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DRIVERS OF STUNTING REDUCTION IN SENEGAL: A COUNTRY CASE STUDY

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Abbreviations

AARC	Average Annual Rate of Change
ACF	Action Against Hunger
AGETIP	Agency for Public Works and Employment
AIDS	Acquired Immune Deficiency Syndrome
ANC	Antenatal Care
ARI	Acute Respiratory Infection
ASC	Agents de Santé Communautaires/Community Health Agents
BCG	Bacillus Calmette–Guérin vaccine
BMI	Body Mass Index
CAADP	Comprehensive Africa Agriculture Development Program
CAGR	Compound Annual Growth Rate
CFA	Communauté financière d'Afrique/Financial Community of Africa
CHE	Community Health Educator
CIX	Concentration Index
CLM	Cellule de Lutte contre la Malnutrition/Coordination Unit for the Fight Against Malnutrition
CNLM	Commission Nationale de Lutte contre la Malnutrition
CRS	Catholic Relief Services
DHIS	District Health Information System
DHS	Demographic and Health Survey
DID	Difference-in-Difference
DPT3	Diphtheria Tetanus Pertussis vaccine
DSRP	Stratégie de Reduction de la Pauvreté/Poverty Reduction Strategy Paper
DSDOM	Dispensateurs de Santé à Domicile/Home Health Providers
ECOWAP	Regional Agricultural Policy for West Africa
ECOWAS	Economic Community of West African States
EPI	Expanded Program on Immunization
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FP	Family Planning
GDI	Gender Development Index
GDP	Gross Domestic Product
GII	Gender Inequality Index
GNI	Gross National Income
HAZ	Height-for-Age Z Score
HIV	Human Immunodeficiency Virus
IHME	Institutes of Health Metrics and Evaluation
IMCI	Integrated Management of Childhood Illnesses
LMIC	Low and Middle-Income Countries
MFDC	Mouvement des forces democratiques de la Casamance/ Movement of Democratic Forces of Casamance
MICS	Multiple Indicator Cluster Surveys
MNCH	Maternal, Newborn and Child Health
MPI	Multidimensional Poverty Index
NESA	Projet Nutrition Enfant et Sécurité Alimentaire/Child Nutrition and Food Security Project
NGO	Non-Governmental Organization
ODA	Official Development Assistance
ORS	Oral Rehydration Salts
PASAV	Food Security Support Project for Vulnerable Households

PDEF	Ten-Year Education and Training Plan
PDIS	Five-Year Integrated Health and Development Program
PEPAM	Programme d'Eau Potable et d'Assainissement du Millénaire/Water and Sanitation Millennium Program
PFSN	Health and Nutrition Financing Project
PISEN	Integrated Education and Nutrition Program
PIUS	Projet d'Iodation du Sel/Universal Salt Iodization Project
PLDM	Fight Against the Determinants of Malnutrition Project
PNA EPT	Plan National d'Actions de l' Éducation Pour Tous/National Action Plan for Education for All
PNC	Project de Nutrition Communautaire/Community Nutrition Project
PNPF	National Program on Family Planning
PNDL	Programme National de Développement Local/National Program for Local Development
PNDP	Document de Politique Nationale de Développement de la Nutrition/ National Nutrition Development Policy Document
PNDS	Plan National de Developpement Sanitaire/National Health Development Plan
PNIA	Programme Nationale d'Investissement Agricole/ National Agricultural Investment Program
PPNS	Protection Nutritionelle des Groupes Vulnerable/ Nutritional Protection of Vulnerable Groups
PPP	Purchasing Power Parity
PQDES	Plan Quadriennal de Développement Economique et Social/Quadrennial Economic and Social Development Plan
PRF	Fortification Enhancement Program
PRN	Program de Renforcement de la Nutrition/Nutrition Enhancement Program
PSE	Plan Senegal Emergent/Emerging Senegal Plan
PSFAMS	Plan Stratégique pour la Fortification des Aliments en Micronutriments au Sénégal/ Strategic Plan for the Fortification of Foods in Senegal
PSSC	Plan Stratégique National de Santé Communautaire/National Community Health Strategic Plan
SD	Standard Deviation
SII	Slope Index of Inequality
SNDES	Stratégie Nationale de Développement Economique et Social/National Strategy for Social and Economic Development
SUN	Scaling Up Nutrition
TAG	Technical Advisory Group
TB	Tuberculosis
UHC	Universal Health Coverage
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
USD	United States Dollar
VIF	Variance Inflation Factors
WASH	Water, Sanitation and Hygiene
WFP	World Food Programme
WHO	World Health Organization

Chapter 1: Background & Introduction

1.1: Global Burden of Stunting and Implications

Chronic malnutrition in infants and young children remains a global public health problem associated with poverty. Linear growth faltering often begins *in utero* with maternal malnutrition, which contributes to intrauterine growth restriction and subsequent low birthweight. During infancy, suboptimal feeding practices and a high burden of infectious diseases further contribute to poor growth. Linear growth stunting, defined as a height-for-age z-score (HAZ) that is ≤2 standard deviations below the mean, is a visible and easily measurable physical manifestation of chronic malnutrition. Children who are stunted have higher rates of mortality and morbidity, and experience suboptimal cognitive and motor development (1).

Globally, stunting prevalence declined from 39.5% to 32.7% to 22.9% across 1990, 2000 and 2016, respectively (2). The 42% reduction noted over 26 years was most rapidly achieved in the post-2000 period. Despite impressive progress, in 2016, about 154.8 million children under the age of 5 years worldwide were still stunted (2). Both regional and within-country disparities exist, with prevalence ranging from 36.7% in eastern Africa to 5.5% in eastern Asia as of 2016 (2). An estimated 17% of mortality in children under-5 years is attributable to stunting (1). Meta-analyses of five prospective cohort studies have shown that a unit increase in HAZ for children ≤2 years was associated with a 0.22 SD improvement in cognitive function later in childhood at 5 to 11 years (3) illustrating the lingering effects of early life chronic malnutrition. This has serious implications for population health and the fulfillment of the intellectual and economic potential of low and middle-income countries (LMIC).

Countries that prioritize the implementation and scale-up of nutrition-sensitive and nutrition-specific policies and programs stand to make great economic gains, as these initiatives generally have very high benefit-cost ratios (4).

1.2: Exploring Exemplars

While several developing countries worldwide have experienced meaningful decreases in stunting prevalence over the past several decades, a handful of countries, or 'positive exemplars', have achieved a more rapid rate of stunting reduction. These high-achieving positive exemplars may provide instructive case studies in the effects of economic and political change on child growth.

Recent analyses have expanded their scope and explored the drivers behind stunting reduction in a handful of high-performing countries worldwide, such as Cambodia (5), Kenya, Zambia (6), Peru (7), Indonesia (8), and Ethiopia (9,10). More comprehensive analyses have examined trends and determinants in multiple countries including Bangladesh, Nepal, India (Odisha), Ethiopia, and Zambia (11), while others have explored the drivers of stunting reduction regionally, such as in high-burden South Asian countries (12). Some of the strongest drivers of stunting reduction identified in these analyses include higher maternal education, improved household asset index, access to improved sanitation, and the scale-up of certain health and nutrition interventions.

Setting out to augment existing literature with more diverse methodologies, our investigation takes a more holistic approach than prior quantitative analyses. In order to tease apart the effects of economic growth and national-level nutrition policy, we took a systematic approach in the selection of country case studies. From the outset, we applied a common conceptual framework and a standardized, rigorous methodological process to evaluate progress on stunting across all country case studies. In our quantitative analyses, we examined multiple levels of determinants (e.g. basic, intermediate, and immediate) of stunting reduction in a hierarchical model. This was coupled with

qualitative data gathered from in-depth interviews and focus groups involving key stakeholders. Additionally, a comprehensive review of prior research and national-level policies enriched our analysis and allowed us to construct a clearer picture of the story of success in stunting reduction

1.3: Exemplar Selection Process: Senegal

In light of accelerated reductions in stunting globally and in several LMICs post-2000, this study focused on highlighting exemplars in the 2000 to 2015 period. The systematic country selection process aimed to identify *true exemplars* i.e. those having reduced stunting prevalence beyond the projected nutritional gains associated with general poverty reduction/economic growth. To this end, the process of selecting case study countries involved plotting the average annual rate of change (AARC) in absolute stunting prevalence as a function of the AARC in gross domestic product (GDP) per capita. We additionally stratified by the World Bank income groups (low, lower middle, and upper middle) so as to examine countries within comparable income bands. Using the plots, we identified those countries with: i) steep declines in stunting rates over time, and/or ii) high AARC in stunting prevalence relative to AARC in GDP per capita. In other words, those countries that demonstrated greater reductions in stunting prevalence while experiencing relatively smaller increases in GDP per capita were ideal candidates for case study selection.

See Figure 1 for the associated scatterplot for low-income countries. Countries ranked in the bottom left quadrant are the closest to exemplar status – Ethiopia, Nepal, Senegal, and Tanzania were considered important contenders in this income band. Across income groups, a total of ten countries were initially shortlisted in this manner (Table 1). The proposed exemplary nations were thereafter deliberated among expert stakeholders [the technical advisory group (TAG)] who considered additional factors such as the countries' total population (minimum threshold of 5 million), variability across income bands and geographic region, physical accessibility/country security, feasibility of case study activities (e.g. qualitative data collection), and the existence of local contacts and potential partners. After the study TAG convening in March 2018, an additional 2 countries were added based on above criteria. At the time of this report, a total of 5 countries were selected as exemplars (Peru, Kyrgyzstan, Nepal, Senegal & Ethiopia), and others were under consideration. Within the low income category, Senegal was chosen as a West Africa example due to a high AARC in stunting relative to GDP growth. Given Senegal's history of remittances, we also examined trends in gross national income (GNI) per capita (which captures all national wealth from any source), and found that trends to be similar to GDP (Appendix 1).

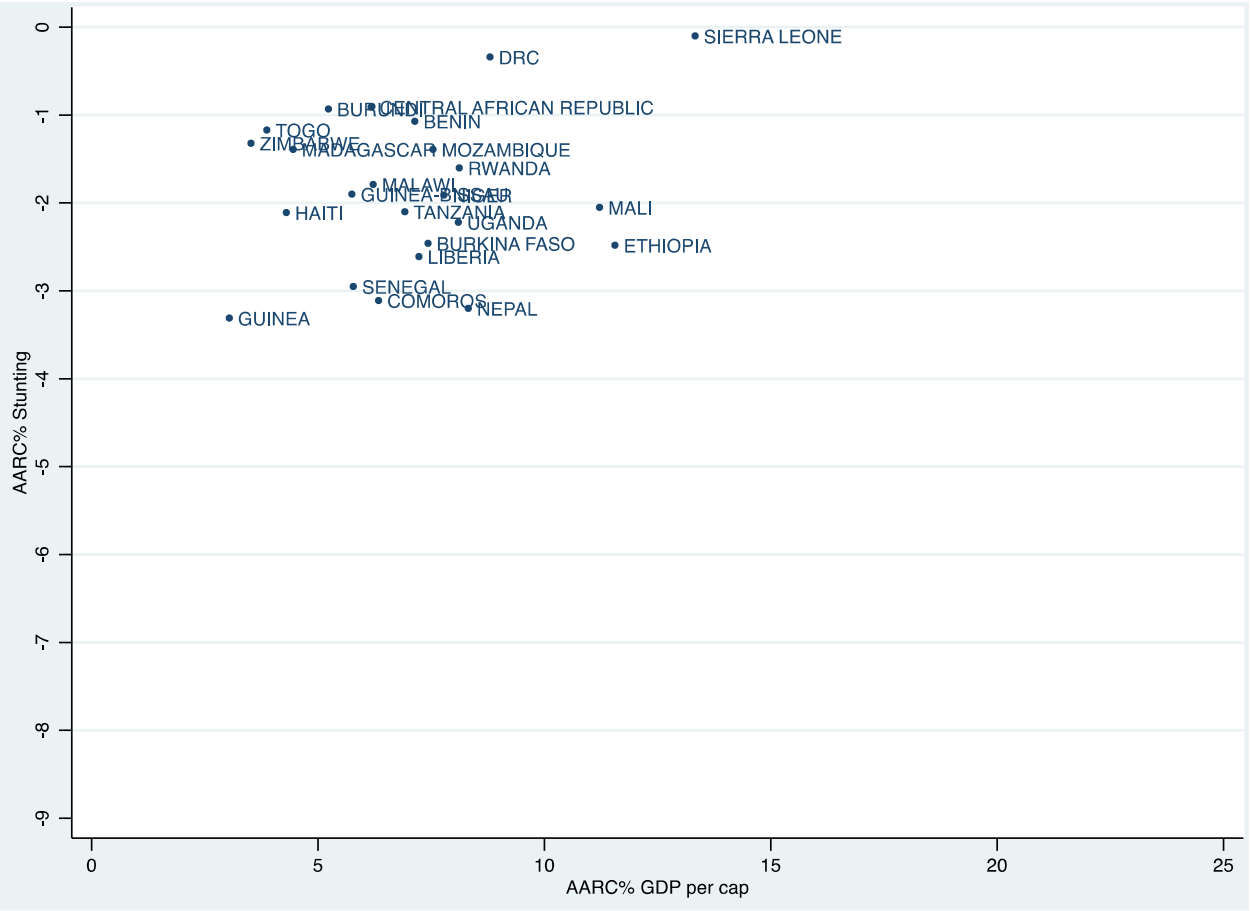


Figure 1: Scatterplot of the average AARC in national-level under-5 stunting prevalence as a function of AARC in GDP per capita for low-income countries.

Table 1: Final shortlist of top ten countries considered for case study selection, stratified by region and income level

	Latin America	**North Africa**	**Sub-Saharan Africa**	**South & Central Asia**	**Southeast Asia**
Low income			• Senegal • Tanzania • Ethiopia • Uganda**	• Nepal	
Lower middle income	• El Salvador	• Morocco • Mauritania		• Kyrgyzstan	• Vietnam* • Cambodia**
Upper middle income	• Peru			• Turkey	
* Vietnam was selected as a potential exemplar to represent Southeast Asia, but did not appear in the original shortlist of ten countries. **Cambodia and Uganda were added based on further technical expert deliberations					

1.4: Senegal's Stunting Reduction

In recent decades, Senegal has achieved substantial reductions in the prevalence of stunting (Figure 2). In 1992, 34.4% of children under-5 years experienced linear growth stunting. By 2005, stunting

prevalence had fallen to below 20%. By 2016, stunting had reached a national low prevalence of 16.6%.

Since 1992, GDP has been increasing steadily. Per capita GDP grew from $1802 to $2471 (constant international, PPP) from 1992 to 2017 (Figure 2). GNI per capita follows similar patterns as GDP per capita (Appendix 1). The annual growth rate GNI per capita has fluctuated during this period, but has generally remained between 0% and +7%.

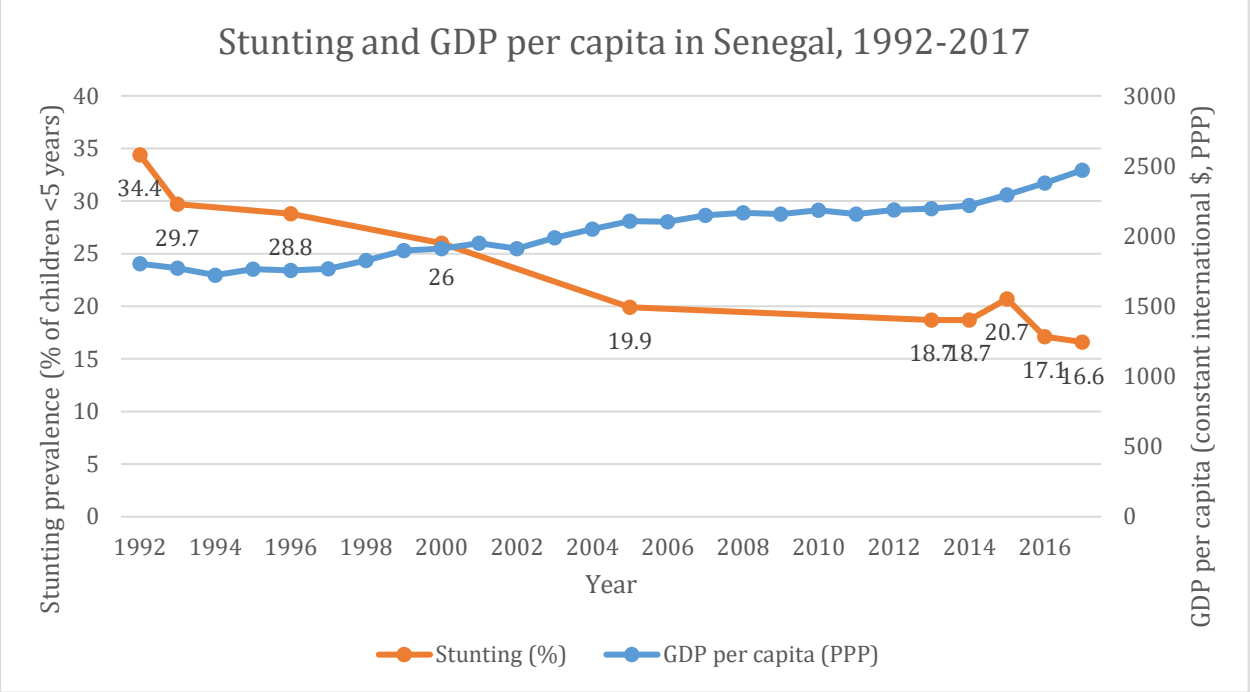


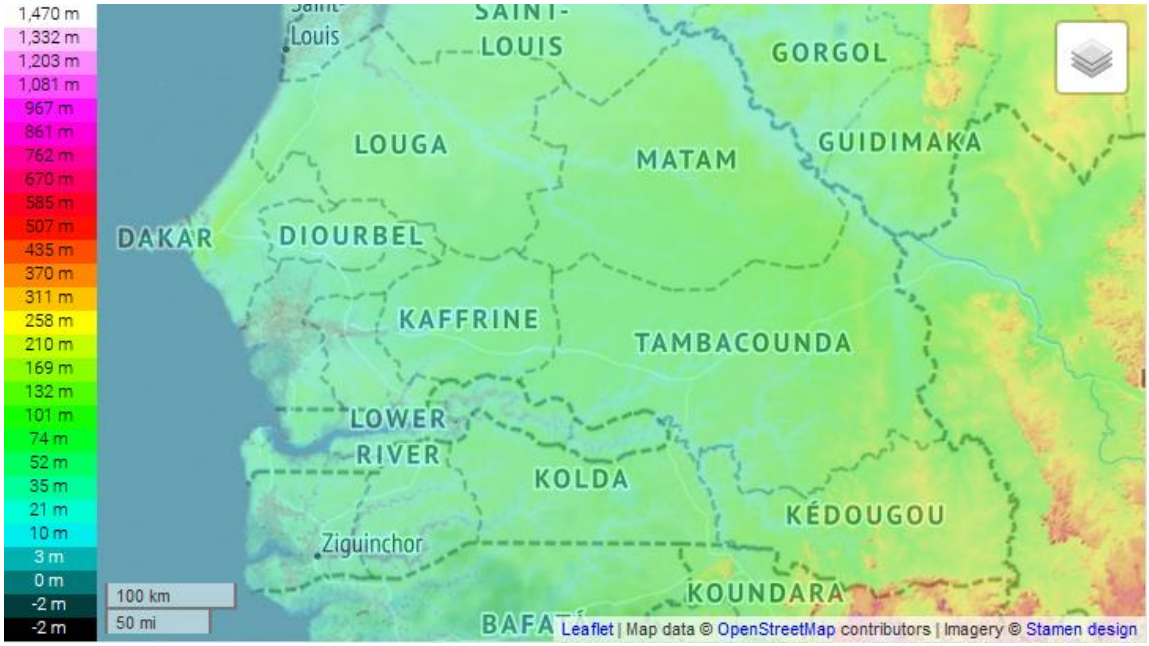
Figure 2: Trends in under-5 stunting prevalence and GDP per capita from 1992 to 2017 in Senegal (13,14).[1]

1.5: Senegal Country Context

Senegal is a country in West Africa that shares borders with several countries including Mauritania, Mali and Guinea and connects to the Atlantic Ocean. As of 2017, Senegal has a population of approximately 15.9 million, just over half of which (53.3%) is located in rural areas (15,16). According to 2017 estimates, Senegal is comprised of seven major ethnic groups: Wolof 37.1%, Pular 26.2%, Serer 17%, Mandinka 5.6%, Jola 4.5%, Soninke 1.4%, other 8.3% (includes Europeans and persons of Lebanese descent) (17).

Geographically, Senegal consists mainly of the sandy plains of the western Sahel. Terrain level is generally low, with the rolling plains rising to foothills in the southeast (Figure 3). The average elevation is 69m. The lowest point in Senegal is at sea level (Atlantic Ocean). The highest point is an unnamed elevation 2.7 km southeast of Nepen Diakha at 648 m (18).

[1] Stunting estimates are based on Joint Malnutrition Estimates (JME). Data sources are as follows: 1992-Other; 1992/93—DHS; 1996, 2000—MICS; 2005-DHS; 2011-MICS, 2013-2016—CDHS. These last surveys are frequent as they represent estimates from continuous DHSs, which Senegal implemented from 2013 onward.



Source: http://en-ca.topographic-map.com/places/Senegal-7869615/

Figure 3: Topographic map of Senegal

Senegal is comprised of 14 administrative divisions (Figure 4). The capital city, Dakar, is located in the province of Dakar which is the most populous of all 14 regions (23.1% of the population), followed by Thiès (13.0%) and Diourbel (11.1%) (19).

Source: https://en.wikipedia.org/wiki/Regions_of_Senegal#/media/File:Senegal,_administrative_divisions_-_en_-_monochrome.svg

Figure 4: Provinces of Senegal

Urbanization varies across the country and, according to the most recent statistics from 2013, ranges from 15.1% to urban areas in Kaffrine, to 96.5% urbanization in Dakar (Figure 5) (20).

