NEZ.

For agropastoral and pastoralists' populations morbidity was higher during the Deyr season, while for IDPs in the NWZ and SCZ it was higher during the Gu seasonal analysis.

DISCUSSION

To our knowledge, this is the first study analysing malnutrition and morbidity trends comprehensively during the period 2007–2016 in Somalia. We observe a decreasing trend in morbidity overall, although with multiple peaks depicting disease outbreaks. Stunting also declined for all groups and in all zones but with more consistent patterns in the northern ones. The wasting trends show a striking peak in 2011, more marked in the SCZ and coinciding with the famine declaration. A slight decreasing trend is observed thereafter although not consistent across all zones and livelihoods, and with a raising slope in 2016, especially among IDPs.

Since early 1990s, the food security and nutrition situation in Somalia has been characterised by protracted and recurrent emergency situations resulting from repeated episodes of drought, flooding, conflict and large-scale population displacement. The frequency and severity of these crises have been exacerbated by the absence of strong government and lack of humanitarian space.[17] Conflict-related violence and insecurity prevent the delivery of humanitarian aid,disrupts livelihoods and breaks down familial and community networks that can provide the necessary support and guidance needed for looking after young children, including their nutritional requirements.[18] Food insecurity and conflict have been shown to have a direct and independent impact on

Table 3 Trend analysis on stunting per period of analysis and season

	Agropastoral	Pastoral	IDPs
North West Zone			
Trend per year			
2007–2010	0.53 (0.37–0.78)	0.79 (0.72–0.88)	0.33 (0.27–0.40)
2012–2016	0.92 (0.77–1.10)	0.82 (0.77–0.88)	0.86 (0.81–0.91)
Season			
Deyr (October–December)	Reference	Reference	Reference
Gu (April-June)	1.32 (0.1–1.64)	1.15 (1.04–1.27)	1.90 (1.70–2.12)
North East Zone			
Trend per year			
2007–2010		0.59 (0.51–0.69)	0.84 (0.80–0.88)
2012–2016		0.87 (0.83–0.91)	0.86 (0.84–0.88)
Season			
Deyr (October–December)	–	Reference	Reference
Gu (April–June)	–	0.89 (0.85–0.89)	0.96 (0.93–1.00)
South Central Zone			
Trend per year			
2007–2010	0.88 (0.86–0.90)	0.92 (0.89–0.95)	0.65 (0.61–0.70)
2012–2016	0.72 (0.70–0.74)	0.89 (0.86–0.92)	0.96 (0.94–0.98)
Season			
Deyr (October–December)	Reference	Reference	Reference
Gu (April–June)	1.04 (1.00–1.10)	1.35 (1.29–1.41)	1.29 (1.23–1.36)

IDPs, internally displaced populations.

malnutrition,[19] but also infectious diseases are identified as main drivers of malnutrition in Somalia.[20]

In relation to wasting, we observe the rising trend in 2009–2010 coinciding with the slow onset of drought driven by four consecutive rain failures, which together with some of the most violent conflict and restricted humanitarian access in Somalia's history contributed to the 2011 famine, reflected in our results with wasting peaks above 35% among IDPS and agropastoralists in the SCZ and above 20% among pastoralists and IDPS in the NEZ. The situation was further aggravated by the economic crisis, characterised by currency devaluation, disrupted trade and market activities and hyperinflation of basic food and non-food items[21] and by al-Shabaab's blocking of humanitarian operations in areas under their control.[22] It is estimated that nearly 260 000 people died during the 2011 famine,[23] half of them children.