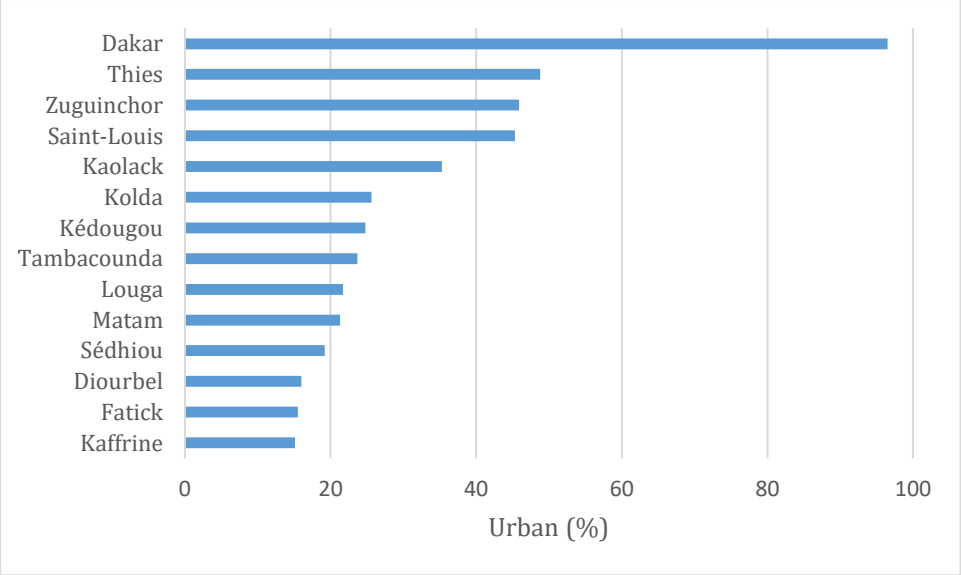


Figure 5: Percentage of urban area in each province of Senegal in 2013.

Dating back to 1982, Senegal has experienced a low-level separatist conflict in its southern Casamance area, which includes the Ziguinchor, Kolda and Sédhiou regions. The conflict was initiated by *Movement des Forces Démocratiques de la Casamance* (MFDC), who aimed to achieve independence for Casamance, due to this area's distinct religious and ethnic populations when compared to the rest of the country. Over the course of this conflict, it is estimated that between 3000-5000 people have died, and many more have been internally displaced (21,22). In 2014, a ceasefire was declared between the Government of Senegal and the MFDC. Despite the length of this internal conflict, Senegal has continued to maintain an international reputation as a largely peaceful country.

1.6: Senegal Governance and Health Care System

Detailed organograms of Senegal's government and ministerial structures are presented in Appendix 2. Senegal's Ministry of Health and Population is one of thirty eight ministries in the executive body of government headed by the Prime Minister. The Ministry is overseen by the Minister of Health, the Cabinet and General Secretary. The Minister heads the Departments of General Social Action which promotes and protects vulnerable groups and persons with disabilities, as well as the Department of General Health, which is sub-divided into several other departments. Sub-departments of the General Health department include, but are not limited to, the National Health Education and Information Service, Poison Control Centre, Reproductive Health department and the Community Health Unit. The Cabinet runs units for the following: Health inspection, universal health coverage, communications and national hygiene service. General information, correspondence, legal proceedings and archiving offices are all headed by the General Secretary.

Senegal's health system has become increasingly decentralized since 1970, with administrative responsibilities gradually shifting to the local level of governance. Management of health facilities hast transferred to regional, municipal and rural communities and in 1998, hospitals were given autonomy over their own finances and management. However, although budgets for regional hospitals are managed by local governments, human resources are still allocated and distributed at the central level (23).

The national health system of Senegal consists of four levels. At the regional level, each medical region has a hospital typically located and in the largest city. Regional hospitals offer the broadest scope of

care and are supervised by a chief regional doctor. Districts within each region contain health centers run by chief district doctors and serve smaller populations. Health posts serve local communities at the sub-district level and are staffed by chief nurses and midwives. Finally, individual villages contain small health points which managed by a community health agent; health points are often sparsely equipped and serve a handful of neighboring villages (24).

1.7: Senegal Background and Demographics

Over our study period (1992-2017), the population of Senegal has nearly doubled, however growth has fluctuated over the years and slowed more recently (Table 2). There has also been continuous urbanization; 39.2% of the population lived in urban areas in 1992, rising to 46.7% in 2017. This has been accompanied by a decline in the rural population, which was 60.8% of the country in 1992, declining to 53.3% in 2017

Both the infant and under-5 mortality rates (per 1000 live births) have reduced significantly in Senegal between 1992 and 2017. In 1992, the infant mortality rate was 70.4 out of 1000 live births, decreasing to 32.7 deaths per 1000 live births in 2017, a 54.0% decline. Under-5 mortality has reduced even more significantly, from 137 deaths per 1000 live births in 1992 to 45.4 deaths in 2017, a 67.0% decline. Maternal mortality (per 100,000 live births) has also decreased over the last two decades, though less drastically, from 509 deaths in 1995 to 315 deaths in 2013, a 38.1% decline.

Related to population growth and survival trends, Table 2 also presents several indicators on economy, healthcare, environment and other contextual factors in Senegal from 1992-2017. For example, in terms of overarching improvements to socioeconomic indicators and income equality, the country's human development index rose from 0.37 in 1995 to 0.51 in 2017, and the GINI Index decreased slightly from 41.4 in 1994 to 40.3 in 2011, a marker of a reduction in income inequalities between the rich and the poor within the country.

Gross Domestic Product (GDP) and Gross National Income (GNI) per capita PPP (constant 2011 international $) have increased by 37% and 36% respectively over our study period, and adjusted net national income per capita (current US$) increased by about 16.0% from 1992 to 2016. Personal remittances received as a percentage of GDP has increased notably, from 2.9% in 1992 to 13.7% in 2017. National-level poverty appears to have reduced moderately over the last several years as suggested by the multidimensional poverty index and poverty headcount data, which show a 9.0% and 8.5% decline, respectively. Those living in extreme poverty, less than $1.90 per day declined more significantly, by 30.0% between 1991 and 2011, though total unemployment has risen slightly from 5.7% of the workforce in 2002 to 7.0% of the workforce in 2015.

Government spending on health as a percent of current health expenditure in the country has fluctuated over the years and declined more recently, as has out-of-pocket health expenditure. Official development assistance (ODA) increased from about 662 million USD to 736 million USD from 1992 to 2016. ODA towards child health and maternal/neonatal health have both increased dramatically over the years. In 2005, ODA was $10 UD per child, rising to $29 USD per child in 2012, a 190.0% increase. Similarly, in 2005, maternal and neonatal health stood at $17 USD per live birth, rising to $55 USD in 2012, 223.5% increase. As of 2015, ODA to reproductive health stands at $151 million.

According to the most recent data from 2015, the median age at first marriage for women in Senegal is about 20 years, rising from approximately 17 years in 1992. Although child marriage has improved since 1992 (47.7%), it remains a significant issue in Senegal, with 31.5% of women 20-24 years old

married by age 18 in 2016. The total fertility rate (average births per woman 15-49) has dropped by about 23.0% between 1992 and 2017, with an average of 6.0 births per woman in 1992 lowering to 4.6 in 2017. The adolescent fertility rate has seen a more marked decline, lowering from 127 births per 1000 girls aged 15-19 years in 1992 to 78 births in 2016, a 38.6% decrease.

Literacy of all adults, female adults (15 and older), and young females (age 15-24 years) have all increased over the study period. Among all adults in Senegal, approximately 52.0% are literate, and among female adults approximately 40.0% are literate. The literacy rate among female youth in Senegal has increased most noticeably, from 41.0% in 2002 to 64.0% in 2017, a 23.0% increase. Composite global indices related to gender inequality and gender development have also shown positive improvements in Senegal in terms of enhancing equality and development, particularly as related to females.

With slight fluctuations, Senegal has made little progress in increasing deployment of general physicians (0.07 per 1,000 population from 1992-2016) and nurses/midwives (0.3 per 1,000 population from 2004-2016) across the country. Interestingly, given the lack of progress in increasing the number of health professionals deployed across the country, births attended by skilled health staff have increased significantly, from about 47.2% of births in 1992 to 68.4% of births in 2017. Even more notable, the percentage of women attending 4+ antenatal care (ANC) visits increased from 14.0% in 1992 to 57.0% in 2017.

Access to improved drinking water sources increased appreciably from about 47.8% to 72.7% between 1992-2017, and at the rural level access increased even more markedly from 25.3% to 62.2% over the same period. Those using piped water as their drinking source also increased across the country from 42.1% in 1992 to 68.3% in 2017. Access to improved sanitation facilities increased from 22.1% to 50.6% between 1992 and 2017, and at the rural level this increase was slightly less, rising from 27.4% in 1992 to 41.6% in 2017. Over the same time period, the percentage of people engaging in open defecation has decreased by 24.0%.

Though both food exports and imports have increased dramatically for Senegal over the last two decades, the country remains a net importer of food (i.e. food imports exceed exports). In 1996, food exports totaled 9.7 million USD of revenue and this rose to 271 million USD by 2016. Food imports, on the other hand, cost 122 million USD in 1996 and grew to cost 431 million USD in 2016. In terms of agricultural production and livestock, Senegal has managed impressive gains in livestock production (such as meat, dairy products and eggs), food production (crops that are considered edible and that contain nutrients), overall crop production (all crops except fodder crops), and cereal production between 1992 and 2016, though forested areas in the country have decreased by about 11.0% over this period.

Table 2: Senegal national demographic, economic, and other contextual statistics and trends

Indicator	**1992**	**2017**	**Change (current metric)**
Total population (millions)[1]	8.03	15.85	+7.82 (2017-1992)
Population growth (annual %)[1]	3.04	2.81	-0.23 (2017-1992)
Rural population (% of total)[1]	60.82	53.26	-7.56 (2017-1992)
Urban population (% of total)[1]	39.18	46.74	+7.56 (2017-1992)
Mortality Rate, Infant (per 1,000 live births)[1]	70.4	32.7	-37.7 (2017-1992)
Mortality Rate, Under-5 (per 1,000 live births)[1]	137	45.4	-91.6 (2017-1992)
Mortality Rate, Maternal (per 100,000 live births)[2]	509 (1995)	315 (2015)	-194 (2015-1995)

Indicator	1992	2017	Change (current metric)
Human Development Index[3]	0.37 (1995)	0.51	+0.14 (2017-1995)
Forest Area (thousands of km^2)[1]	92.6	82.7 (2015)	-9.9 (2015-2000)
Improved drinking water source (% with access)[4]	47.8	72.7	+24.9 (2017-1992)
Improved drinking water source, rural (% of rural population with access)[4]	25.3	62.2	+36.9 (2017-1992)
Piped water drinking source (% using)[4]	42.1	68.3	+26.2 (2017-1992)
Improved sanitation facilities (% with access)[4]	22.1	50.6	+28.5 (2017-1992)
Improved sanitation facilities, rural (% of rural population with access)[4]	27.4	41.6	+14.2 (2017-1992)
Open defecation (% engaging in)[4]	38.9	14.9	+24.0 (2017-1992)
Adjusted net national income per capita (current US$)[1]	692.75	803.16 (2016)	+110.41 (2016-1992)
Multidimensional Poverty Index (MPI)[5]	0.42 (2011)	0.33	-0.09 (2017-2011)
GDP per capita, PPP (constant 2011 international $)[1]	1802.43	2470.58	+668.15 (2017-1992)
GNI per capita, PPP (constant 2011 international $)[1]	1758.26	2384.17	+625.91 (2017-1992)
Personal remittances received (% GDP)[1]	2.93	13.67	(2017-1992)
Poverty headcount ratio at national poverty lines (% of population)[1]	55.2 (2001)	46.7 (2011)	-8.5 (2011-2001)
Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)[1]	68.4 (1991)	38 (2011)	-30.4 (2011-1991)
Total unemployment (% of total labour force)[1]	5.65 (2002)	6.97 (2015)	+1.32 (2015-2002)
Total health expenditure (% of GDP)[1]	4.63 (2000)	3.97 (2015)	-0.66 (2015-2000)
Domestic General Government Health Expenditure (% Current Health Expenditure)[1]	36.7 (2000)	31.7 (2015)	-5.0 (2015-2000)
Out-of-pocket health expenditure (% of total health expenditure)[1]	54.01 (2000)	44.18 (2015)	-9.83 (2015-2000)
Net ODA received (current US$) (millions)[1]	662.38	736.39 (2016)	+74.01 (2016-1992)
ODA to Child Health per child (US$)[6,7]	10 (2005)	29 (2012)	+19 (2012-2005)
ODA to Maternal and Neonatal Health per live birth (US$)[6,7]	17 (2005)	55 (2012)	+38 (2012-2005)
Total ODA to Reproductive Health (million US$)[7]	*No data*	151 (2015)	*N/A*
ODA to Additional Reproductive Services per capita women 15-49 (US$)	*No data*	*No data*	*N/A*
Age at first marriage (median, women 20-49)[4]	16.6	19.7 (2015)	+3.1 (2015-1992)
Child marriage (% women 20-24 married by age 18)[1]	47.7	31.5 (2016)	-16.2 (2016-1992)
Total fertility rate (births per woman 15-49)[4]	6.0	4.6	-2.6 (2017-1992)
Antenatal Care, 4+ visits (% of women)[4]	14.0	57.0	+43 (2017-1992)
Births attended by skilled health staff (% of total)[4]	47.2	68.4	+21.2 (2017-1992)
Adolescent fertility rate (births per 1000 girls aged 15-19 years)[4]	127	78	-49.75 (2016-1992)
Adult literacy rate (% of adults ages 15 years and above)[1]	39.28 (2002)	51.9	+12.62 (2017-2002)
Female adult literacy rate (% of females ages 15 years and above)[1]	29.25 (2002)	39.8	+10.55 (2017-2002)

Indicator	1992	2017	Change (current metric)
Female youth literacy rate (% of females ages 15-24 years)[1]	40.97 (2002)	63.5	+22.53 (2017-2002)
Gender Inequality Index (0-1; closer to 1 is higher inequality)[3]	0.64 (1995)	0.52	-0.12 (2017-1995)
Gender Development Index same as above[3]	0.781 (1995)	0.911	+0.13 (2017-1995)
GINI Index (0-100; closer to 100 is higher inequality)[1]	41.4 (1994)	40.3 (2011)	-1.1 (2011-1994)
Density of Physicians (per 1,000)[1]	0.07	0.07 (2016)	0.0 (2016-1992)
Density of Nurses and Midwives (per 1,000)[1]	0.3 (2004)	0.31 (2016)	+0.01 (2016-2004)
Food exports (USD) (millions)[8]	9.68 (1996)	270.67 (2016)	+260.99 (2016-1996)
Food imports (USD) (millions)[8]	122.14 (1996)	431.20 (2016)	+309.06 (2016-1996)
Livestock production index* (shows livestock production for each year relative to the base period 2004-2006)[8]	76.89	125.22 (2016)	+48.33 (2016-1992)
Food production index** (shows food production for each year relative to the base period 2004-2006)[8]	73.74	148.46 (2016)	+74.72 (2016-1992)
Crop production index*** (shows crop production for each year relative to the base period 2004-2006)[8]	73.87	155.54 (2016)	+81.67 (2016-1992)
Cereal production**** (million metric tons)[8]	0.97	1.98 (2016)	+1.01 (2016-1992)

Sources: World Bank[1], UN-MMEIG[2], UNDP[3], DHS[4], OPHI[5], Countdown to 2015[6], Countdown to 2036[7], FAO[8]

* includes meat and milk from all sources, dairy products such as cheese, and eggs, honey, raw silk, wool, and hides and skins

** Food production index covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value.

*** Crop production index shows agricultural production for each year relative to the base period 2004-2006. It includes all crops except fodder crops. Regional and income group aggregates for the FAO's production indices are calculated from the underlying values in international dollars, normalized to the base period 2004-2006.

**** Production data on cereals relate to crops harvested for dry grain only. Cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded.

1.8: Research Aim and Objectives

Senegal's has had modest improved in several areas since the early 90s, including in economic growth, poverty reduction, reduced total and adolescent fertility rates, increased adult/youth literacy and gender equality, improvements in water/sanitation facilities, and changes in agricultural production patterns and consumption – hint at a multifactorial stunting success story. Understanding and disentangling these causes was the broader aim of this study.

Research Aim: To conduct a systematic in-depth assessment of the determinants, specifically national (macro), community and household, and individual level factors, and relevant nutrition-specific and nutrition-sensitive interventions/innovations/policies/strategies, that have driven stunting reduction in Senegal from 1992 to 2017.

Specific Objectives:

1. To quantitatively examine determinants of stunting reduction in Senegal and to decompose long-term stunting change into relative contribution from key drivers;
2. To explore national and community level perspectives on Senegal's nutrition evolution (focused on progress in stunting) and the major contributing factors behind it;
3. To generate a systematic landscape of the major stunting-relevant policies and programs in Senegal, with focus on both nutrition-specific and –sensitive initiatives; and

4. To track and document nutrition-related investments in Senegal by government and partners (e.g. financial allocations, expenditures).

Chapter 2: Methodology

2.1: Study Design

This mixed methods study applied several complementary approaches to inform study objectives. Methodological details of the literature review, and quantitative and qualitative inquiry approaches are discussed below. Table 3 briefly summarizes each method type and its purpose in our work.

Table 3: Methods utilized and purpose

Method	**Purpose**
Systematic literature review	To synthesize information on contextual factors, national and subnational interventions, policies, strategies, programs, and initiatives that may have theoretically contributed to reductions in child stunting in Senegal over time. Retrieved literature would inform the research process from study planning, answering study objectives, to results interpretation.
Geospatial, equity and growth curve analysis	To examine the distribution of stunting across the country and between important population subgroups to examine inequalities To assess child growth faltering trajectories by age to gain an understand of stunting risk at birth vs postnatal and how that changes over time
Linear mixed effect regression	A panel datasets time-series analyses using individual/household level data from 1992 to 2017 to understand the major predictors of stunting decline in Senegal
Oaxaca-Blinder decomposition	A complementary regression-based analysis based on individual- and household-level data to understand the major predictors of stunting decline in Senegal from 1992 to 2017.
Focus group discussion/in-depth interviews	To understand national and community stakeholder perspectives on Senegal's nutrition evolution (focused on progress in stunting) and the major contributing factors behind it To access key sources of data related to financials/budget/expenditure on nutrition-specific and -sensitive initiatives
Policy and program document review	To gain a comprehensive understanding of the major nutrition-specific and –sensitive policies/programs/strategies; this would be supplemented with information from key informants.

2.2: Systematic Scoping Literature Review

A systematic search of published peer-reviewed and grey literature related in Senegal was undertaken in order to synthesize information on contextual factors, national and subnational interventions, policies, strategies, programs, and initiatives that may have theoretically contributed to reductions in child stunting in Senegal over time. Three broad categories of search terms were used: stunting, child, and Senegal. Keywords representing these terms were combined with Boolean operators, adapted with appropriate syntax, and executed in multiple databases. An example of a search syntax is provided below:

1. *Stunting*: "stunting" or "linear growth" or "linear growth stunting" or "HAZ" or "height" or "height-for-age" or "LAZ" or "length" or "length-for-age" or "undernutrition" or "malnutrition" or "nutr*"
2. *Child*: "child*" or "infan*"
3. "Senegal*"
4. 1 AND 2 AND 3

The search for indexed literature was conducted in 15 online databases: MEDLINE, Embase, AMED, CAB Abstracts, CINAHL, Cochrane CENTRAL, Campbell Collaboration, EPPI Centre Trials Register (TRoPHI), 3ie, JOLIS, African Journals Online, WHOLIS, LILACS, Scopus, and Web of Science. Additional searches for grey literature were conducted using Google, a hand search of reference lists of relevant reviews, and direct searching organizational websites, including: National, regional and headquarter websites for UNICEF, WHO, UNDP, WFP, FAO, World Bank Group Open Knowledge Repository, Nutritional International, Global Alliance for Improved Nutrition, International Food Policy Research Institute, Government of Senegal including the Ministry of Health and Social Action, and Ministry of Agriculture and Rural Development.

The exported set of records were de-duplicated and screened for relevance. Records were included if they met all of the following inclusion criteria:

i) included an under-5 population in Senegal;
ii) published between 1990-2017;
iii) examined one or more of the determinants of chronic undernutrition (e.g. determinants, risk factors, policies, programs, interventions, or initiatives); and
iv) examined effects on child growth or a reduction in stunting

Initial database searches returned 2,718 records, which was reduced to 1,728 after de-deduplication. Applying the screening criteria to titles and abstracts left 81 records, which was then reduced to 44 upon full-text review. All included studies were categorized for the purposes of thematic exploration and mapping. Three broad categories of studies were identified: i) quantitative analysis of child health or nutrition outcomes; ii) qualitative studies with quantitative analysis; and iii) grey literature reports from non-governmental and multilateral organizations. See Figure 6 for a flow diagram outlining the components and progression of the review. Relevant literature was iteratively synthesized and summarized to inform our research questions and to contrast our findings with existing evidence.

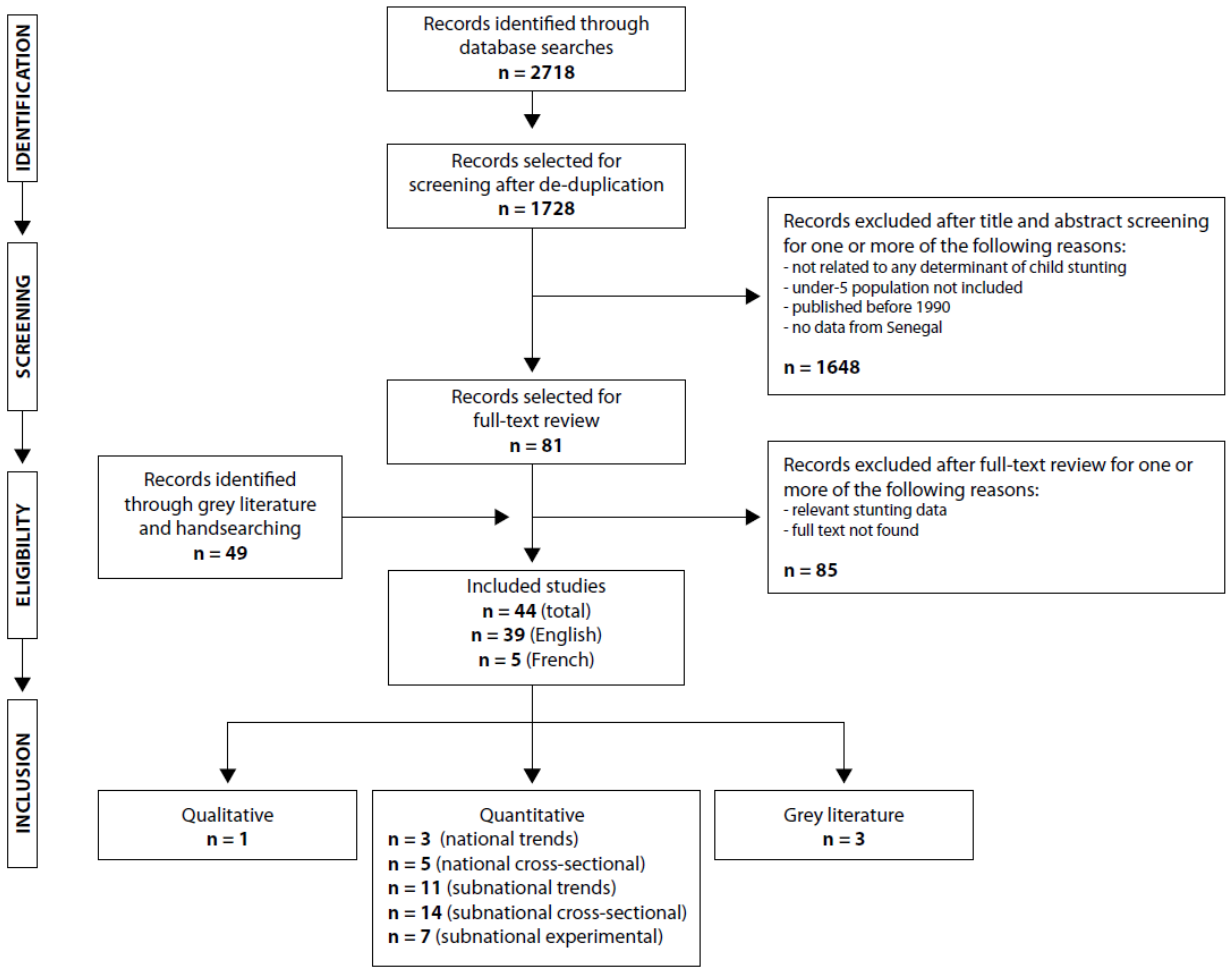


Figure 6: Literature review flow diagram

Targeted additional searches were completed for key topics to supplement and expand on important factors in the Senegal stunting narrative; a total of 217 additional documents spanning grey literature and published peer-reviewed reports were collated and summarized.

2.3: Quantitative Analyses

2.3.1: Data Sources

Senegal's series of Demographic and Health Surveys (DHS) (1992/93, 2005, 2017) were the primary quantitative datasets used in this study. These nationally-representative household surveys have comparable, standardized methods with data for a wide range of indicators in the areas of population, health, and nutrition (25–28). Detail on DHS methodology and content areas are available elsewhere (25–28). From 2013-2016, Senegal has had continuous annual DHS implemented; these surveys are designed to be nationally-representative, however often are missing certain regions. The DHS 2017 was a full DHS (not continuous) and we thus used this as an endpoint. We also analyzed the Senegal Multiple Indicator Cluster Survey (MICS) 2000 as no DHS was conducted this year, however the year served as a key stunting inflection point. It should be noted that Senegal's 2010/11 DHS survey had severe anthropometry quality concerns (e.g. flagged/implausible values were >20%) and thus this survey was excluded from all analyses. Available under-5 anthropometry data by survey round are presented in Table 4 (index child - to be subsequently described) and Table 5 (all under-5 children).

The detailed description of sample size changes while selecting the index child can be found in Appendix 4.

Table 4: Sample size by survey year based on the index child with valid anthropometric data

Age group	**Year of survey**			
	DHS 1992/93	**MICS 2000**	**DHS 2005**	**DHS 2017**
Under-5	1840	4225	1355	5076
Under 36 months	1567	3445	1139	4013
6 – 23 months	834	1892	636	2286
24 & above	623	1495	450	2053
Under six months	383	838	269	737

Table 5: Based on non-index child with valid anthropometric data

Age group	**Year of survey**			
	DHS 1992/93	**MICS 2000**	**DHS 2005**	**DHS 2017**
Under-5	3864	8420	2847	10702
Under 36 months	2551	5174	1827	6642
6 – 23 months	1288	2649	956	3477
24 & above	2050	4853	1536	6115
Under six months	526	918	355	1110

2.3.2: Analyses Time Periods

Senegal experience gradual stunting decline from the early 1990s to 2000, followed by a sharp drop from 2000 to 2005, and only marginal decline from 2005 to 2017. Given these trends, evidently, initiatives that were implemented from the early 90s to early mid-2000s would have had the most impact on stunting decline in Senegal. Our analyses and inference are thus presented in line with these periods when relevant.

2.3.3: Outcome Definition

Two related indicators of chronic undernutrition in children (height-for-age z-score, % stunted) were the primary study outcomes. Outcomes were calculated using WHO child growth standards (29). The HAZ reflects the number of standard deviations below or above the population average a child's anthropometry value falls. Children were classified as stunted if their HAZ was more than 2 standard deviations below the median of the WHO reference population.

2.3.4: Conceptual Framework and Determinants

Factors that may have contributed to stunting reduction in Senegal are organized in line with the established UNICEF undernutrition conceptual framework (30). A modified version of it was published in the 2008 Lancet nutrition series (31) (Figure 7).

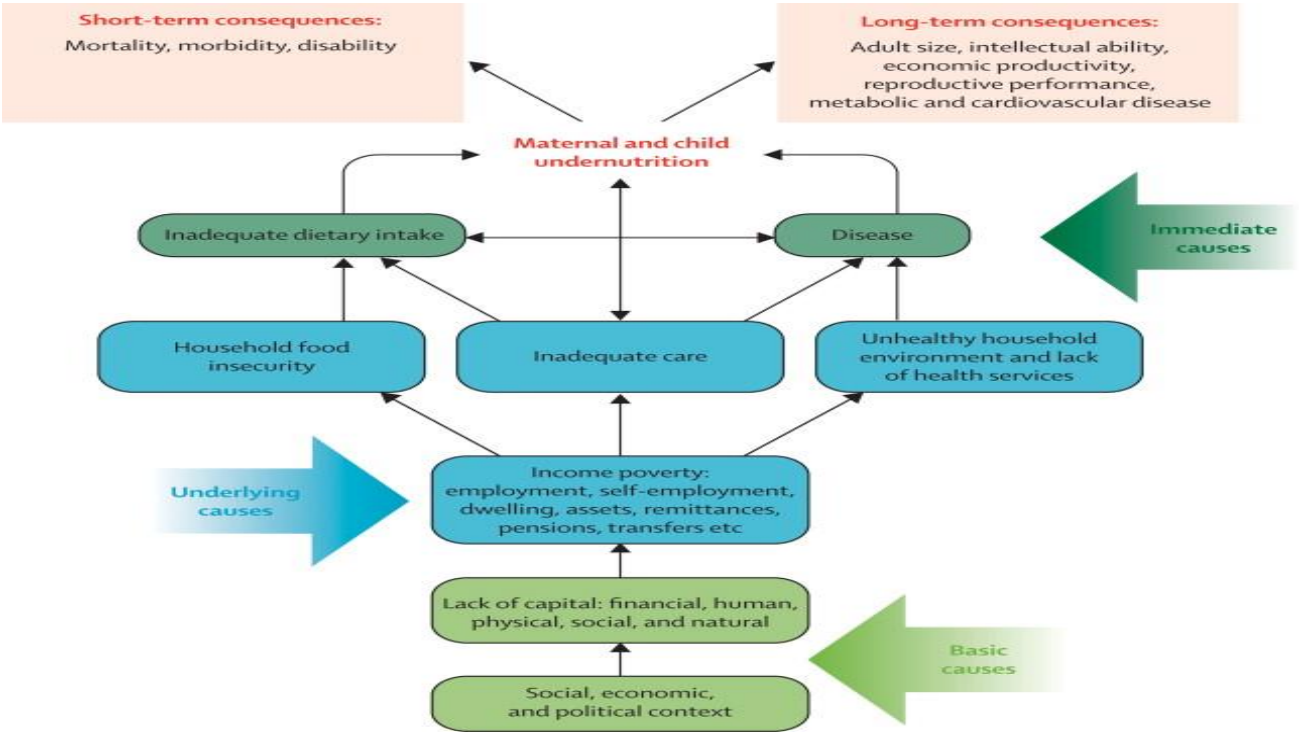


Figure 7: Evidence-based framework for the basic, underlying and immediate causes of undernutrition in mothers and children

We prepared an adapted version of this framework for the Senegalese context and present it in Figure 8. The new conceptual framework resulted from an iterative team discussion and consensus that led to modifications deemed relevant to the scope of our study and based on data availability.

In brief, determinants of maternal and child undernutrition can be grouped in different hierarchical levels, in terms of their causal proximity to the impact of interest, specifically in "basic causes", "underlying causes" and "immediate causes". Each of these lay on a causal path towards nutritional outcomes, with more proximal causes functioning as mediators of the distal determinants.

Variables that were available for analysis are categorized for hierarchical analysis as follows:
Distal level (basic causes): Socioeconomic factors
Intermediate level (underlying causes): Unhealthy household environment, inadequate care and health services, and inadequate feeding practices and food insecurity
Proximal level (immediate causes): Disease and inadequate dietary intake. The proximal level also includes child and maternal characteristics, which are especially important to track factors that directly impact the child's nutritional status. For example, intergenerational transmission of malnutrition and epigenetic effects, which could be measured by proxies such as low birthweight, maternal height and body mass index (BMI) amongst others.

It should be noted that some important factors, including many direct nutritional interventions (e.g. complementary feeding practices, food intake including frequency and diet diversity, etc.), were only

available for the 6-23 month subset of under-5 children. DHS typically administers a separate food recall questionnaire to collect this information from the infant and young child cohort. Though we examined these variables and considered their use in the 6-23 month subgroup analyses, because we did not have sufficient change in HAZ score between start and end surveys for this age group, the age group was not analyzed separately and thus these dietary variables were thus not utilized. Robust data on food insecurity were not found for inclusion in the quantitative analysis. Important factors such as maternal height, maternal BMI, maternal anemia, and vitamin A supplementation were not analyzed as this data was not available in all survey rounds, particularly start and end surveys: DHS 1992/93 and 2017.

Though we searched for meaningful ecological (subnational) variables to include as potential determinants in our analysis, we could not track meaningful and consistently available indicators. Thus our analyses include only original variables from DHS and MICS surveys. A complete list of analysis variables, their definitions and sources is shown in Appendix 5.

Figure 8 presents the *universe* of variables considered in the analysis of children <5 years of age.

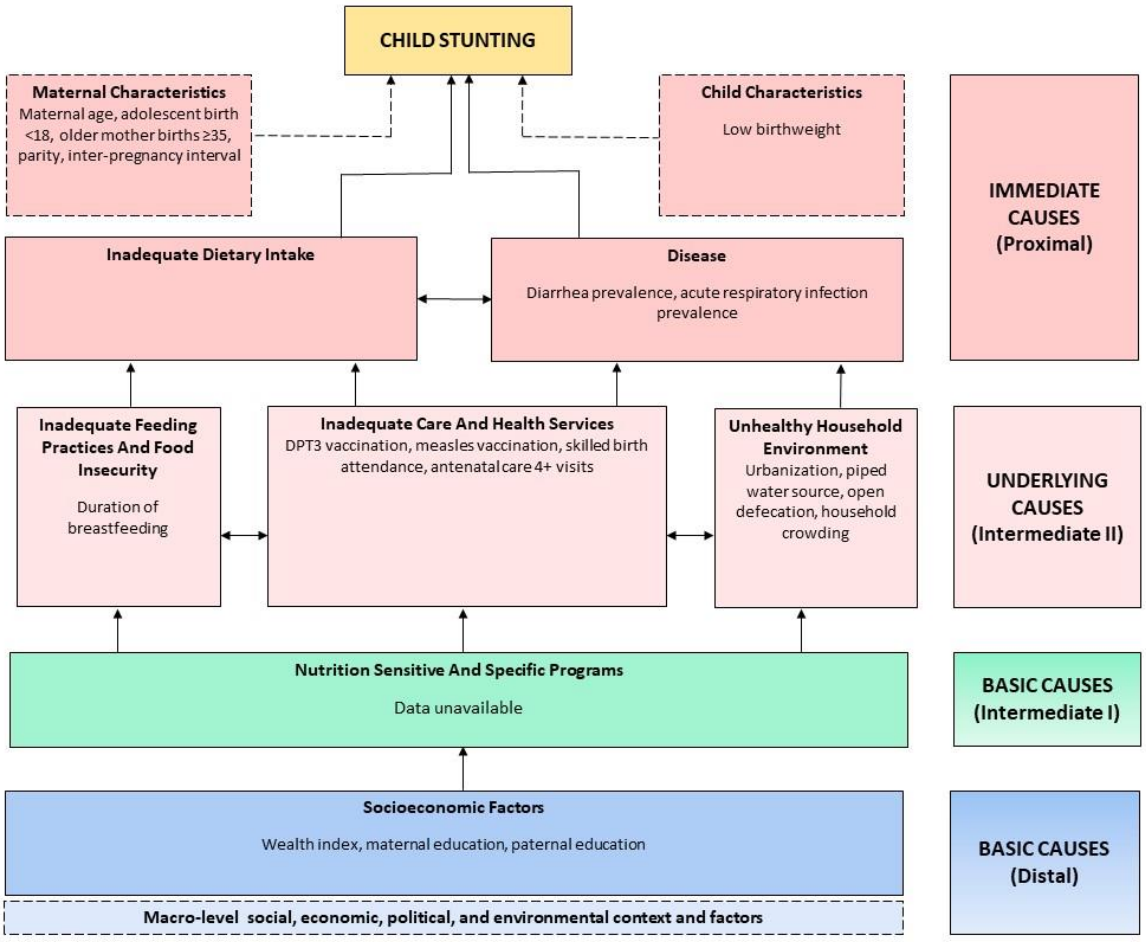


Figure 8: Conceptual framework showing distal, intermediate and proximal determinants of stunting

Note: Maternal height, maternal BMI, maternal anemia, and vitamin A supplementation have been removed from analyses as this data was not available in all survey rounds, particularly in the DHS 1992/93 and 2017. Complementary feeding and inadequate dietary intake variables (including: minimum dietary diversity, grains, legumes, dairy, flesh foods, eggs, vitamin A rich fruits and vegetables, other fruit and vegetables) were considered for inclusion, however were only measured for the 6-23-month population; however this subgroup was not analyzed. The total mean HAZ change for the 6-23-month age group was too small for our model's results to be meaningful, and analysis resulted in a model with unstable results. Exclusive breastfeeding was also considered for inclusion, however it was only measured for the <6-month-old population, which was omitted from analysis due to small sample size.

2.3.5: Descriptive Analyses

Subnational analyses

Stunting estimates for subnational dimensions were calculated using standardized and well-established methods (32–34). Dimensions examined include wealth quintile, maternal education, area of residence and child gender. Wealth quintiles were derived from asset indices based on principal components analyses in a survey level. The scores were then broken into five quintiles, with the lowest quintile (Q1) representing the poorest 20%, and the highest quintile (Q5) richest 20%. Maternal education was classified as none, primary, or secondary education and higher. Area of residence was defined as rural or urban, and child gender estimates were obtained for boys and girls. Estimates accounted for survey design and weighting.

We also calculated the Slope Index of Inequality (SII) and Concentration Index (CIX) to measure absolute and relative socioeconomic inequalities, respectively. Indicators of relative inequality measure the degree of unfairness between extreme wealth groups (relative to one another) and absolute measures quantify the actual gap between the richest and poorest and thus the required effort to close it (35,36). Estimated from logistic regression models of the cumulative distribution of the asset index (x-axis) plotted against the stunting prevalence (y-axis), the SII and CIX are weighted for population size and take into account any changes in the ordinal categories of the socioeconomic marker (e.g. differentials between wealth quintiles 2, 3 and 4). The difference in predicted values of the highest and lowest quintile (Q5 - Q1) generate each of the SII and CIX (37). Positive values indicate higher stunting prevalence among the wealthy, negative values suggest stunting is greater among the poor, and values of 0 suggest no difference between the richest and poorest populations. The SII and CIX presented in this study range from -100 to +100. All equity analyses accounted for survey design and weighting.

To explore within-department stunting variation, we obtained 5x5 km area stunting estimates as produced by the Institutes of Health Metrics and Evaluation (IHME) (38). The IHME used all available Senegal DHS and other survey datasets incorporated into Bayesian spatial models to generated posterior predicted prevalence of stunting. The model draw strength from covariables, years, and locations where data is available. General details on these methods have been previously published (39–41).

Annual rates of change

We calculated province-level stunting prevalence across all survey years to examine geospatial stunting patterns. Estimates accounted for survey design and weighting. Subsequently, province-level average annual % point change in stunting (AARC) were estimated through ordinary least square regression models, whereby stunting prevalence was regressed on survey year for the following periods: 1992/93-2017, 1992/93-2005, and 2005-2017. Regional performance was determined by ranking the model β estimate or AARCs and assessing statistical significance of p-values. These are interpreted as the *actual* average annual change in stunting prevalence. We also calculated compound annual growth rate (CAGR) formula to assess *relative* change (decline) in stunting prevalence over time for each region.

Multivariable Analyses

We undertook two sets of hierarchical multivariable analyses as discussed below. Using complementary approaches, each of these analyses attempts to answer the same research question i.e. what are the main predictors of change in child linear growth in Senegal during 1992/93-2017? The linear regression based on panel datasets uses a difference-in-difference analysis framework where time*covariable interactions are used to assess factors impacting HAZ decline. This allows the

analysis of multiple years of survey data and adjusts for baseline levels of covariables and varying hypothesized growth trajectories through the interaction term. The Oaxaca-Blinder decomposition is based on the same set of individual/household level data (with ecological variables). However, by design, the decomposition only uses two survey time points in a given analysis and thus "ignores" in-between survey rounds and any intermittent fluctuations in the predictors. As has been suggested in previous decomposition analyses, we operationalize child HAZ as the linear growth outcome due to its greater statistical efficiency relative to the dichotomous child stunting variable. Each of the two multivariable regression-based analysis methods pose their own strengths and limitations – however, as sensitivity analyses, study inferences should be anchored in both and congruent findings between the methods strengthen the key messages.

2.3.6: Linear Multivariable Regression (Difference-in-Difference Analysis)

We undertook linear multivariable regression analyses, and included all covariables and adjustment factors as fixed effects. We added interaction terms between each potential determinant and time (i.e. time*covariable interaction terms), which signify whether a change in a proposed predictor of HAZ leads to a change in HAZ over the studied time period. The four cross-sectional surveys used in this analysis were assembled into panel datasets, and difference-in-difference (DID) analyses were used. Univariate statistics were estimated using means/standard deviations and frequencies/proportions as appropriate. We used the interaction estimators in unadjusted and adjusted regression methods to estimate the DID effect. The general model specification included an interaction term between time and the various indicators. The multivariable regression models were adjusted for child age, sex and region. Effect estimates were reported with 95% confidence intervals. All statistical analyses were performed using Stata version 14.0. The complex sampling design of DHS surveys was taken into account by using the STATA's svyset function. Standard errors were estimated using the Taylor series linearization method, which incorporates sampling weight, primary sampling unit, and stratum appropriate to the DHS sample design.

To examine the association between HAZ and various indicators, we conducted a series of step-wise linear regression models. A hierarchical modelling approach using distal, intermediate and proximal level variables was executed as suggested by Victora 1997 (30) to generate the final multivariable models. Variables within each level were selected from our general conceptual framework as defined in Figure 8. Step 1 was a series of bivariate regressions to determine crude associations between indicators in our conceptual framework and HAZ outcome. Step 2 was to use all candidate variables for multivariable model building (i.e. with p-value ≤0.20) irrespective of their direction to move forward for multivariable modeling. Selected variables are entered into backward stepwise elimination modeling within their respective levels and those with p-values <0.15 are retained. At each step, the crude and adjusted associations between the indicator and HAZ was analyzed for statistical significance. Multicollinearity among adjustment variables was evaluated using variance inflation factors (VIF) where VIF>3 were considered suspect for collinearity.

2.3.7: Kernel Density Plots and Victora Curves

HAZ Kernel Density Plots

The distributions of HAZ scores for Senegalese children under the age of 5 were plotted using Kernel density plots. These plots produce smooth curves which estimate the probability density function of the continuous variable HAZ. Each plot displays four curves using data from the 1992/93 DHS, 2000 MICS, 2005 DHS and 2017 DHS. This allows us to observe the change in mean and kurtosis of child HAZ distributions.

Victora Curves
Child growth curves, or *Victora* curves, display predicted child HAZ from smoothed local polynomial regressions that have been plotted against child age. We plotted four curves using data from the four surveys with a 95% confidence interval band around each. These curves allow for the examination of the growth faltering process from birth to 5 years of age among Senegalese children.

Victora Curve Splines
To assess the functional form of HAZ over the first 60 months of life, raw values of HAZ were regressed on child age using kernel-weighted local polynomial smoothing. Expected values of HAZ were generated for each of the five countries at two time points and plotted against child age. For ease of interpretation, piecewise linear splines were fitted to the polynomial curves with knots corresponding to major changes in gradient occurred. Optimal knot placement was determined based on visual inspection of the plotted curves. Predicted values of HAZ at each month from 0 to 60 were obtained using linear combinations of the beta coefficients for each spline and the predicted value of HAZ at the previous knot (or the model intercept in the case of the first spline) as follows:

$\boldsymbol{0 \leq\ m \leq k_1}$**:**

1) $$\propto\ +(m *\ \beta_{s1})$$

$\boldsymbol{k_1 + 1 \leq\ m \leq k_2}$:

2) $$\propto\ +(k_1 *\ \beta_{s1}) + ((m - k_1) * \beta_{s2})$$

$\boldsymbol{k_2 + 1 \leq\ m \leq k_3}$:

3) $$\propto\ +(k_1 *\ \beta_{s1}) + \big((k_2 - k_1) * \beta_{s2}\ \big) +\ ((m - k_2) * \beta_{s3})$$

...

$\boldsymbol{k_n \leq\ m \leq 60}$:

4) $$\propto\ +(k_1 *\ \beta_{s1}) + \big((k_2 - k_1) * \beta_{s2}\ \big) +\ \big((k_3 - k_2) * \beta_{s3}\big) + \cdots + ((m -\ k_n) *\ \beta_{sn})$$

where:
$\propto$ = model intercept
β = slope for linear spline
s = splines 1 to n
k = values of knots 1 to n
m = month of age

For months (m) 0 to k1 (the value of the first knot), the predicted value of HAZ was computed as the mean value of HAZ at 0 months of age (α) plus the horizontal distance from the intercept to m (m - 0) multiplied by the beta coefficient for the first slope (βs1) (Equation 1). For months k1+1 to k2 (the value of the second knot, if present), the predicted value of HAZ at month m was computed in the same manner, except this time using the beta coefficient for the second slope (βs2), the distance between m and the previous knot (m – k1) and a derived intercept for the second slope (i.e. the predicted value of HAZ at k1 given by Equation 1 when m = k1) (Equation 2). This process was repeated for values along the third slope (if present) and so forth until the final slope beginning at the last knot value (kn) (Equation 4). Lines connecting the predicted values of HAZ at 0-60 months were overlaid onto the original polynomial curves for visual comparison.