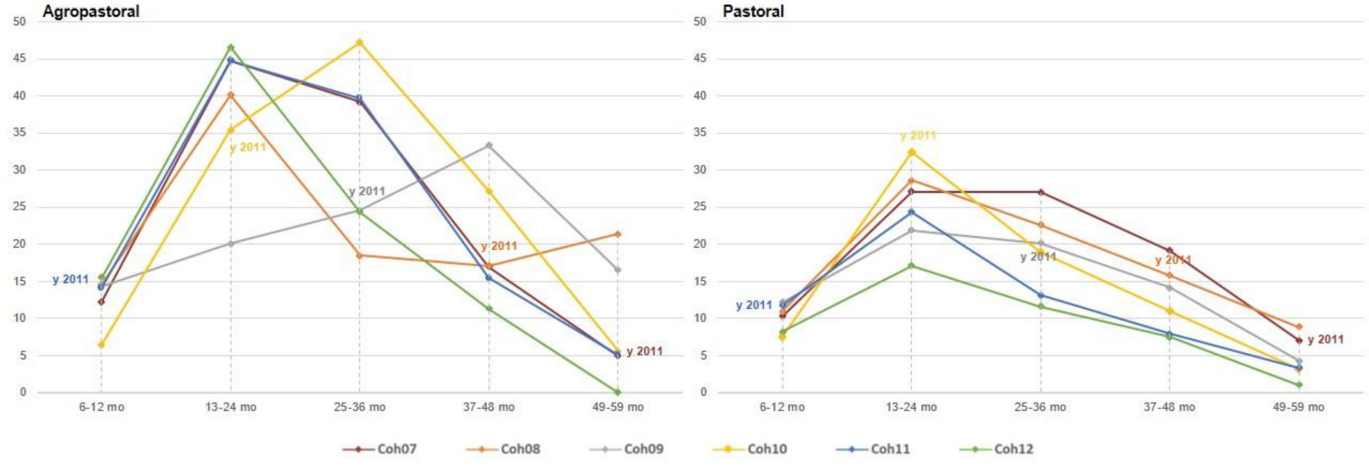

Figure 3 Growth patterns cohorts of children 6–59 months in agropastoralists and pastoralists populations in the South Central zone of Somalia.

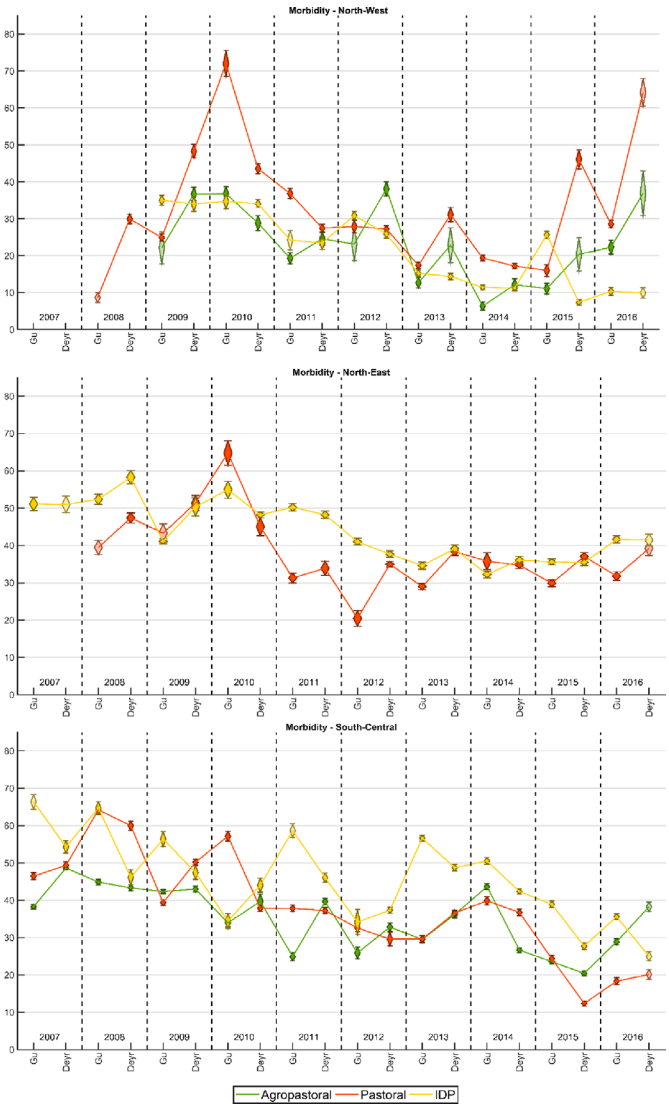

Figure 4 Morbidity estimates and CIs at 95% (diamond shapes) by year and season of analysis for each livelihood and disaggregated in the three operational zones (NWZ, NEZ and SCZ). Diamond shapes in lighter colour depict estimations that were imputed. NEZ, North East zone; NWZ, North West zone; SCZ, South West zone.

After the 2011 peak, the wasting prevalence dropped from the extremely high levels registered in the SCZ and NEZ to around 15%, at the level it remained for the rest of the period, still a very high prevalence which flags the threshold for emergency according to WHO.[24] The pronounced decrease was mainly the result of the intense humanitarian actions but could also be reflecting the increased under five mortality in 2011, which affected severely acutely malnourished children primarily, and that peaked at 5.83 deaths per 10 000 in the SCZ.[25 26] The SCZ was the most affected by the 2011 famine and shows the highest wasting levels for all livelihoods in the consequent years. This zone is impacted by higher intensity of conflict, flooding of the riverine areas, continued displacements, restrictions of movements and goods due to clan and religious insurgency, and low availability and poor quality of health services.[27] Moreover, the IDPs show consistently the highest estimates of wasting in all zones. They are considered to be among the poorest population groups in the country and their vulnerability to malnutrition is highly linked to poor access to food, income, healthcare and safe water coupled with high morbidity burden.[28] In this group, our results show the raising trend in wasting in early 2016 which resulted in a declaration of high famine risk in early 2017[29] previously mentioned. Stunting estimates are also consistently higher among IDPs, especially in the NEZ and the SCZ.