2.3.8: Oaxaca-Blinder Decomposition

We also undertook the commonly used Oaxaca-Blinder decomposition methods (11,42) to assess determinants of nutritional change over time in Senegal. These methods based on individual-level data have high statistical power and have been widely used to assess nutrition determinants in low and middle income settings (10–12,43).

We analyzed individual-level data from four rounds of Senegal's DHSs: 1992/93, 2005, and 2017, as well as the 2000 MICS. Our analysis focused on the index mother-child pair from each survey round. Defined as the youngest child of the youngest mother in each household, selection of an index pair simplifies the model and interpretation, and is common practice in advanced analysis of DHS datasets. The total number of index pairs available from each survey were n=1840, n=4225, n=1355, and n= 5076 for DHS 1992/93, MICS 2000, DHS 2005, and DHS 2017, respectively. A flow chart outlining sample size breakdown during the index pair selection process is presented in Appendix 4. Given that the dietary needs/practices and growth trajectories of children in the first 1000 days of life vary notably from children beyond 2 years of age, it has been suggested that these two cohorts be analyzed separately to unmask true effects of environmental conditions and other factors on undernutrition. We conducted analyses for the entire under-5 year child population, the 24-59 month child population, and the 6-23-month population (44). There was an insufficient sample size in the <6-month population which prevented us from analyzing this age group. The 6-23-month population had too small a change in HAZ, thus rendering the results of analysis not meaningful. Thus, only the decomposition results for the under-5 and 24-59-month populations are presented.

We used the continuous formulation of HAZ (as opposed to categorical stunting) as the dependent outcome to strengthen statistical power of the analyses. Linear least square regression models - accounting for survey design and weights - were used to assess associations between $\boldsymbol{y_{i,t}}$, our outcome variable measured for a child *i* at time *t*, a vector of time-varying determinants (**X**), time-invariant child age and sex control variables (**C**), and a survey round time variable (**T**) to capture any trend effects. Collectively, with the standard error term, the model is expressed in Equation 1.

$$\boldsymbol{Y_{i,t}} = \boldsymbol{\beta}\, \boldsymbol{X}_{i,k} + \boldsymbol{C}_i + \boldsymbol{T} + \varepsilon_{i,t} \qquad \text{[Equation 1]}$$

The conceptual framework and corresponding list of covariables, their data sources, and definitions used in decomposition assessment are included in Appendix 5. Applying the conceptual framework, we used a similar hierarchical modelling approach (as described for DID analysis) whereby we examined the distal, intermediate, and proximal level determinants of HAZ.

Equation 1 was applied to derive β coefficients for determinants (DHS 1992/93 – DHS 2017). To explain the relative contribution of each covariable over time to HAZ change, we used the Oaxaca-Blinder decomposition under the assumption that the β coefficients are the same across the two populations and the error term has the mean zero. Using the estimated parameters from Equation 1 and the (weighted) means of explanatory variables in the two time points, we applied Equation 2 (e.g. for years 1992/93 to 2017) to obtain the predicted change in HAZ due to the change in each determinant (33).

$$\Delta\bar{Y}_{i,t} = \beta \ \left(\bar{X}_{2017} - \bar{X}_{1992/93}\right)$$

The product coefficients for individual determinants were subsequently ranked to identify the relative contribution of each factor to HAZ change. Like determinants were also grouped into broader domains for interpretation. We examined variance inflation factors (VIF) to assess multicollinearity between variables whereby a VIF > 3 was considered suspect of high inter-variable correlation. For model building, a p-value <0.20 was considered statistically important and variables with p< 0.15

were retained in the final hierarchical multivariable models. All analyses were carried out in Stata version 14.0.

2.4: Qualitative Inquiry Processes

The qualitative component of the case study aimed to understand the drivers of stunting reduction among children in Senegal through exploring the perspectives of key national stakeholders in the development and implementation of relevant policies and programs, the experiences of community health workers and mothers in the community. Specific qualitative research objectives included:

1) To explore nutrition-specific and –sensitive key events (policies/strategies/programs/guidelines) in Senegal that may have contributed to a reduction in child stunting;
2) To identify important contextual factors that have functioned as enablers/drivers and barriers to reduction of stunting in Senegal; and
3) To document community-level insight and experiences on the stunting transition in Senegal from community/volunteer health workers and mothers of young children.

The conceptual framework (Figure 7) by Black et al., informed the development of an adapted framework (Figure 8), the design of the in-depth interview and FGD guides, as well as analysis and interpretation of the qualitative data. Our qualitative data collection tools were also informed by existing literature and nutrition questionnaires; for example, the International Food Policy Research Institute's nutrition-focused qualitative data collection toolkit was consulted and relevant tools were adapted to our research objectives as appropriate. Data was analyzed using key themes including: basic causes, underlying causes, and immediate causes of reduction in stunting and malnutrition.

2.4.1: Qualitative Research Design

We undertook three independent research activities to inform study objectives. At the first stage, national stakeholders were interviewed to provide insight and expertise on objectives 1 and 2. This top-down approach aimed to solicit macro-level perspectives and experiences in health and nutrition in Senegal. All the experts were interviewed in Dakar, where main administrative structures and institutions are located. To understand how individuals in the community received and implemented major nutrition-specific and –sensitive policy/program events and their experiences in the nutritional transition as a whole, we consulted childcare workers in the community (e.g. at schools, health facilities, etc.) and the mothers of these children. These latter two research activities largely informed objectives 2 and 3, but also shed light on objective 1.

Sampling and Recruitment Strategy
Participants were identified and selected using purposive sampling strategies (45), including snowballing sampling (46). National stakeholders were purposively selected due to their involvement in the design, implementation, monitoring or evaluation of nutrition-specific or –sensitive policies and programs (Table 6). Key informants were asked to identify and refer the research team to other individuals with knowledge and expertise in the area of nutrition, policy, and stunting reduction. Participants were recruited by phone and a follow-up email was sent to request their participation in the study. Community health workers were purposively selected based on their experiences of working in communities for over five years, delivering primary health services, including nutrition-related services for communities. Community health workers also identified mothers of children born between 1992 to 1997 and 2012 to 2017. In the visited localities, the mothers of the different generations were identified thanks to the actors of the health system and mainly, the community health actors (health community workers).

Table 6: Inclusion Criteria

Type of Stakeholder	Inclusion Criteria
National Stakeholders	• Key informants with extensive experience in and knowledge of design, implementation and evaluation of nutrition-specific and –sensitive policies and programs in Senegal. Examples include: national policymakers (e.g., Ministry of Health, Ministry of Gender, etc.), bilateral/multilateral organization (e.g., UNICEF, WHO), international/local NGOs (e.g., Hellen Keller International, Action Against Hunger).
Regional Stakeholders	• Paid/voluntary community stakeholders in Louga, Diourbel or Kaolack regions. Examples include: teacher, imam, chair of community health posts, traditional Chief, community health worker, midwives and local NGO representative.
Mothers in Communities	• Mothers of children born in 1992-1997; • Mothers of children born 2012-2017; and • Currently living in Louga, Diourbel or Kaolack regions.

Semi-structured with regional respondents and focus group interviews with mothers were conducted in three regions: Louga, Diourbel and Kaolack. These three regions were selected based on their geographic location, ability to capture urban and rural perspectives, as well as the substantial progress made in these regions to reduce stunting among children. Focus communities were purposively selected, using convenience sampling. One rural and urban community was randomly selected within each focal region, and two FGDs were conducted in each. These sampling strategies helped to ensure that a range of diverse perspectives at national and community levels were captured. According to the 2013 population census, population estimates by region include: Diourbel (1,497,455), Kaolack (960,875) and Louga (874,193) and these regions represent the 3rd, 4th and 6th most populated regions respectively (47).

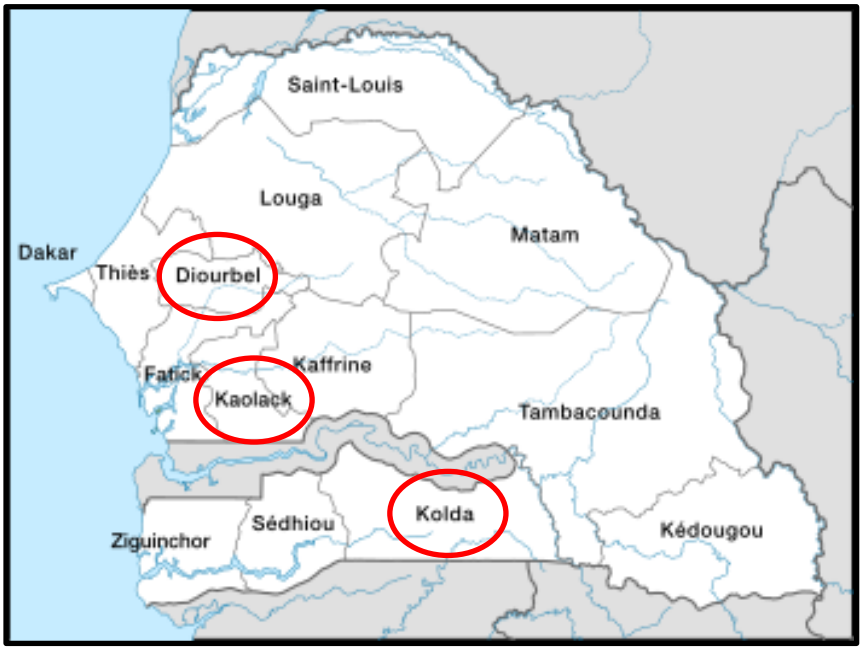


Figure 9: Regional map of Senegal displaying study sites for subnational key informant interviews and focus group discussions.

2.4.2: Research Methods

In-Depth Interviews
Firstly, 21 interviews were conducted with experts in Dakar. These experts were officials from the Malnutrition Control Cell (the main structure dedicated to the fight against malnutrition), from ministries directly or indirectly concerned by the issues of reducing malnutrition, including the Ministry of Health and experts from the specialized agencies of the Nations, international NGOs as well as professors of pediatrics at the University, active or retired. These individuals were purposively selected based on their expertise in nutrition, health and other sectors.

Secondly, 20 interviews were conducted in the three regions of Louga, Diourbel and Kaolack. These interviews targeted resource persons with several functions: nursery school teachers, health staff (doctors, nurses, midwives, community health workers, treasurers of health committees), NGO workers serving as implementation for anti-malnutrition programs, imams, and village chiefs. Interviews were conducted in both urban and rural areas. In each of the three regions, two interviews with resources persons (e.g., nurse, community health worker, kindergarten teacher, local NGO representative, etc.) were conducted in rural areas and two in urban areas.

Focus Group Discussions
Thirdly, 12 focus groups discussion were organized, with four groups per region. In each region, two focus groups were held with mothers who gave birth between 1992 and 1997 and 2 focus groups with younger women who gave birth between 2012 and 2017.

Data Analysis
Data generated during focus group discussions, and semi-structured interviews were analyzed using the UNICEF Nutrition Framework (30), Lancet Nutrition framework (48), and the adapted framework for the country case studies (Figures 1 & 2). These conceptual frameworks guided the qualitative analysis and interpretation of key determinants and contextual factors, as well as facilitators and barriers to nutrition-specific and –sensitive events. The qualitative analysis explored distal/basic causes (e.g., GDP, education, political context), nutrition-sensitive and -specific programs, underlying causes (e.g., inadequate feeding practices, and food insecurity, inadequate care and health services and unhealthy environment), and proximal/immediate causes (e.g., maternal characteristics, inadequate dietary intake, disease, and child characteristics). Responses from national, regional and mothers at community level were analyzed separately. Thematic analysis was conducted to explore key themes that emerged based on stunting determinants including socioeconomic status (e.g., living conditions), migration, hygiene and sanitation, and nutrition and eating behaviours.

All interviews were audio recorded with permission from research participants. Interviews were conducted in French, transcribed for analysis and translated into English. All in-depth interviews and FGDs were conducted by a team of four interviewers.

2.5: Nutrition Policy/Program Timeline and Financing Analysis

We assembled a timeline of key nutrition-specific and –sensitive policies and programs in Senegal through an iterative approach drawing several of the above methods. Starting with a desk review of literature identified through our systematic approach, a suggested timeline was proposed by the Senegal study Principal Investigator and research team members. This timeline was shared with expert stakeholders to obtain their corroboration and insight on any missing initiatives. After reviewing additional literature and specific policy/program documents as suggested by experts, a second iteration of the timeline was proposed. This process ensued until consensus was reached between country experts and the Senegal research team.

A similar multi-pronged data collection and corroboration exercise was undertaken to track financial data linked to the nutrition policy and program timeline. The aim was to tag a dollar amount to financial allocations/actual disbursements and budgets/expenditures of the various programs, policies, interventions and other initiatives. The scan for financial commitments and spending spanned many sectors, including government, development partners, NGOs, others as applicable.

Chapter 3: Results – Quantitative Analysis

3.1: Subnational Variation Over Time

Stunting prevalence in Senegal declined remarkably between 1992/93 and 2017 (Figure 10). Stunting for the under-5-year-old population in Senegal was 25.0% in 1992/93, falling to 17.7% by 2005, 17.2% in 2015/16, and down to 15.0% by 2017. Although national stunting prevalence has reduced significantly, geographic disparities do exist, with some areas of the country making more gains than others. Additionally, 5x5 km geospatial maps reveal important disparities within provinces and districts in Senegal (Appendix 9).

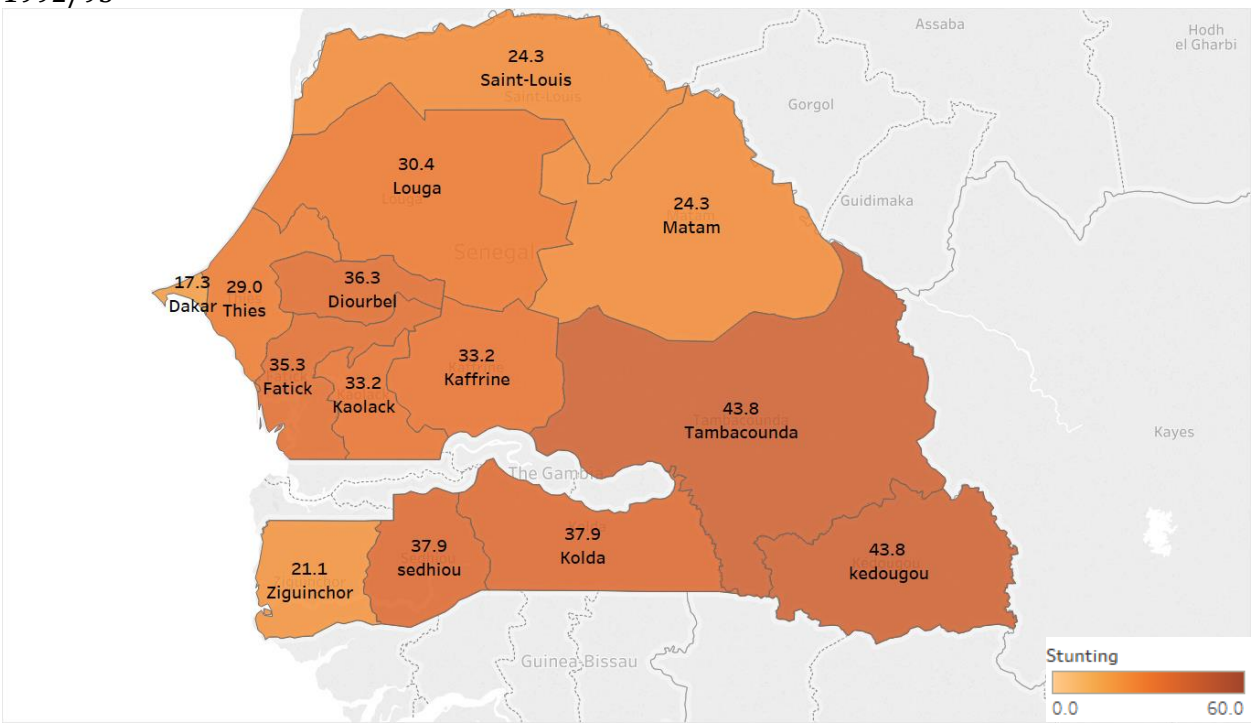
Senegal is divided into 14 regions with varying stunting prevalence. In 1992/93, the two easternmost regions had the highest stunting prevalence, at 43.8% for both Tamacounda and Kedougou. Seven regions had a stunting prevalence of over 30%, while four had a stunting prevalence of over 20%. Only one region, Dakar, had a stunting prevalence of under 20%, though it was still rather high at 17.3%. The discrepancy between the region with the highest and lowest stunting prevalence was 26.5%.

By 2000, stunting had declined in eight regions, remained the same in two regions, and rose in the remaining four regions. The regions with the highest prevalence were Sedhiou and Kolda, in the south of Senegal, where 38.9% of children under-5 were stunted. Three regions had stunting prevalence below 20%, including Thies (18.8%), and Saint-Louis and Matam (both: 16.5 %). The gap between highest and lowest prevalence narrowed slightly to 22.4%.

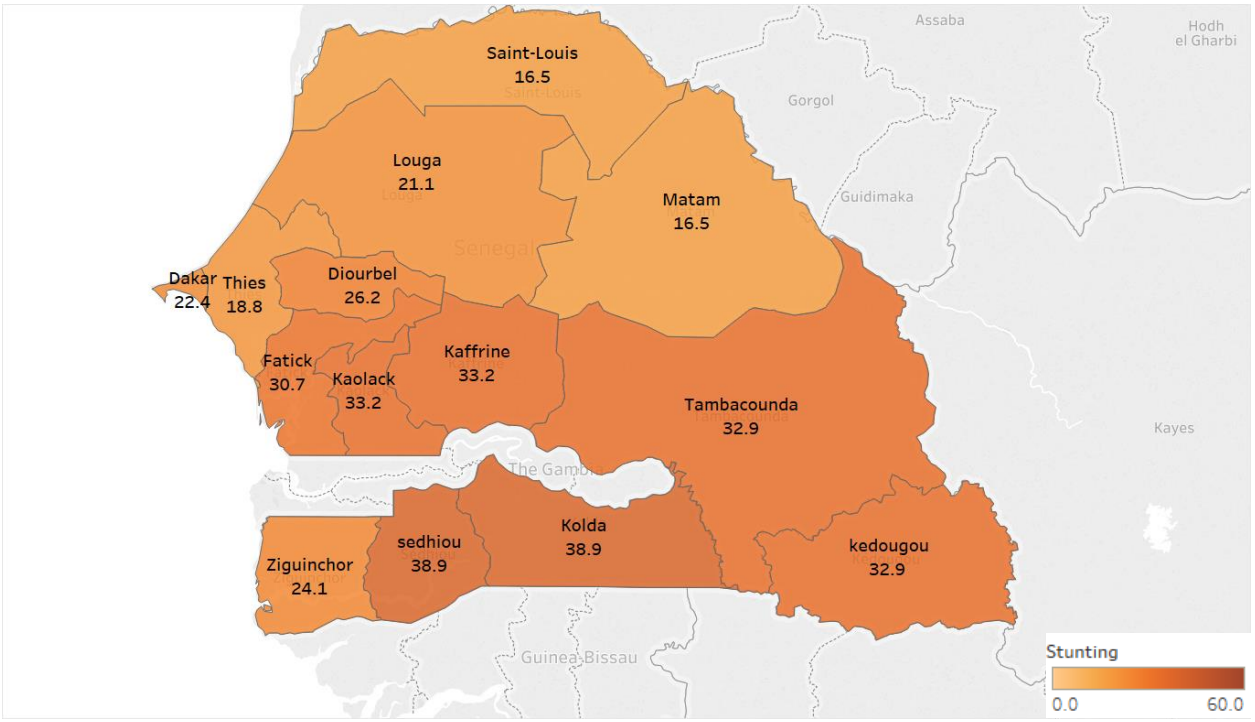
Five years later, in 2005, 12 regions experienced declines in stunting prevalence, with most of the declines occurring in the westernmost regions. Two regions in the north of Senegal experienced increases in stunting prevalence over this period of time: Saint-Louis (28.5%) and Matam (24.1%). Kolda and Sedhiou remained the regions with the highest prevalence, and both declined slightly to 38.3% of under-5 children stunted. Dakar had the lowest stunting prevalence, and was the only region to have a prevalence of below 10%.

By 2017, only five regions had a stunting prevalence of over 20%. Kolda (31.6%) was the only province with a stunting prevalence of over 30%, while Sedhiou (28.8%), Kedougou (26.6%), Tambacounda (26.0%), and Kaffrine (25.7%) comprised the remaining of the top 5 regions. Dakar remained the region with the lowest prevalence at 7.0%. The other westernmost regions continued to have the lowest stunting prevalence, with Thies (12.7%), Fatick (13.6%), Diourbel (14.8%) the regions with the lowest stunting prevalence after Dakar.

1992/93


Assaba
Hodh el Gharbi
Gorgol
Guidimaka
Kayes
Saint-Louis
Louga
Matam
Dakar
Thies
Diourbel
Fatick
Kaolack
Kaffrine
Tambacounda
Kolda
sedhiou
Ziguinchor
kedougou
24.3
30.4
24.3
17.3
29.0
36.3
35.3
33.2
33.2
43.8
37.9
37.9
21.1
43.8
Guinea Bissau
Stunting
0.0
60.0

2000


Assaba
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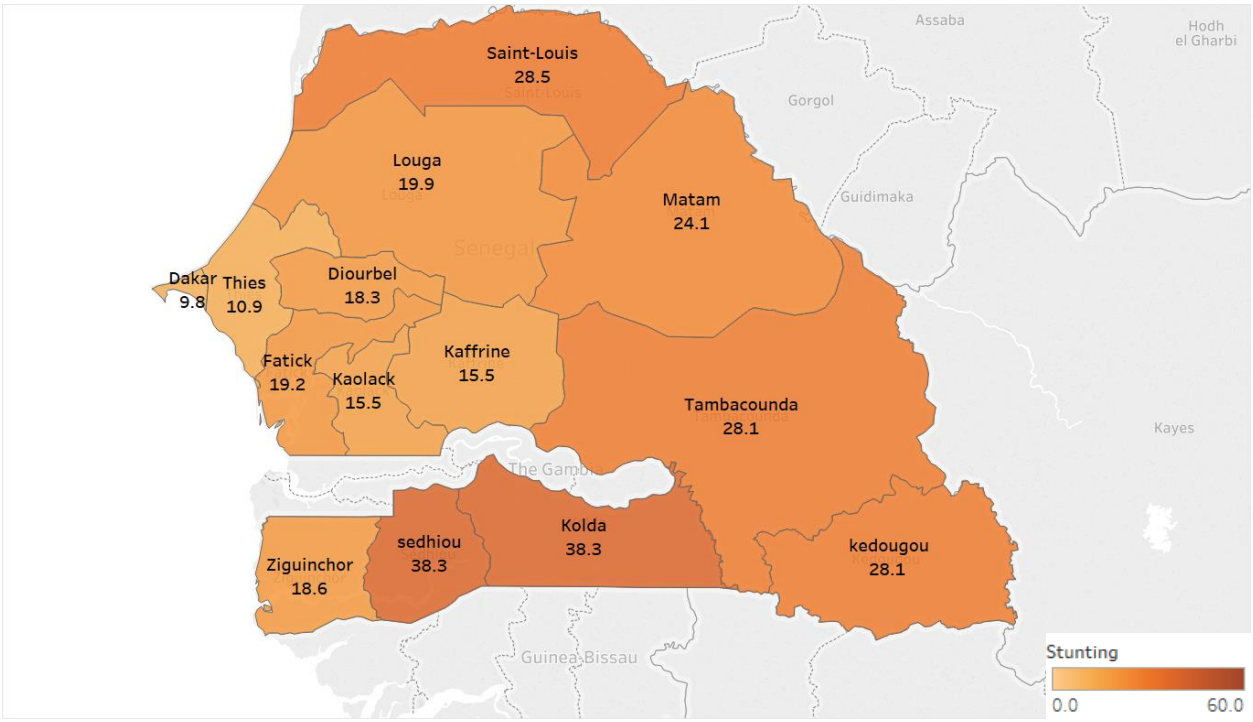
Dakar
Thies
Diourbel
Fatick
Kaolack
Kaffrine
Tambacounda
Kolda
sedhiou
Ziguinchor
kedougou
16.5
21.1
16.5
22.4
18.8
26.2
30.7
33.2
33.2
32.9
38.9
38.9
24.1
32.9
Guinea Bissau
Stunting
0.0
60.0

2005



2017

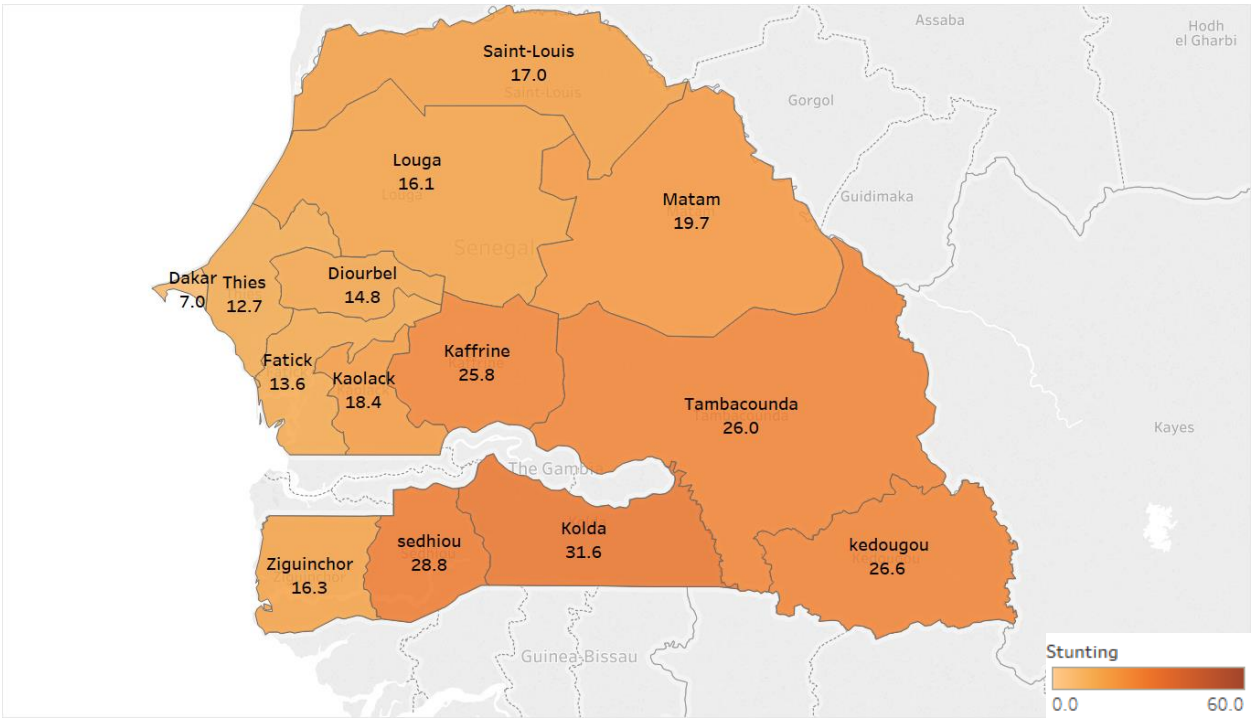


Figure 10: Stunting estimates for children under-5 years old

Table 7 and Figure 11 depict the average annual rate of change in stunting prevalence by region through the years 1992/93 to 2017. The region that performed the best was Diourbel which had an AARC of -0.9, followed closely by Fatick with an AARC of -0.8. Tambacounda and Thies each had an AARC of -0.7, followed by Kadougou and Louga (AARC -0.6, both), Kaolack (AARC -0.5), Sedhiou, Dakar and Kolda (AARC -0.4 each), and Kaffrine (AARC -0.3). The lowest performing regions were

Saint Louis, Ziguinchor, and Matam which each had an AARC of -0.2. Figure 11 depicts the AARCs in visual form, with Diourbel having the greatest AARC, while Matam has the lowest AARC.

Table 7: Prevalence and average annual rate of change of stunting among under-5 children, 1992/93 – 2017

Region	1992/93	2017	Stunting		
			AARC*	S.E.	p-value
Matam	24.3	19.7	-0.002	0.001	0.117
Ziguinchor	21.3	16.2	-0.002	0.002	0.354
Saint louis	24.3	17.5	-0.002	0.001	0.040
Kaffrine	33.1	25.1	-0.003	0.001	0.035
Kolda	38.1	30.7	-0.004	0.001	0.002
Dakar	17.4	7.3	-0.004	0.001	0.000
Sedhiou	38.1	26.9	-0.004	0.001	0.002
Kaolack	33.1	18.8	-0.005	0.001	0.001
Louga	29.9	15.7	-0.006	0.001	0.000
Kadougou	43.8	27.7	-0.006	0.002	0.001
Thies	29.0	12.8	-0.007	0.001	0.000
Tambacounda	43.8	26.1	-0.007	0.002	0.000
Fatick	34.8	14.1	-0.008	0.002	0.000
Diourbel	36.3	14.7	-0.009	0.002	0.000

* Average annual rate of change
Note: estimates for regions in earlier years were estimated from their pre-separation regions

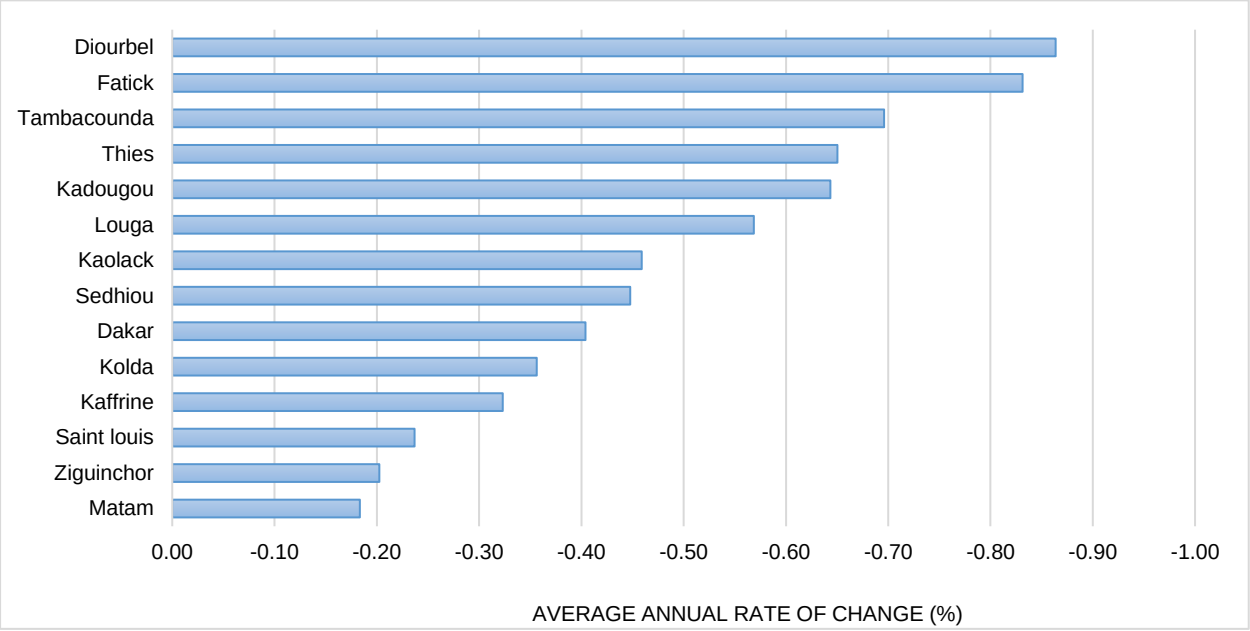


Figure 11: Average annual rate of change of stunting among under-5 children, region ranking 1992/93 – 2017

Table 8 and Figure 12 show the AARC in stunting prevalence for children under-5 between 1992/93 and 2005. For this time period, the changes in stunting prevalence are not uniformly

decreases, as four regions experienced increased stunting prevalence. The four regions with stunting increases were Sedhiou, Kolda (AARC 0.0 each), Matam, and Saint-Louis (AARC 0.2 each). The four regions with the largest stunting declines were Thies, Diourbel, Kaffrine, and Kaolack, each with an AARC of -1.4. Figure 12 is a visual representation of the average annual rate of change for this time period, by region.

Table 8: Prevalence and average annual rate of change of stunting among under-5 children, 1992/93 – 2005

Region	1992/93	2005	Stunting		
			AARC*	S.E.	p-value
Saint louis	24.3	26.8	0.002	0.003	0.482
Matam	24.3	26.8	0.002	0.003	0.482
Kolda	38.1	38.3	0.000	0.003	0.960
Sedhiou	38.1	38.3	0.000	0.003	0.960
Ziguinchor	21.3	18.5	-0.002	0.005	0.647
Dakar	17.4	9.8	-0.006	0.002	0.018
Louga	29.9	19.9	-0.008	0.003	0.023
Fatick	34.8	19.2	-0.012	0.005	0.013
Tambacounda	43.8	28.1	-0.012	0.004	0.003
Kadougou	43.8	28.1	-0.012	0.004	0.003
Kaolack	33.1	15.5	-0.014	0.003	0.000
Kaffrine	33.1	15.5	-0.014	0.003	0.000
Diourbel	36.3	18.2	-0.014	0.004	0.003
Thies	29.0	10.9	-0.014	0.002	0.000

* Average annual rate of change
Note: estimates for regions in earlier years were estimated from their pre-separation regions

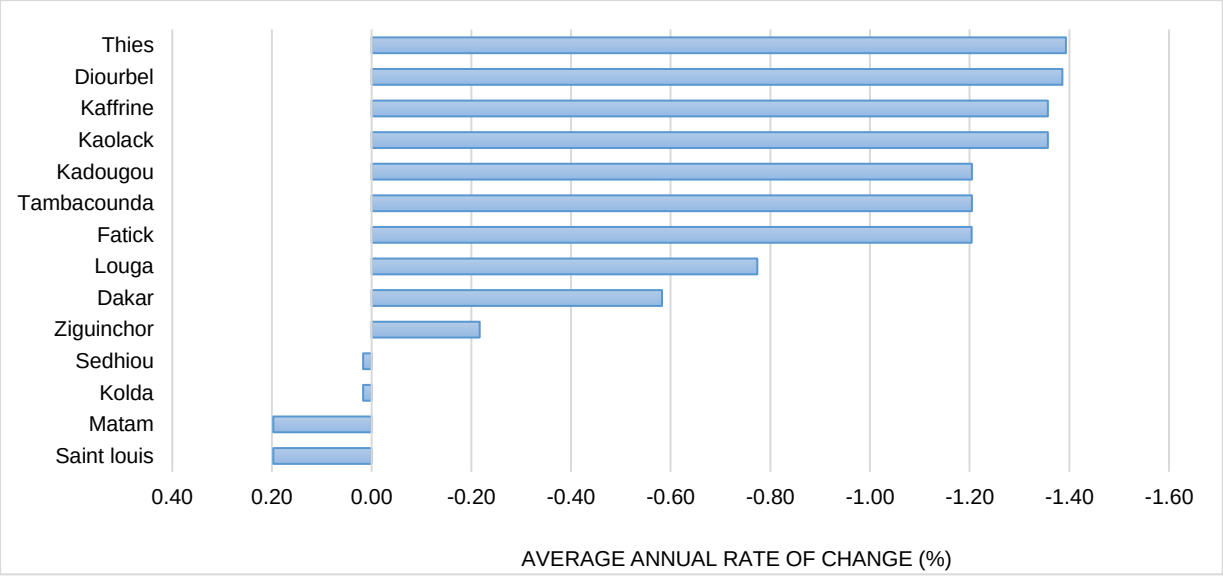


Figure 12: Average annual rate of change of stunting among under-5 children, region ranking 1992/93 - 2005

Table 9 and Figure 13 depict the AARC in stunting prevalence for the time period from 2005 to 2017. Three regions had stunting increases over this time period, and these were regions that had

large decreases in stunting prevalence from 1992/93 to 2005. These three regions were: Thies (AARC 0.2), Kaolack (AARC 0.5), and Kaffrine (AARC 0.8). The three regions with the largest declines in stunting over this time period were Sedhiou, which had an AARC of -1.0, followed by Saint Louis (AARC -0.9), and Kolda (AARC -0.8). A visual representation of the average annual rates of change by region is depicted in Figure 13.

Table 9: Prevalence and average annual rate of change of stunting among under-5 children, 2005 - 2017

Region	2005	2017	Stunting		
			AARC*	S.E.	p-value
Kaffrine	15.5	25.1	0.008	0.003	0.004
Kaolack	15.5	18.8	0.005	0.002	0.024
Thies	10.9	12.8	0.002	0.002	0.378
Kadougou	28.1	27.7	0.000	0.003	0.912
Tambacounda	28.1	26.1	-0.001	0.003	0.648
Ziguinchor	18.5	16.2	-0.002	0.003	0.562
Dakar	9.8	7.3	-0.002	0.002	0.391
Diourbel	18.2	14.7	-0.003	0.003	0.359
Louga	19.9	15.7	-0.003	0.003	0.279
Matam	24.1	19.7	-0.004	0.005	0.428
Fatick	19.2	14.1	-0.004	0.003	0.196
Kolda	38.3	30.7	-0.008	0.003	0.023
Saint louis	28.5	17.5	-0.009	0.004	0.013
Sedhiou	38.3	26.9	-0.010	0.004	0.010

* Average annual rate of change
Note: estimates for regions in earlier years were estimated from their pre-separation regions

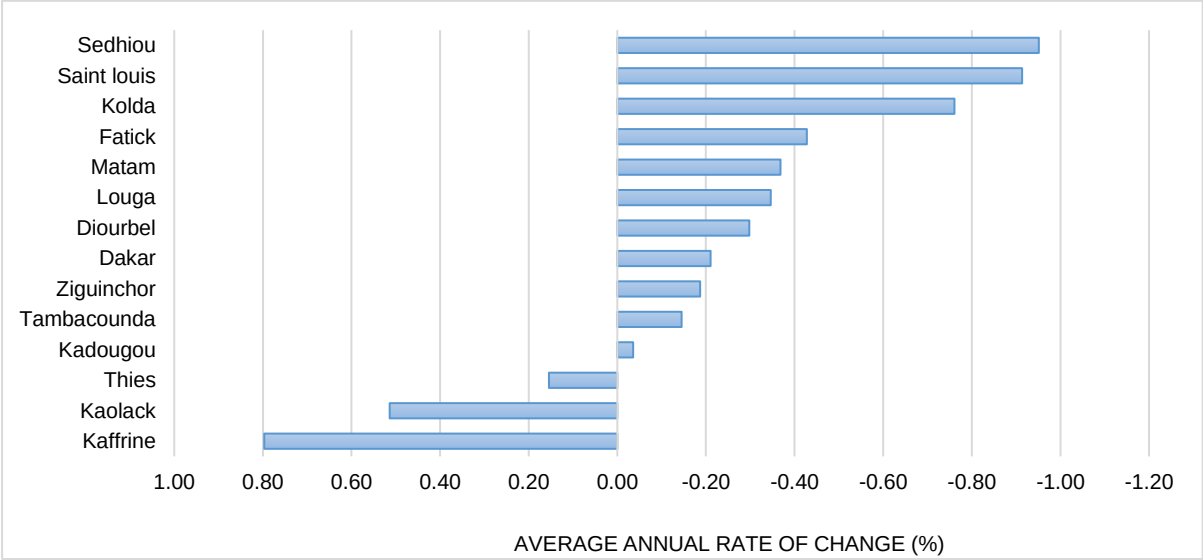


Figure 13: Annual rate of change of stunting among under-5 children, region ranking 2005 - 2017

Table 10 and Figure 14 show the compound annual growth rate (decline), which is the annual change in the percentage of stunting among under-5 children by province. Fatick had the largest

annual reduction in stunting with a CAGR of -3.7. Diourbel had the next largest annual reduction in stunting (CAGR -3.70), followed by Dakar (CAGR -3.6), Thies (CAGR -3.4), Louga (CAGR -2.7), Kaolack (CAGR – 2.3), Tambacounda (CAGR -2.1), Kadougou (CAGR -1.9), and Sedhiou (CAGR -1.4). The five regions with the smallest annual reductions in stunting were Saint Louis, with a CAGR of -1.4, Kaffrine (CAGR -1.2), Ziguinchor (CAGR -1.1), Kolda (CAGR -0.9), and finally Matam (CAGR -0.9). Figure 14 shows the CAGR visually by region. Fatick has the largest CAGR, followed very closely by Diourbel, while Matam has the lowest.

Table 10: Prevalence and compound annual growth rate (decline) of stunting among under-5 children, 1992/93 - 2017

Province	1992/93	2017	CAGR*
Matam	24.3	19.7	-0.87
Kolda	38.1	30.7	-0.90
Ziguinchor	21.3	16.2	-1.12
Kaffrine	33.1	25.1	-1.16
Saint louis	24.3	17.5	-1.35
Sedhiou	38.1	26.9	-1.44
Kadougou	43.8	27.7	-1.89
Tambacounda	43.8	26.1	-2.13
Kaolack	33.1	18.8	-2.33
Louga	29.9	15.7	-2.65
Thies	29.0	12.8	-3.36
Dakar	17.4	7.3	-3.57
Diourbel	36.3	14.7	-3.70
Fatick	34.8	14.1	-3.71

* Compound annual growth rate
Note: estimates for regions in earlier years were estimated from their pre-separation regions

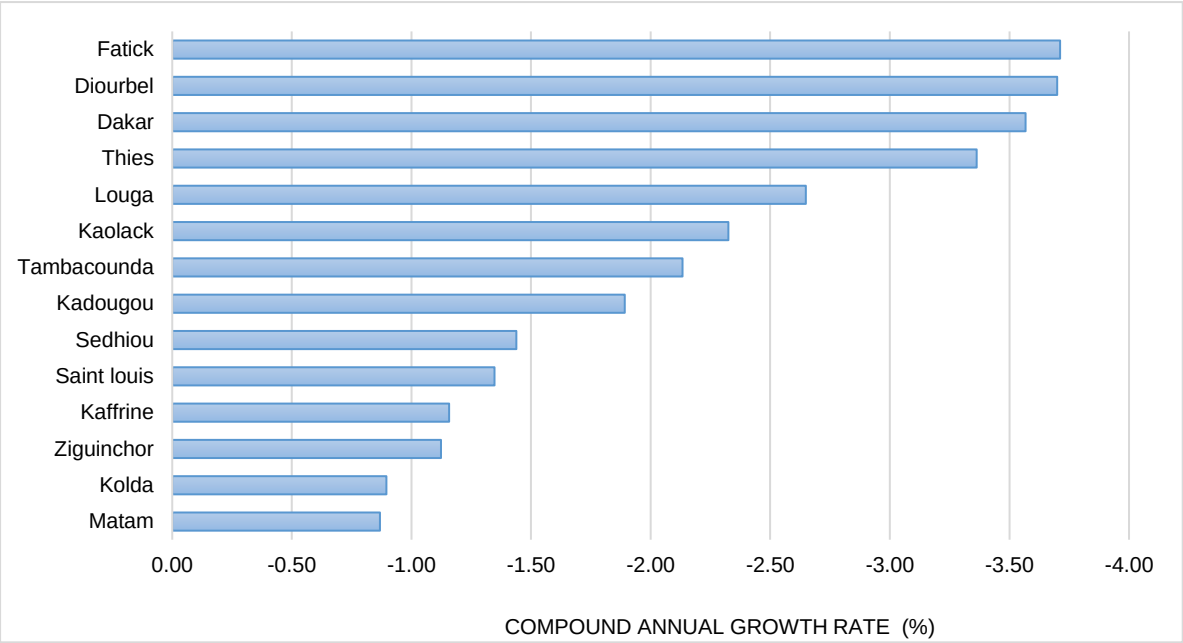


Figure 14: Compound annual growth rate (decline) of stunting among under-5 children, region ranking 1992/93 - 2017

Table 11 and Figure 15 depict the CAGR of stunting from 1992/93 to 2005. Over this time period, the three regions with the greatest declines in stunting were Thies (CAGR -7.8), Kaffrine, and Kaolack (CAGR -6.1 each). Four regions had increases in stunting over this time period: Sedhiou, Kolda (CAGR 0.1 each), Matam, and Saint Louis (CAGR 0.8 each). Figure 15 depicts the compound annual growth rates by region for this time period. Ten provinces had declines in stunting, while four had increases.