These results are in line with the FSNAU annual technical reports when compared with specific years or populations groups (to be found at http://www.fsnau.org), as could not be otherwise, but adding the broad perspective of data aggregated at the operational zone level and by livelihood system thus helping to interpret the impact of policies already implemented and to better target future interventions based on operational zones and type of livelihood.

The overall pattern of stunting is a declining trend for all livelihood groups in the three zones. This decline had been projected by policy reports and international tracking tools[30 31] based on data collected in 2009. Our results show the trends with data collected in the period 2007–2016 by operational zones and by livelihood systems which can help to better target the efforts needed to maintain a stunting declining trend as to reach the World Health Assembly targets by 2025.

Pastoralists' children seem to be more resilient to stunting, with estimates consistently lower, reaching very low levels (below 5%) in all three zones at the end of the period. Other studies have suggested this is a result of the physical stature of Somali pastoralists as tall and lean, which may mask the actual estimates of chronic malnutrition,[32] but decreasing trends are clear nonetheless. Another potential explanation for this differentiation is that pastoral groups have relatively better asset base and access to animal products, especially milk and cow's blood, which provide high protein diets even when food is scarce. This type of diet, also rich in iron, calcium and other micronutrients will favour continued height growth rather than soft tissue. The opposite applies for agriculturalists as energy may be provided by cereals, but protein and micronutrient intake may be compromised, favouring stunting but less wasting. The higher rates of malnutrition observed among pastoralists in the analysis after the Gu rains may be associated with the restricted access to their typical diet in the precedent Jilal season. During that extended dry season from mid-January to mid-April the pastoralists adult men and adolescent boys migrate with the livestock to distant grazing areas, leaving women and young children behind with limited access to milk and other animal source products.[33] And this is consistent with findings from pastoralist populations of other countries in the region.[12] Also the amount and intensity of the Gu rains tends to be high in the NWZ and SCZ which can lead to increased morbidity among IDPS

Table 4 Trend analysis on morbidity per period of analysis and season

	Agropastoral	Pastoral	IDPs
North West Zone			
Trend per year			
2007–2010	0.70 (0.55–0.89)	1.5 (1.4–1.6)	1.00 (0.86–1.15)
2012–2016	0.90 (0.83–0.99)	1.0 (1.0–1.1)	0.77 (0.74–0.80)
Season			
Deyr (October–December)	Reference	Reference	Reference
Gu (April–June)	0.77 (0.67–0.88)	0.86 (0.81–0.91)	1.29 (1.20–1.38)
North East Zone			
Trend per year			
2007–2010		0.99 (0.89–1.1)	0.85 (0.81–0.89)
2012–2016		1.04 (1.01–1.06)	0.99 (0.97–1.00)
Season			
Deyr (October–December)	–	Reference	Reference
Gu (April–June)	–	0.79 (0.74–0.83)	0.94 (0.90–0.98)
South Central Zone			
Trend per year			
2007–2010	0.95 (0.93–0.97)	0.89 (0.87–0.92)	0.78 (0.74–0.82)
2012–2016	0.85 (0.83–0.87)	0.81 (0.78–0.83)	0.82 (0.80–0.83)
Season			
Deyr (October–December)	Reference	Reference	Reference
Gu (April–June)	0.84 (0.80–0.87)	1.01 (0.98–1.05)	1.38 (1.32–1.44)

IDPs, internally displaced populations.

due to increased contamination and infections. And although this may have a more clear impact on wasting as an indicator sensitive to short-term changes, our results show the same seasonal fluctuations in stunting estimates, and recent studies are highlighting the role of seasonality as potential risk factor to poor growth among young infants.[34]

Also important to notice is the stunting peak consistently shown for all livelihoods in the immediate years after the famine, probably reflecting the effects in stunting of the extremely high rates of wasting.

These same observations are replicated in the results of the agropastoralists and pastoralists artificial cohorts we created for the SCZ. The stunting rates are consistently lower and the stunting fluctuations consistently softer among the pastoralists' cohorts as compared with the agropastoral ones, and a relation is observed between the high wasting peak in 2011 and the stunting in the subsequent years.

The overall growth pattern we observe in our cohorts, with stunting peaks within the 13–24 months of age, is consistent with the growth faltering observed in other deprived populations of the world, which shows a stunting crowning around 24 months of age which decreases thereafter.[35] The interpretation of childhood catch-up after 24 months is that a combination of the normal postnatal maturation of the children's immune systems and the development of a broad range of adaptive responses against previously encountered pathogens reduces the frequency and severity of growth-impairing infections.[36] This is the observed pattern in most of the pastoralists' cohorts we created in the SCZ. However, among the agropastorals, the only cohort that follows that clear pattern is the Coh2012, which encompasses the children born after the 2011 famine. In all the rest of the cohorts the growth pattern changes, as the stunting prevalence experiences a sharp increase a year after the children have experienced the 2011 famine, independently of the age of the children during that period. This suggests a strong impact of the high wasting rates in the subsequent stunting prevalence. This association has been shown in longitudinal studies that have reported that children with wasting or negative changes in weight for height are at greater risk of linear growth retardation,[34 37] and the differentiated patterns for children among pastoralists and agropastoralists populations are consistent with similar studies conducted in the region.[12]

In relation to morbidity, although it declined during the period of analysis, prevalence were still high, especially among IDPs. Pervasive morbidity is associated with limited access and use of basic health and water services and IDPs reside in temporary infrastructures and crowded conditions, which exacerbate their vulnerability to infectious diseases.[38] Also, and for all the livelihood groups,

the morbidity trends showed numerous peaks reflecting disease outbreaks such as measles, polio, acute watery diarrhoea and cholera almost every year since 2007. Somalia is one of the acute watery diarrhoea/cholera-endemic countries in the world and according to UNICEF, contains 'the largest known reservoir of unvaccinated children in a geographic area in the world' (around half a million children). The rise in morbidity observed in 2016 corresponds with the cholera and measles outbreaks occurring in that year[39 40] which further contributed to the rise in acute malnutrition and mortality which reached near-famine thresholds at the start of 2017, only averted by the large-scale and sustained humanitarian actions.[29]

As already shown by other studies, the provision of malnutrition and morbidity estimates, when seen in the context of historical values and viewed as specific to different livelihood groups can provide useful timely warning of the need for intervention to mitigate developing nutritional crises.[12]

Limitations and strengths of the study

The sample characteristics in terms of size and number of surveys allowed for a high precision in the analysis and for the stratification by livelihood system. However, despite the enhanced precision of the estimates of malnutrition and morbidity showed by the narrow CIs, due to the effects of confounding and bias (measurement and or recall bias) inherent in cross-sectional and nutritional surveys, the analysis may produce spuriously precise but biased estimates of association and stability.

The aggregation of the data at the operational level and by livelihood system permitted the analysis from a different perspective and additional insights for policy makers. The so-called IDPs livelihood was over-represented in the overall population as recent data indicated that the proportion of IDPs in Somalia population was around 14%,[38] thus the importance of the stratified analysis.

Although the data were collected at village level and could have the potential to derive the impact of locality and environmental conditions on individual outcomes the geolocalisation of the clusters surveyed was challenging due to a lack of updated Somalia cartography and changes in villages names and spelling over the years during the period of study.

Data were collected in field conditions, which may have an impact on the accuracy of measurements, although the FSNAU survey enumerators' long-time experience and routinely training may have minimised this limitation.

Imputed values have to be interpreted with caution as they can introduce a bias. However, as shown in the figures, the imputed values are randomly distributed in the years, zones and livelihood groups studied, thus, we do not consider they are impacting the trends patterns in a systematic way.

Accurate age estimation can be a major problem as there are no accurate records of birth in Somalia and age determination mostly relies on maternal recall. However, FSNAU conducted the ENA plausibility checks on every survey to minimise any potential bias and the age distribution in the sample shows the expected distribution.

Finally, the construction of artificial cohorts to assess the impact in growth retardation of the wasting peaks during the 2011 famine showed interesting results. We recommend to apply this methodology when longitudinal data are not existent but repeated cross-sectional data are available for the population of study.

CONCLUSIONS

The international community has been implementing humanitarian, recovery and development programmes for the Somali population in a complex and varied environment for the last decade, with ambivalent results.

Although wasting and morbidity prevalence remained high during the period of analysis, there was a slight but clear decreasing trend for both indicators, only reversed at the end of the period, 2016, when severe drought conditions impacted most parts of the country. Furthermore, the decrease in stunting for the 2007–2016 period is remarkable.

The association found between high-wasting prevalence and subsequent high-stunting estimates calls for a more holistic response which addresses humanitarian life-saving needs and development work simultaneously.

Moreover, the focus on reducing malnutrition in Somalia clearly needs to move away from the short-term response aimed at addressing acute food insecurity and treatment of acutely malnourished children to a more integrated response that includes access to clean water, the promotion of hygiene and sanitation and the improvement of access to basic health services among its priorities.

Finally, the households' vulnerability towards morbidity and malnutrition varies according to the type of livelihoods they pursue. Significant improvements can only be realised taking into account the specific challenges and opportunities within the various livelihoods across Somalia.

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current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of FSNAU.

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