Table 11: Prevalence and compound annual growth rate (decline) of stunting among under-5 children, 1992/93 - 2005

Region	1992/93	2005	CAGR*
Saint louis	24.3	26.8	0.84
Matam	24.3	26.8	0.84
Kolda	38.1	38.3	0.05
Sedhiou	38.1	38.3	0.05
Ziguinchor	21.3	18.5	-1.18
Louga	29.9	19.9	-3.36
Tambacounda	43.8	28.1	-3.62
Kadougou	43.8	28.1	-3.62
Dakar	17.4	9.8	-4.67
Fatick	34.8	19.2	-4.85
Diourbel	36.3	18.2	-5.56
Kaolack	33.1	15.5	-6.14
Kaffrine	33.1	15.5	-6.14
Thies	29.0	10.9	-7.82

* Compound annual growth rate

Note: estimates for regions in earlier years were estimated from their pre-separation regions

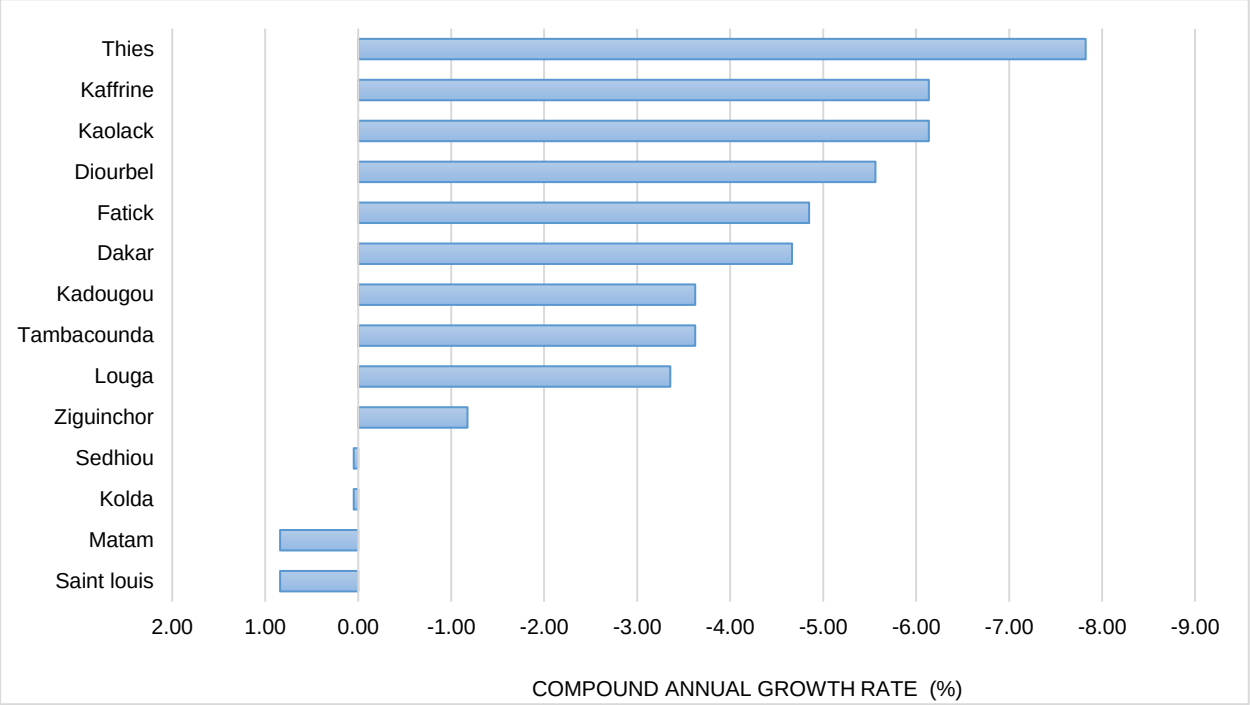


Figure 15: Compound annual growth rate (decline) of stunting among under-5 children, region ranking 1992/93 - 2005

The compound annual growth rate for children under-5 between 2005 and 2017 is depicted in Table 12 and Figure 16. There were three regions that had increases in stunting over this time period, and these were Thies (CAGR 1.4), Kaolack (CAGR 1.8), and Kaffrine (CAGR 4.5). These three regions had the greatest decreases in stunting over the previous time period between 1992/93 to 2005. The three provinces with the greatest declines in stunting between 2005 and 2017 were Saint Louis (CAGR -4.3), Sedhiou (CAGR -3.2), and Fatick (CAGR -2.8). The remaining regions also had declines in stunting over this time period. Figure 16 depicts the CAGR by province, and shows Kaffrine as the region with the greatest increase in stunting, while Saint Louis has the greatest decrease.

Table 12: Prevalence and compound annual growth rate (decline) of stunting among under-5 children, 2005 - 2017

Region	2005	2017	CAGR*
Kaffrine	15.5	25.1	4.47
Kaolack	15.5	18.8	1.79
Thies	10.9	12.8	1.43
Kadougou	28.1	27.7	-0.14
Tambacounda	28.1	26.1	-0.68
Ziguinchor	18.5	16.2	-1.17
Matam	24.1	19.7	-1.82
Diourbel	18.2	14.7	-1.96
Kolda	38.3	30.7	-1.99
Louga	19.9	15.7	-2.11
Dakar	9.8	7.3	-2.68
Fatick	19.2	14.1	-2.79
Sedhiou	38.3	26.9	-3.16
Saint louis	28.5	17.5	-4.32

* Compound annual growth rate
Note: estimates for regions in earlier years were estimated from their pre-separation regions

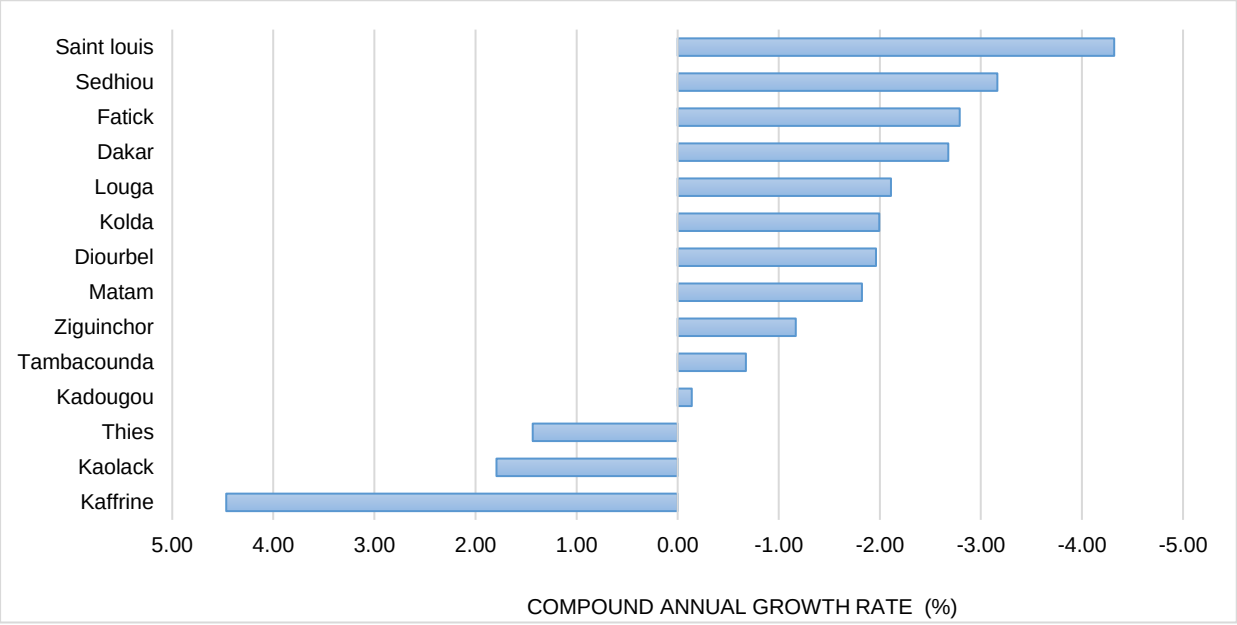


Figure 16: Compound annual growth rate (decline) of stunting among under-5 children, region ranking 2005 - 2017

3.2: Stunting Equity Analyses by Dimension and Over Time

We disaggregated national stunting prevalence into important subnational populations and examined reductions in inequalities over time. We discuss inequalities by wealth quintile, maternal education, urban vs rural residence, child gender, and double disaggregation by wealth and residence (Figures 17-21). The absolute numbers of stunted children in each group are included in Appendix 10.

Wealth Quintile: Stunting prevalence was disproportionately high for the poor in Senegal, and decreased with each subsequent wealth quintile. This was true for each of the four studied years. The gap in stunting prevalence between the poorest and richest wealth quintiles was 19.6% points in 1992/93, and 20.8% points in 2017, indicating that not only are the disparities not diminishing with time, they are in fact becoming more pronounced. Stunting prevalence for the poorest wealth quintile decreased by 8.8% points in the 25 studied years, while stunting prevalence for the highest wealth quintile declined by 10.1% points. The middle wealth quintile experienced the greatest reduction in stunting prevalence between 1992/93 and 2017, as prevalence declined by 16.9% points. Thus, not only are the wealthy experiencing lower prevalence of stunting, but they are also experiencing larger declines in stunting over time. Although stunting prevalence declined over the study period, the absolute number of stunted children in Senegal remained similar, due to an increase in the under-5 population size. The absolute number of stunted children varied greatly by wealth quintile, with the highest number of stunted children in the lowest wealth quintile for all studied years. An estimated 173,942 stunted children were in the lowest wealth quintile in 2017, while an estimated 27,279 stunted children were in the highest wealth quintile. (Appendix 10). ***Key takeaways:*** Stunting decline has occurred across all wealth quintiles from 1992/93 to 2017, however gaps between rich and poor have increased slightly over this time period, as the wealthy experience lower stunting prevalence and larger declines over time.

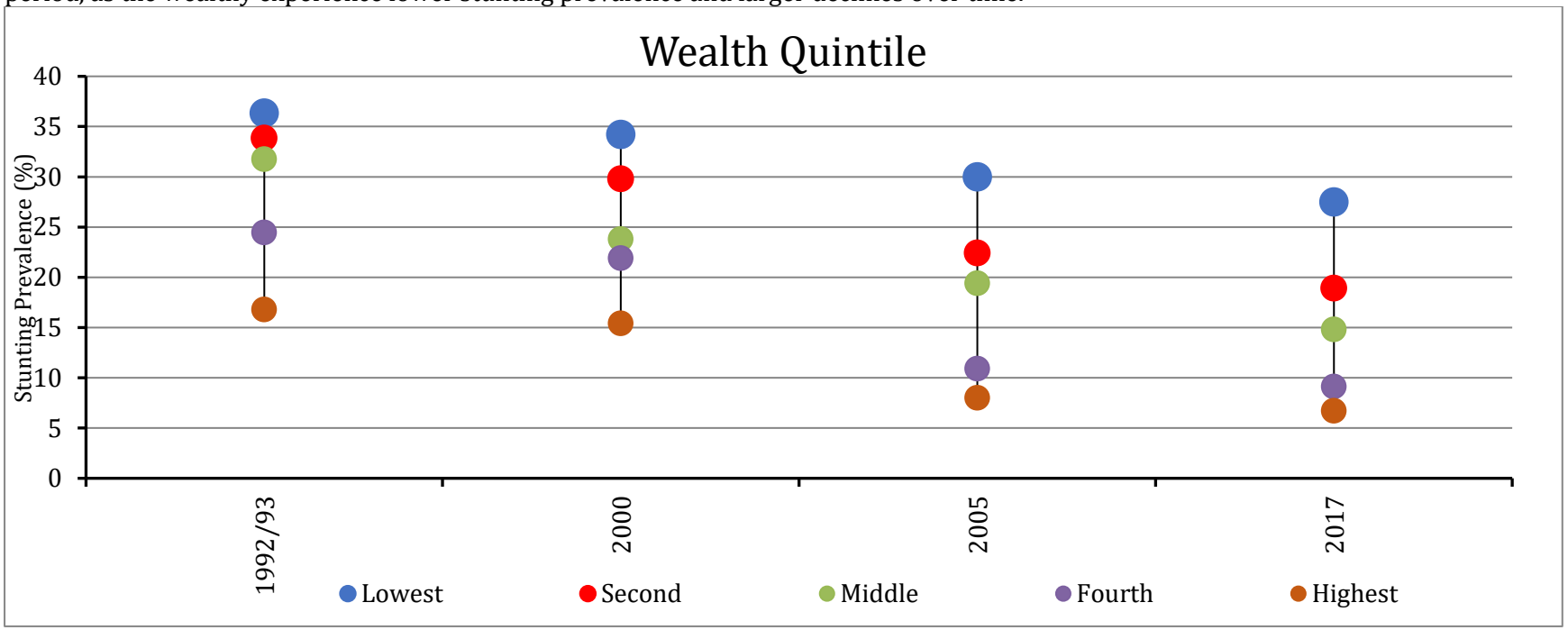


Figure 17: Stunting prevalence by wealth quintile 1992/93 – 2017

Maternal education: Stunting prevalence was consistently highest among mothers with no education, and lower for mothers with any level of education. The largest gap in stunting prevalence between mothers based upon education was in 1992/93 when mothers lacking an education had a 22.6%-point higher prevalence than mothers with a secondary or higher education. This gap narrowed to 8.5% points by 2017. The largest gains in stunting reduction over this 25-year period occurred among mothers lacking an education, as prevalence for this group declined by 13.5% points. Mothers with a secondary or higher education actually saw a slight increase in stunting prevalence by 0.6% points between 1992/93 and 2017. For all survey years, the absolute number of stunted children was far higher among mothers with no education, compared to those with primary, secondary, or higher educations. In 2017, mothers with no education had an estimated 310,215 stunted children, while mothers with primary level of education had 72,449 stunted children, and mothers with a secondary or higher level of education had 45,293 stunted children (Appendix 10). ***Key takeaways:*** Mothers with no education experienced more notable declines in stunting prevalence compared to those with any level of education; however, children of educated mothers consistently have lower stunting prevalence.

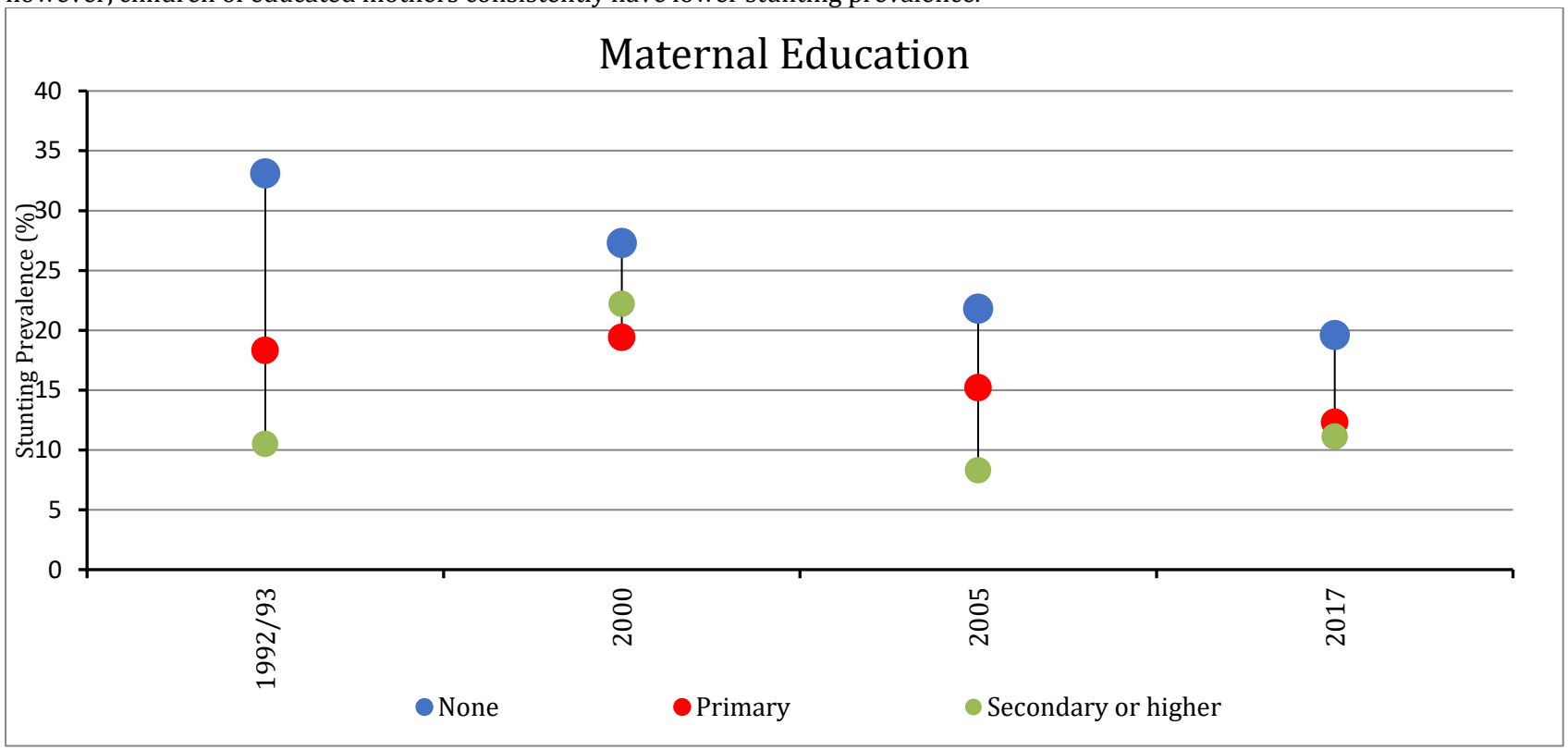


Figure 18: Stunting prevalence by maternal education 1992/93 – 2017

Residential area: Disparities between children living in urban and rural areas have existed for the entire study period, though they have declined in later years. In 1992/93, children living in rural areas experienced 16%-point higher stunting prevalence than did children living in urban areas. This gap narrowed to 10% points by 2017, which is an improvement, though stunting prevalence in rural areas remains double that of urban areas. Although there was a decrease in stunting prevalence for children in urban areas over the 25 years of study (decline by 9.2% points from 1992/93 to 2017), those living in rural areas experienced greater declines (15.3% points) over this same period. The disparities in stunting prevalence between urban and rural populations are also evident when comparing the absolute number of stunted children in each residential area. Throughout the studied years, the absolute number of stunted children remained noticeably higher in rural areas compared to urban ones, and in 2017, an estimated 332,067 stunted children lived in rural areas, while 95,889 lived in urban areas (Appendix 10). ***Key takeaways:*** Stunting prevalence was reduced for children living in both urban and rural areas. Though greater reductions occurred for children in rural areas, those living in urban areas consistently experience significantly lower stunting prevalence rates.

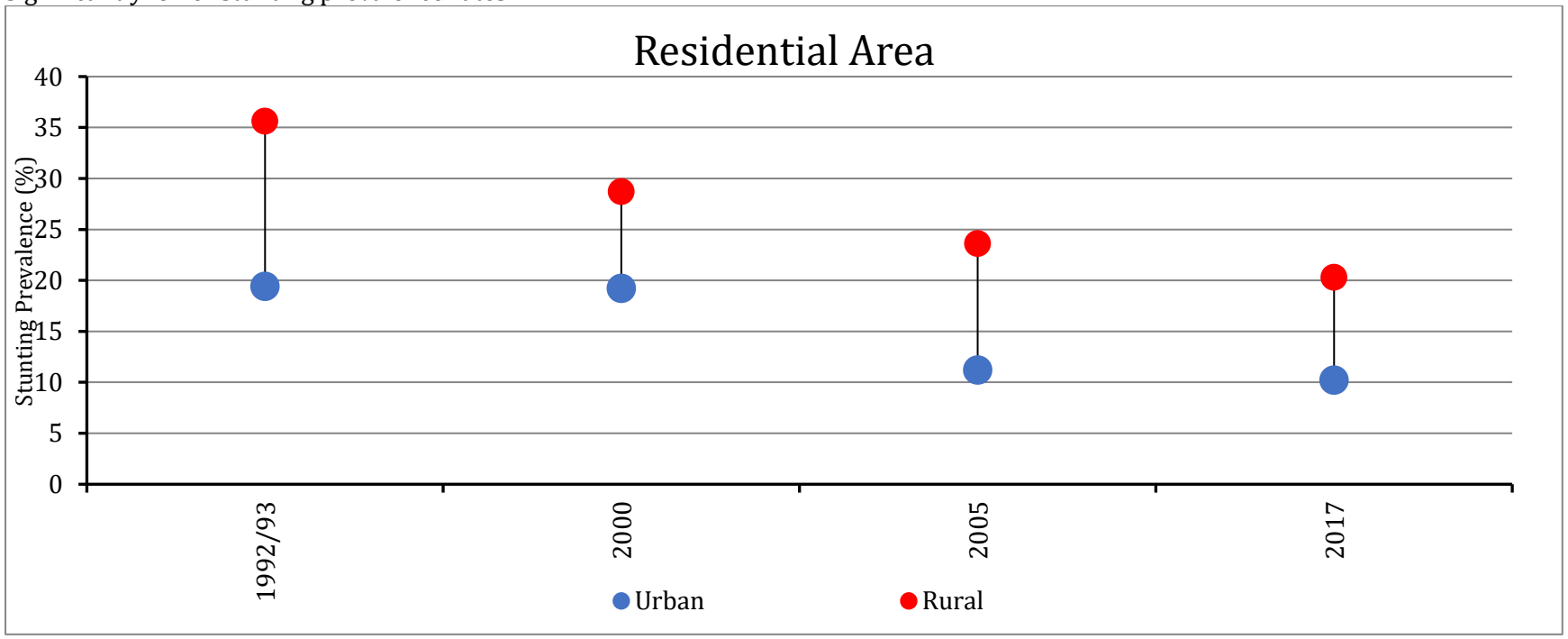


Figure 19: Stunting prevalence by residential area 1992/93 – 2017

Gender: Male children under-5 have consistently experienced slightly higher stunting prevalence in Senegal over the 25-year study period. The gap between stunting prevalence in male and female children has narrowed from 5.2% points in 1992/93 to 3.0% points in 2017. Overall, stunting prevalence has decreased steadily for all children, though male children had a slightly larger overall decline. Males experienced a 14.1%-point decline in stunting prevalence between 1992/93 while females experienced an 11.9%-point decline in this time. The absolute number of stunted male and female children is similar, though consistently, more males were stunted than females. In 2017, an estimated 187,139 stunted children were female, while 240,818 stunted children were male (Appendix 10). ***Key takeaways:*** Although gender disparities in stunting are not as prevalent as the other equity dimensions, they persist through the study period. Male children experienced higher rates of stunting than female children, though this gap has narrowed somewhat over the years.

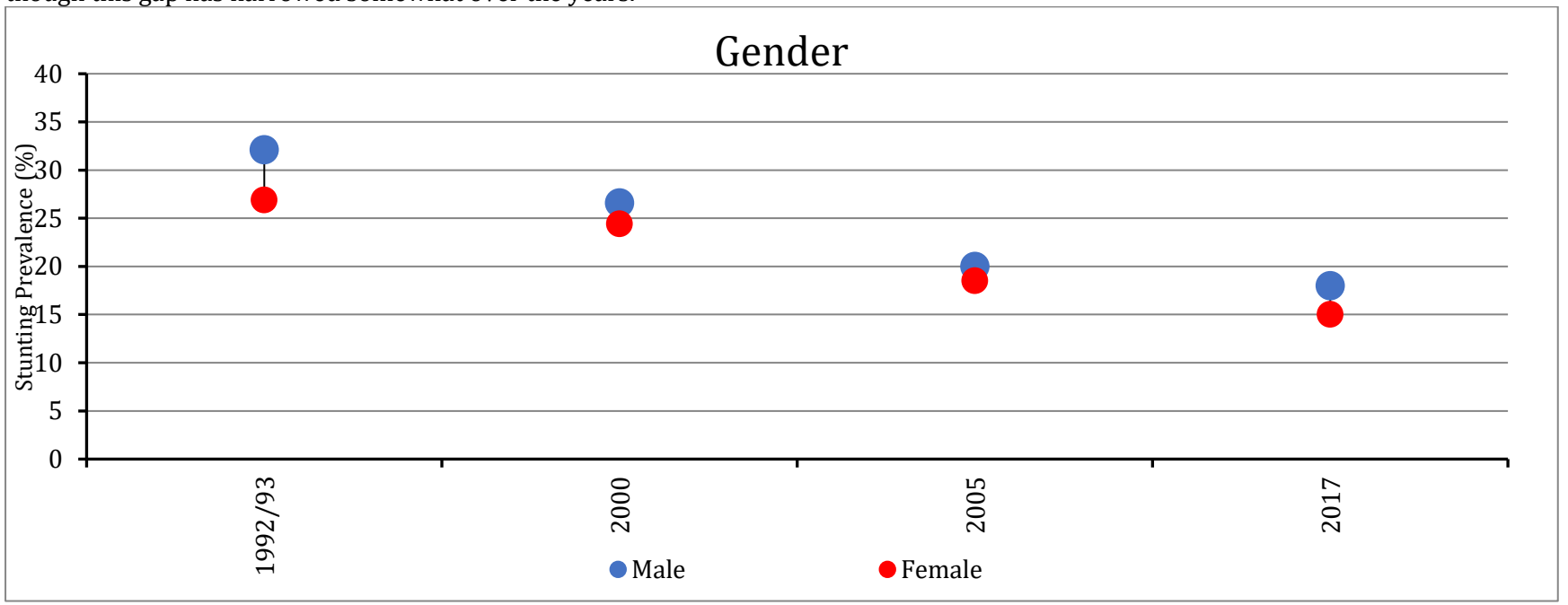


Figure 20: Stunting prevalence by gender 1992/93 – 2017

Double Disaggregation (Wealth vs Residence): In almost every year, the highest stunting prevalence was among the poorest children living in rural areas. The highest disparities in stunting prevalence between richest and poorest occur in rural areas, though disparities are increasing in urban areas over time. In 2017, stunting was lowest among the richest living in urban areas, while it was the highest among the poorest living in rural areas. ***Key Takeaway:*** Disparities in stunting prevalence by wealth quintile are more pronounced in rural areas compared to urban areas, with the highest stunting prevalence occurring among the rural poor.

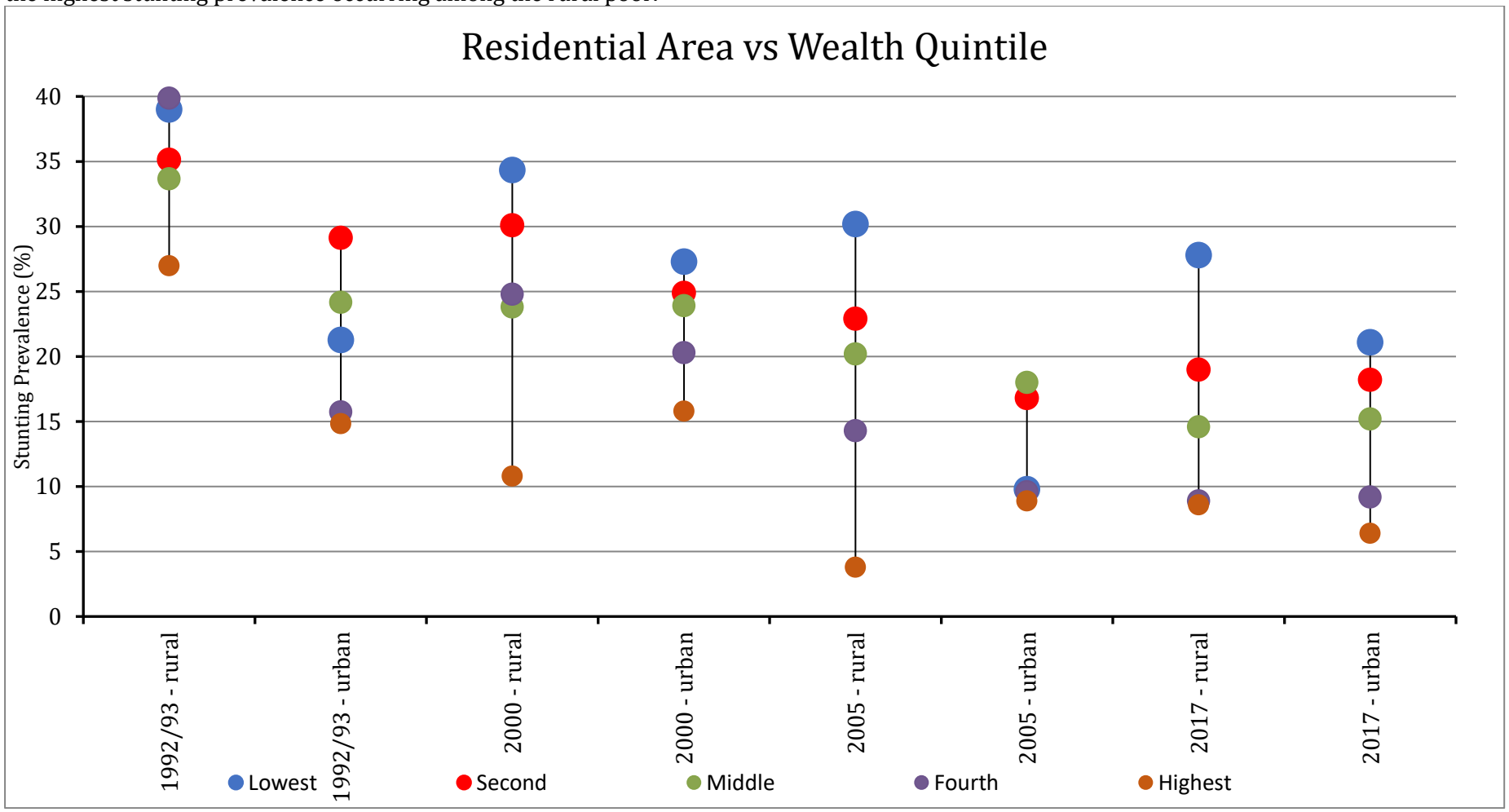


Figure 21: Stunting prevalence by residential area and wealth quintile 1992/93 – 2017

3.3: Stunting Equity: SII and CIX

Figures 22 and 23 present the slope index of inequality (SII) and the concentration index (CIX), respectively, over time to measure the extent of socioeconomic inequality in stunting burden in Senegal. As detailed in the methods, the SII measures absolute inequalities and the CIX measures relative inequalities – both are important for revealing the full picture of socioeconomic inequality. Relative inequalities measure the degree of unfairness between extreme wealth groups (relative to one another) and absolute inequalities quantify the actual gap between the richest and poorest and thus the required effort to close it (35,36). Conveying similar messages as those observed in the trends by wealth quintile (Figure 17), the SII and CIX use more of the wealth distribution and thus estimates are a more robust depiction of wealth inequality. Positive values indicate higher stunting prevalence among the wealthy, negative values suggest stunting is greater among the poor, and values of 0 suggest no difference between the richest and poorest populations. The SII and CIX presented in this study range from -100 to +100. Data were calculated for all survey years, and are presented below.

In terms of absolute inequalities (Figure 22), we observe a shift of SII from less negative to more negative values from 1992/93 to 2017. That is, from stunting being more prevalent in the poor and the gap between the rich and the poor becoming larger. This trend is not clear year over year, as SII meandered over the studied years and did not follow a general linear trend. In 1992/93, the SII gap was about -24 – indicating that the poorest populations had about 24 % point greater prevalence of stunting. Consequently, this is the gap that would need to be closed to achieve equality between the poorest and richest. From 1992/93 to 2017 the rich-poor gap increased by about 2% to about -26 by 2017. The largest discrepancy, however, is between 2005, when SII was at its highest point at -23, and 2005 when SII was lowest at -28. These findings suggest that larger reductions in stunting in Senegal were among the wealthiest segments of the population, and this may have been a strong contributor to the stunting decline in that period. There is room for improvement in terms of stunting reduction as a large rich-poor gap exists in Senegal.

Relative inequalities measure the comparative extent to which stunting prevalence is higher in the poorest vs richest populations. For example, in Figure 23, the relative ratio of stunting was 36.3%/16.8% = 2.2 times higher in the poorest populations in 1992/93; and this was increased to 27.5%/6.7% = 4.1 times in 2017. This change in relative inequalities is also reflected in the CIX values in Figure 23. Values over time fluctuated between -13 in 1992/93 to -27 in 2017, suggesting the relative rate at which the poorest are more undernourished than the richest is increasing over time (Figure 23).

In terms of the magnitude of inequalities, all SII values are alarmingly large and are generally increasing. CIX values being at -13 and increase to -27 across all years, which is suggestive that the relative differences between wealth groups is increasing with time.

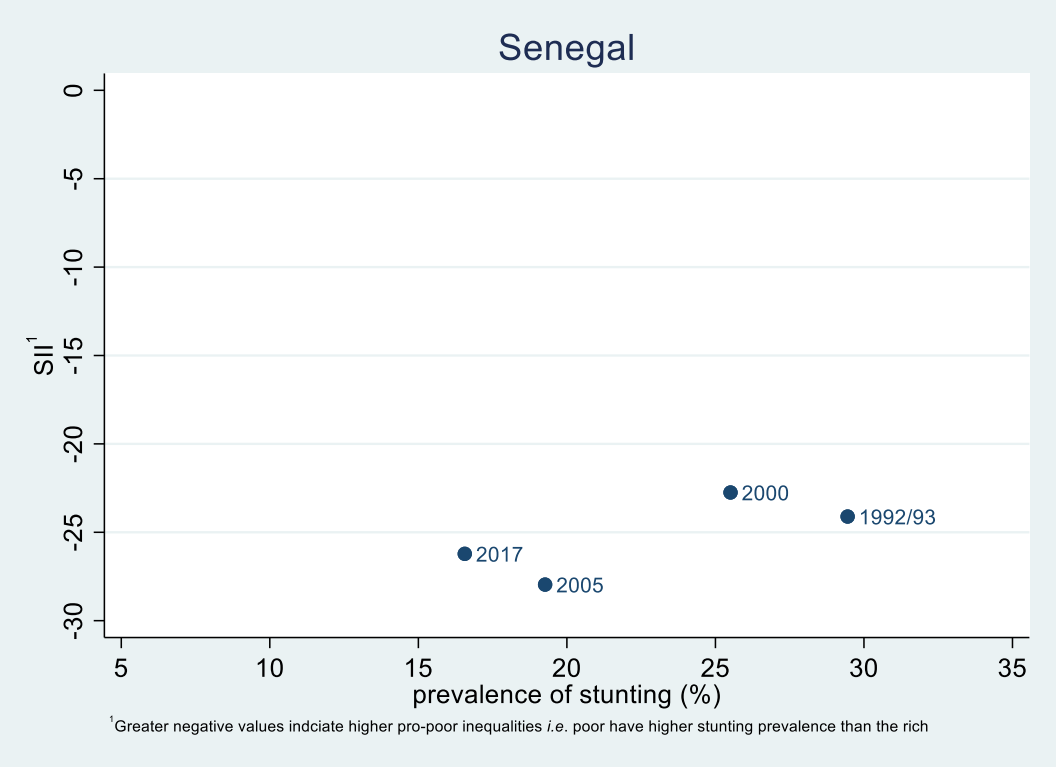


Figure 22: Change in absolute SII by year in Senegal

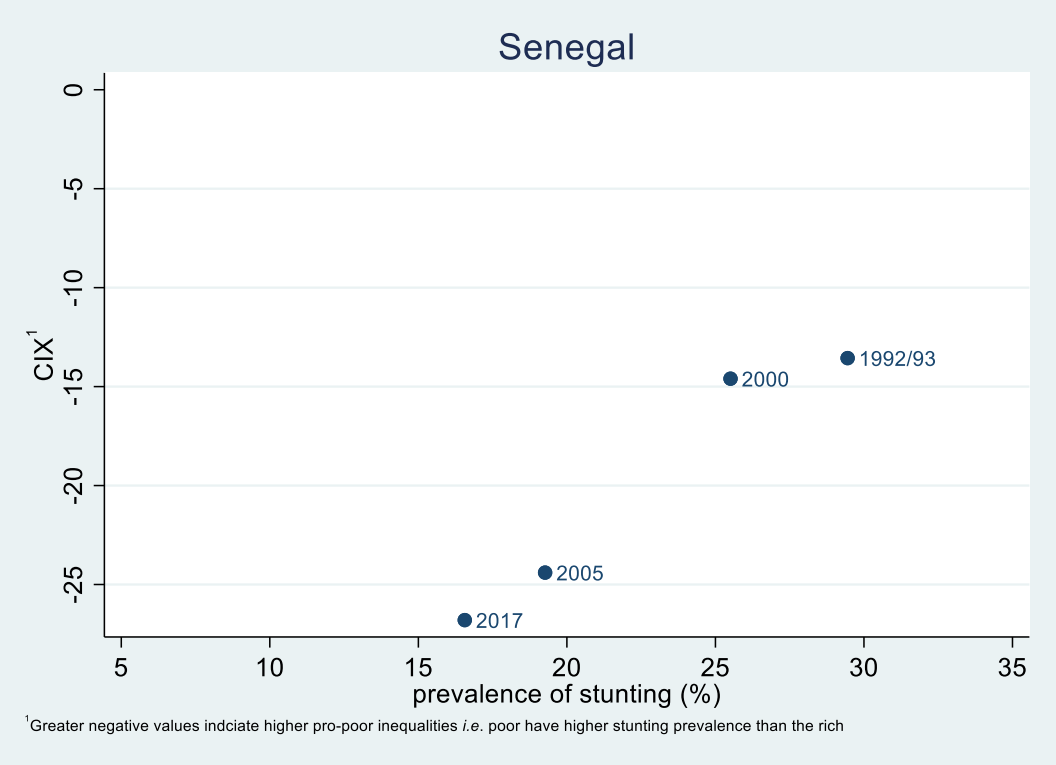


Figure 23: Change in relative CIX by year in Senegal

3.4: Intervention Equity Analyses by Dimension and Over Time

We disaggregated national prevalence of various essential interventions and child morbidities into important subnational populations and examined reductions in inequalities over time. We discuss inequalities by wealth quintile, maternal education, urban vs rural residence, child gender, and geographic region. Plots can be found in Appendix 11. Data were suppressed for categories of indicators that had fewer than 50 children in the sample size.

3.4.1: Breastfeeding

Breastfeeding interventions were analyzed through looking at early initiation of breastfeeding, exclusive breastfeeding, and duration of breastfeeding (Appendix Figures 6-20). Early initiation of breastfeeding rose steadily from 1992/93 to 2017. Disparities in wealth quintile, maternal education, residential area, and gender were minimal, especially compared to geographic region gaps. In 2017, the regions with the largest prevalence of early initiation of breastfeeding were Ziguinchor, and Kolda which reached approximately 70% prevalence. The regions with the lowest prevalence of early initiation of breastfeeding in 2017 were Dakar and Diourbel which had prevalence of about half of that at approximately 35%.

Exclusive breastfeeding rose dramatically from a prevalence of close to 0% in 1992/93 to around 40% by 2017. Minimal differences were found by residential area and gender. Discrepancies among wealth quintiles, maternal education levels, and geographic regions were largest in 2005, and were reduced by 2017. Children of mothers who were richer and with higher education levels had higher levels of exclusive breastfeeding. The districts with the highest levels of exclusive breastfeeding were Ziguinchor, Dakar and Thies.

Duration of breastfeeding was the indicator with the least variation among the three looking at breastfeeding. It declined from 14 months in 1992/93 to 11 months in 2017. There was little variation in duration of breastfeeding between wealth quintiles, residential area, and gender. In 2017, mothers with no education breastfed for longer than those with higher education levels. Mothers in Kolda breastfed the longest, while those in Ziguinchor breastfed for the shortest duration.

3.4.2: Child Morbidities

Diarrhea and acute respiratory infection incidence in the past two weeks were analyzed based upon the same subnational populations as the previous section (Appendix Figures 21-30). Diarrhea incidence decreased slightly from 1992/93 to 2017. In 2017, children in highest wealth quintile had the lowest incidence of diarrhea, while those in the lowest wealth quintile had the highest incidence. Mothers with higher levels of education had children with substantially lower incidence of diarrhea as compared to mothers at other education levels. Those living in urban areas had a lower incidence of diarrhea, while there was virtually no difference based upon gender. Diarrhea incidence varied greatly be geographic region. Dakar had an incidence below 10%, while in Fatick, incidence was nearly 30%.

ARI incidence declined by approximately 10% between 1992/93 and 2017. There was virtually no difference based upon residential area, and gender in 2017. Differences among the wealth quintiles and maternal education levels were minimal in 2017, though they did vary in 2005. Once again, the largest discrepancies were among the geographic regions. Like with diarrheal incidence, ARI

incidence was highest in Fatick, and reached over 30%. ARI incidence was lowest in Tambacounda, and reached around 5%.

3.4.3 Integrated Management of Childhood Illnesses

The Senegal DHS lacked complete information on some measures of integrated management of childhood illnesses (IMCI), thus we analyzed three indicators: diarrhea treatment seeking, oral rehydration therapy, and ARI treatment seeking (Appendix Figures 31-45). The first indicator, named diarrhea treatment seeking, shows the proportion of children for whom advice or treatment was sought, of the total number of children who had an episode of diarrhea. Minimal variation in diarrhea treatment seeking prevalence can be observed by residential area, and by gender. Disparities by wealth quintile are evident, though they have diminished somewhat between 1992/93 and 2017. Those in the highest wealth quintiles sought treatment for diarrhea at higher levels than did those in the lowest wealth quintiles. Mothers with higher education had higher prevalence of diarrhea treatment seeking, though the disparities diminished with time. There were consistent discrepancies in diarrhea treatment seeking by geographic region, with residents of Ziguinchor seeking diarrhea treatment at the highest rates for all three studied years.

The following set of plots details the proportion of children who received oral rehydration salts (ORS), of the total number of children under-5 who had diarrhea in the past two weeks. ORS provision increased over the studied time period, and did not have much variation by dimension, as compared to other interventions studied. Differences in ORS provision by gender, residential area, and maternal education were minimal in 2017. Some differences can be observed in the wealth quintiles, with the lowest levels of ORS provision to children living in the lowest wealth quintiles. Variation exists by geographic region as well, as Ziguinchor had the highest proportion of children receiving ORS following an episode of diarrhea, while Diourbel had the lowest proportion.

ARI treatment seeking varied greatly by all equity dimensions, save gender. People living in the highest wealth quintiles sought ARI treatment at much higher rates than did those in the lowest wealth quintile, and disparities between rich and poor have been growing since 1992/93 until 2017. ARI treatment seeking among mothers with higher education reached a prevalence of over 90% in 2017, while prevalence was under 50% among mothers with no education. Prevalence was notably higher among urban residents compared to rural residents, and this gap widened with time. Finally, disparities among geographic regions were clearly present, as people living in Dakar sought treatment for ARI at the highest rates (78%), while residents of Louga sought treatment for ARI at much lower rates (35%).

3.4.4: Vaccination for children under-5

We analyzed BCG, DPT3, and measles vaccines by equity dimension (Appendix Figures 46-60). BCG vaccination for the under-5-year-old population was already quite high in 1992/93, and increased over the studied years, while showing a significant narrowing in gaps. There remained differences based upon wealth quintiles, where the poorest wealth quintile had the lowest prevalence of BCG vaccine, while the richest wealth quintile had the highest prevalence. Also notable was that Tambacounda was an outlier with a prevalence of BCG vaccine that was about 20% points lower than all the other regions. DPT3 vaccination shows a similar pattern with the largest discrepancies occurring in 1992/93, and the gaps narrowing by 2017. Once again, Tambacounda had markedly lower prevalence of DPT3 vaccination rates as compared to the other regions. Of the three vaccines, measles vaccination shows the most variation across dimensions in the under-5 children's population. Those in the richest wealth quintile had noticeably higher rates of measles vaccination

compared to those in the lowest wealth quintile. In addition, measles vaccination was highest among children whose mothers had the highest levels of education, and lowest for children born to mothers with no education. Dakar had the highest prevalence of measles vaccine, while Tambacounda remained the region with the lowest prevalence.

3.4.5: Vaccination for children 12-23 months

Similar to the under-5 age group, three vaccines were studied across the subnational dimensions for the 12-23-month age group (Appendix Figures 61-75). BCG vaccination for this population was also very high in 1992/93 and rose by 2017. There were discrepancies among wealth quintiles, with the richest wealth quintile having complete vaccination rates, while the poorest quintile had a rate just below 90%. Discrepancies in maternal education levels, gender and residential area were minimal. Similar to the under-5 age group, Tambacounda had vaccination rates that were far below the other districts. DPT3 vaccination rates followed a similar pattern, with variation occurring among wealth quintiles, and geographic regions. Again, the richest wealth quintile had the highest levels of vaccination, while the poorest had the lowest level. Tambacounda remained an outlier with markedly lower DPT3 vaccination rates, as compared to the other provinces. Measles vaccination showed the largest discrepancies across dimensions. Higher wealth quintiles, higher levels of education, and urban residence all had higher measles vaccination prevalence. There was virtually no difference in measles vaccination prevalence based upon gender. Like with the other vaccines, measles vaccination was substantially lower in Tambacounda compared to the other regions.

3.4.6: Water, Sanitation, and Hygiene

WASH improvements were measured through four interventions: access to improved water source, piped water access, access to improved sanitation, and open defecation reduction (Appendix Figures 76-95). These were all disaggregated across the subnational dimensions to determine gaps.

Access to improved water sources varied by wealth quintile, maternal education, residential area, and geographic region. Though gaps in these dimensions improved over the studied time period, they remained prominent by 2017. The people living in the highest wealth quintiles had the highest levels of access to improved water sources, while those in the lowest wealth quintiles had distinctly lower access. Children of mothers with higher education had higher levels of access to improved water sources than those of mothers with no education. People living in urban areas consistently had high levels of access to improved water sources over the studied time period. Improvements can be observed among those living in rural areas, who experienced a rise from 25% access in 1992/93 to over 60% access in 2017. The dimension that showed the greatest disparities was geographic region. Consistently, over 95% of people living in Dakar had access to improved water sources, while only 20% of people living in Kolda had access to improved water sources in 2017.

Piped water access did not increase greatly over the studied time period and variation across equity dimensions existed for all but gender from 1992/93 to 2017. Gaps narrowed over the years, but did not disappear. Those in the highest wealth quintiles had much higher levels of piped water access compared to those living in the lowest wealth quintiles. Mothers with higher levels of education had increased access to piped water compared to those with no education. Urban areas had higher access to piped water across all years. Gains were made in piped water access for those living in rural areas, and the gap narrowed over the studied years. There were virtually no

discrepancies in piped water access between genders. The greatest discrepancies in access to piped water were between geographic regions. People living in Dakar nearly all had access to piped water, while only around 10% of people living in Kolda had access.

Access to improved sanitation varied greatly by wealth quintile, maternal education, residential area and geographic region. There were nearly no gender differences based upon this intervention. Discrepancies based upon wealth quintile grew more prominent between 2017 and 2005, with the people in the top three wealth quintiles having over 60% access to improved sanitation, while the people in the bottom two had well below 50% access. Only approximately 10% of people living in the lowest wealth quintile had access to improved sanitation. Mothers with higher education had the highest access to improved sanitation, while those with no education had the lowest access. By 2017, those living in urban areas had significantly higher levels of access to improved sanitation. Large variation in access to improved sanitation by geographic region can be observed. Those living in Tambacounda had the lowest access to improved sanitation in 2017, while those in Dakar and Diourbel had the highest access. This is noteworthy, as people living in Dakar and Diourbel had nearly no access to improved sanitation in 1992/93, but by 2017, over 60% and 70% had access, respectively.

Open defection rates decreased from 1992/93 across Senegal. Large gaps existed across all dimensions though they decreased over the studied years. The only dimension that showed no variation was gender. Urban areas had consistently lower levels of open defection, and by 2017 urban areas had no open defection, while rural areas had a prevalence of over 20%. Lower wealth quintiles had higher levels of open defection, as did mothers with no education. Large discrepancies existed among geographic regions, with people living in Dakar having no open defecation prevalence, while those living in Diourbel and Fatick experienced a prevalence of nearly 30%.

3.5: Linear Multivariable Regression (Difference-in-Differences Analysis)

The following two sets of analyses (bivariate and multivariable regressions which include time*covariable interaction terms) examine the relationship between proposed predictors and the stunting outcome, as well as the DID effect between predictors and time. The interaction/DID terms indicate whether the change in the covariable leads to a change in the outcome (HAZ) over time. Bivariate correlations estimate the absolute crude associations between the covariable and the outcome, and they highlight the total (unadjusted) effect of the factor on HAZ. In multivariable analysis, the final multivariable regression coefficient is adjusted for child age, sex and region (control variables) and all confounders in preceding levels.

3.5.1: Children under-5 years old from 1992/93 - 2017

The results of multivariable mixed effect regression for children under-5 years old can be found in Table 13. This analysis takes into account three time points: 1992/93, 2005 and 2017. Highlighted in red is the statistically significant interactions between maternal education level and time, indicating that the relationship between maternal education and HAZ changed over time.

Table 13: Difference-in-differences multivariable regression for children under-5 years from 1992/93 - 2017

Domain/Indicator	Outcome = HAZ (Height for age z-score for under-5 children)	
	Period 1992/93 - 2017	
	Bivariate regression coefficient	Final multivariable regression coefficient*
	b estimate (95% CI) *p*-value	b estimate (95% CI) *p*-value
Distal level		
Basic causes & Income poverty		
Wealth Index (six components using PCA) (0 - 10)	0.085 (0.073; 0.097) <0.0001	0.042 (0.029; 0.056) <0.0001
Wealth Index#Year (0 - 10)	0.001 (-0.0004; 0.002) 0.319	
Mother years of schooling	0.054 (0.045; 0.064) <0.0001	2.49 (0.406; 4.57) 0.019
Maternal education # year	-0.002 (-0.003; -0.0004) 0.006	-0.001 (-0.002; 0.0002) 0.020
Father years of schooling	0.046 (0.037; 0.055) <0.0001	_
Father education # Year	-0.001 (-0.002; -0.0003) 0.006	_
% of residual variance explained by covariates		**10.8%**
Intermediate level		
Inadequate feeding practices and food insecurity		
Duration of breastfeeding (in months)	-0.054 (-0.061; -0.047) <0.0001	_
Duration of breastfeed # Year	0.002 (0.001; 0.002) <0.0001	_
Early initiation of breastfeeding (% infants)	-0.039 (-0.119; 0.040) 0.335	_
Early initiation of breastfeeding # Year (% infants)	-0.003 (-0.011; 0.005) 0.451	_

Domain/Indicator	Outcome = HAZ (Height for age z-score for under-5 children)	
	Period 1992/93 - 2017	
	Bivariate regression coefficient	Final multivariable regression coefficient*
	b estimate (95% CI) *p*-value	b estimate (95% CI) *p*-value
Inadequate care and health services		
Live births attended by Skilled birth attendants (% women)	0.441 (0.359; 0.523) <0.0001	_
Live births attended by Skilled birth attendants # Year	-0.004 (-0.012; 0.004) 0.296	_
Antenatal care (% women with at least 4 visits)	0.365 (0.278; 0.452) <0.0001	0.185 (0.106; 0.263) <0.0001
Antenatal care # Year	-0.007 (-0.017; 0.002) 0.142	_
total number of government hospitals per 10000 population	_	_
total number of government hospitals per 10000 population # Year	_	_
total number of primary health care centers per 10000 population	_	_
total number of primary health care centers per 10000 population # Year	_	_
total number of health posts or lower level health facilities per 10000 population	_	_
total number of health posts or lower level health facilities per 10000 population # Year	_	_
Outreach clinics held per 10000 population.	_	_

Domain/Indicator	Outcome = HAZ (Height for age z-score for under-5 children)	
	Period 1992/93 - 2017	
	Bivariate regression coefficient	Final multivariable regression coefficient*
	b estimate (95% CI) *p*-value	b estimate (95% CI) *p*-value
Outreach clinics held per 10000 population # Year	–	_
Number of mother group meetings held per 10000 population.	–	–
Number of mother group meetings held per 10000 population # Year	–	–
Unhealthy household environment		
Urbanization (% of urban population)	0.484 (0.394; 0.573) <0.0001	0.122 (0.026; 0.218) 0.013
Urbanization # Year	-0.003 (-0.011; 0.005) 0.489	_
Open defecation (% population)	-0.360 (-0.448; -0.271) <0.0001	_
Open defecation # Year	0.002 (-0.006; 0.010) 0.600	_
Water source - piped (% of population)	0.416 (0.331; 0.502) <0.0001	_
Water source - piped # Year	-0.004 (-0.012; 0.004) 0.303	_
Household crowding	0.002 (-0.005; 0.008) 0.633	_
Household crowding # Year	0.0003 (-0.0003; 0.001) 0.314	_
% of residual variance explained by covariates		**11.2%**
Proximal level		
Disease		
Acute Respiratory incidence/ reports	0.076 (-0.038; 0.190)	_

Domain/Indicator	Outcome = HAZ (Height for age z-score for under-5 children)	
	Period 1992/93 - 2017	
	Bivariate regression coefficient	Final multivariable regression coefficient*
	b estimate (95% CI) *p*-value	b estimate (95% CI) *p*-value
(% under-5 population within last 2 weeks)	0.189	
Acute Respiratory incidence # Year	-0.006 (-0.016; 0.003) 0.196	_
Diarrhea incidence/reports (% under-5 population within last 2 weeks)	-0.067 (-0.156; 0.021) 0.135	_
Diarrhea incidence # Year	0.001 (-0.007; 0.009) 0.827	_
Maternal characteristics		
Age (Mean, mothers 15-49)	0.001 (-0.004; 0.006) 0.676	_
Age# Year	0.0004 (-0.00002; 0.001) 0.058	_
Index births within last 5 years (% mothers <18 years)	-0.355 (-0.475; -0.235) <0.0001	-0.288 (-0.403; -0.173) <0.0001
Index birth within last 5 years # Year	0.003 (-0.008; 0.014) 0.603	_
Index births within last 5 years (% mothers >= 35 years)	-0.050 (-0.152; 0.052) 0.334	_
Index birth within last 5 years # Year	0.004 (-0.007; 0.014) 0.496	_
Anemia percentage among estimated pregnancies	_	_
Anemia percentage among estimated pregnancies # Year	_	_
BMI level (Mean mothers 15-49 years)	_	_

Domain/Indicator	Outcome = HAZ (Height for age z-score for under-5 children)	
	Period 1992/93 - 2017	
	Bivariate regression coefficient	Final multivariable regression coefficient*
	b estimate (95% CI) *p*-value	b estimate (95% CI) *p*-value
BMI level # Year	_	_
Height (Mean mothers 15-49 years)	_	_
Height # Year	_	_
Parity (Total fertility rate)	-0.035 (-0.049; -0.020) <0.0001	_
Parity # Year	-0.0004 (-0.002; 0.001) 0.520	_
Interpregnancy interval (in months)	0.004 (0.003; 0.005) <0.0001	0.002 (0.001; 0.004) 0.001
Inter pregnancy intervals # Year	0.00004 (-0.0001; 0.0002) 0.488	--
% of residual variance explained by covariates		**11.6%**
Time		
Time		
Year	0.010 (0.006; 0.014) <0.0001	-0.014 (-0.023; -0.005) 0.002

* Adjusted for child age, sex, and province

Figure 24 shows the margins plots for maternal education level. Higher levels of maternal education is associated with a greater impact on HAZ and this relationship persists over time.

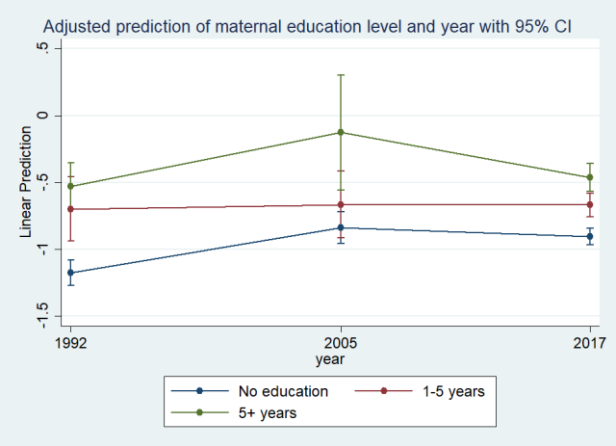


Figure 24: Margins plots for maternal education level and time for children under-5

While many other indicators such as wealth index, antenatal care, urban living, proportion of mothers under 18 among index births within the last five years and interpregnancy interval show statistically significant association with HAZ score, their interaction terms are not significantly associated with HAZ score. The p-value threshold for significance is $p<0.1$. The percentage of variance explained by covariates in this model is: 10.8% at the distal level, 0.4% at the intermediate level, and 0.04% at the proximal level.

3.5.2: Children 24 to 59 months old from 1992/93 - 2017

The results of the multivariable linear DID regression analysis of children between 24 and 59 months from the three DHS surveys (1992/93, 2005 and 2017) can be found in Appendix 12. This analysis was conducted to understand potential determinants of change in the older child age group. Among distal level indicators, only wealth index shows a statistically significant association with HAZ after adjustment for other covariables. Additionally, some intermediate level variables: presence of a skilled birth attendant, antenatal care (4+ visits) and open defecation are significantly associated with HAZ. The interaction terms for skilled birth attendant and antenatal care are significantly associated with HAZ. This indicates that according to this model, the relationships between the presence of a skilled birth attendant and antenatal care with HAZ have changed over time. At the proximal level, the proportion of mothers under 18 among index births in the last five years, total number of children and interpregnancy interval are all significantly associated with HAZ, but none showed time-dependent effects.

Figure 25 depicts the margins plots for the time-dependent relationship with the presence of a skilled birth attendant and antenatal care. The margins plot shows that the absence of a skilled birth attendant leads to a negative effect on HAZ change in all years studied compared to births where a skilled birth attendant was present, and the same is true of antenatal care. The narrowing of the gap between the lines suggests that the magnitude of these effects may have decreased over time. The percentage of variance explained by covariables is: 18.6% at the distal level, 0.5% at the intermediate level, and 1.1% at the proximal level.

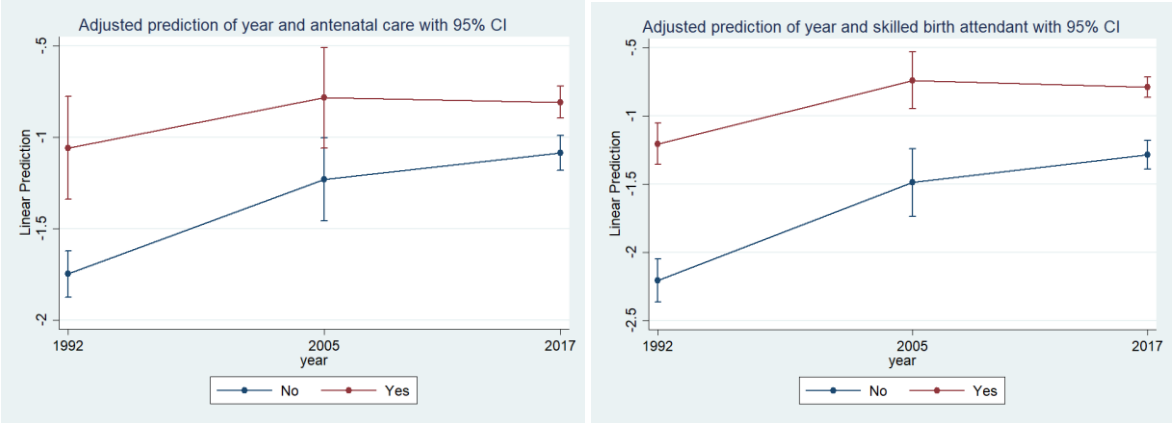


Figure 25: Margins plots for variables with significant interaction terms for children 24-59 months

3.5.3: Children 6-23 months old from 1992/93 - 2017

The multivariable linear DID regression analysis of children between the ages of 6 and 23 months uses indicators from three DHS surveys (from 1992/93, 2005 and 2017). The following indicators are significantly associated with HAZ in our multivariable model with a p-value < 0.1: wealth index, antenatal care, urbanization, and acute respiratory infections. Maternal characteristics such as age and total number of children also show significant associations with HAZ at a p-value level of < 0.1. The percent of variance explained by distal level covariables in this model is 12.0%, intermediate level covariables explain 1.4% of variance, and proximal-level covariables explain 0.3% of variance.

3.5.4: Children under 6 months old from 1992/93 - 2017

The final linear DID regression analysis examines data on children under 6 months old (Appendix 12). Only one factor at each level is significantly associated with HAZ with a p-value < 0.1. Wealth index (distal), antenatal care (intermediate) and the proportion of women under 18 among index births in the last five years (proximal). No interaction terms are statistically significant. The variance explained by covariables in this model are as follows: 2.5% for distal level factors, 0.9% for intermediate level factors, and 0.23% for proximal level factors.

3.6: Oaxaca-Blinder Decomposition

3.6.1: Descriptive HAZ trends

Figure 26 shows the HAZ distribution for Senegalese children under-5 years of age. The HAZ distribution from 1992/93 underwent a parallel rightward shift over the seven years to 2000. Over this time period, the distribution did not reach a higher peak, indicating that the entire population of under-5 children has seen nutritional gains, though they remain relatively widely distributed. The 2005 curve underwent not only a parallel rightward shift, but also a narrowing as it reaches a higher peak. This narrowing signals that more children cluster around a common mean HAZ that is closer to that of international reference populations. By 2017, the curve has shifted slightly leftward, but the peak is higher. Overall, the largest change in HAZ score can be seen between the years 2000 and 2005, after which minor changes in HAZ score occur. Additionally, incremental improvements in reach can be seen as the curve narrows, with more Senegalese children under-5 reaching the population mean HAZ score.

The mean HAZ score has changed by 0.28 standard deviations between the years 1992/03 and 2017. There have been incremental changes from -1.25 SDs in 1992/93 to -1.04 SDs in 2000, to -0.92 SDs in 2005, and finally to -0.97 SDs in 2017. Stunting prevalence follows a similar pattern, with steady declines over the studied time period. The percentage of Senegalese children experiencing stunting decreased from 25% in 1992/93 to 18% in 2005, and finally to 15% in 2017. Overall, stunting prevalence declined by 10% over the course of these 25 years.

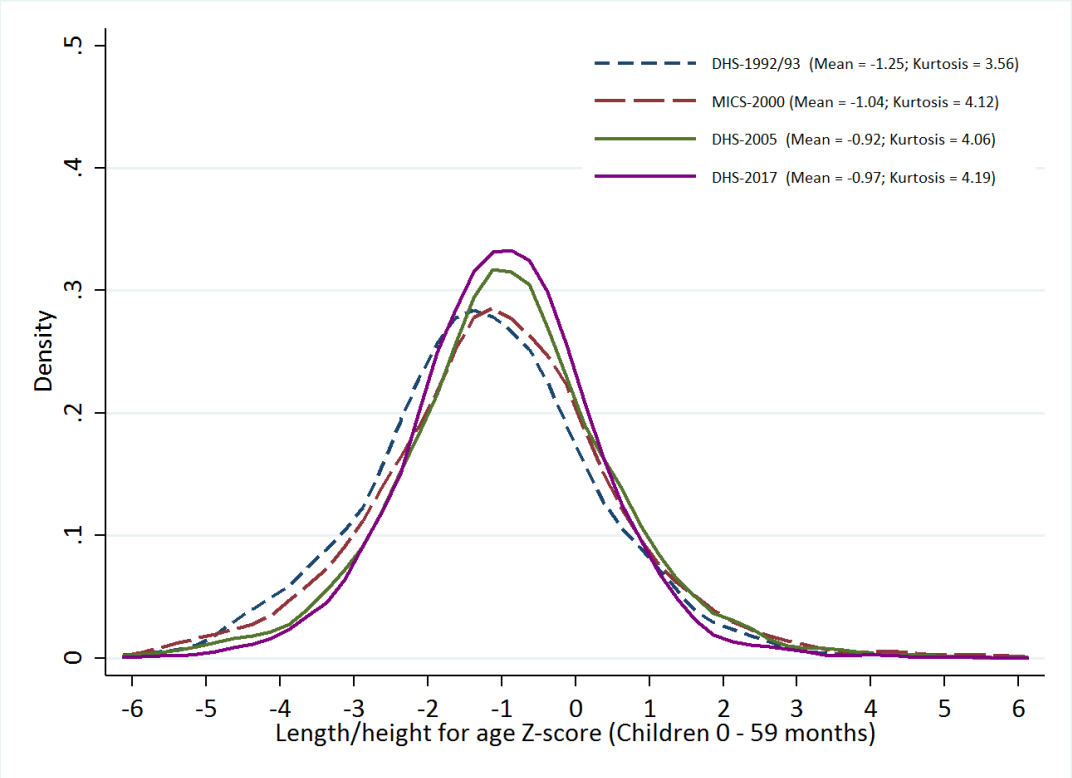


Figure 26: Kernel density plot for HAZ distribution in children <5 years DHS 1992/93, MICS 2000, DHS 2005, 2017

Figure 27 shows the HAZ distribution for Senegalese children aged between 24 and 59 months. Between 1992/93 and 2000, the distribution shifted rightward as the mean HAZ moved toward the international reference population mean from -1.64 to -1.24. The curve flattened out over this time

period, which indicates that differences in HAZ among this age group are more pronounced. By 2005, the HAZ distribution curve moved further rightward to a HAZ of -1.18, but the larger difference was the increased Kurtosis (higher peak). The narrowing of the curve indicates that more children aged 24-59 months are clustering around the mean. By 2017, the mean HAZ was -1.10, which continued the trend of the curve shifting to the right. Also, the 2017 curve narrowed further indicating that more children had this improved HAZ. Stunting in this age group dropped by 19.2% between 1992/93 and 2017.

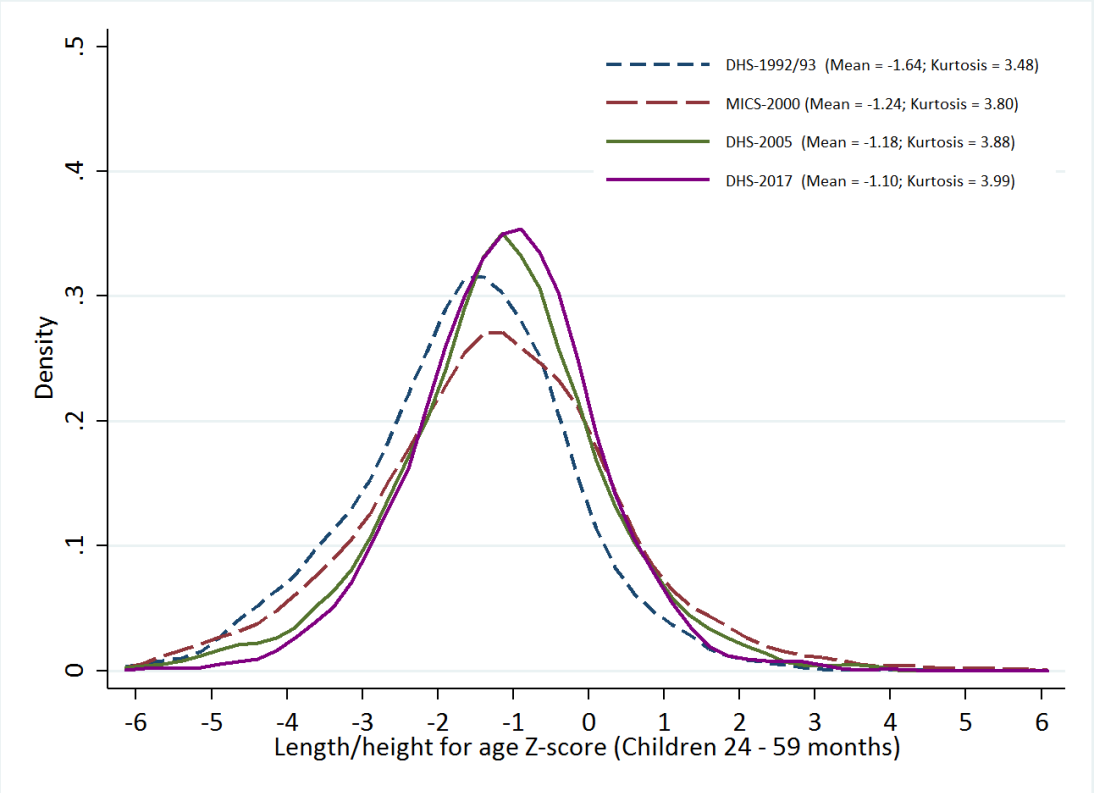


Figure 27: Kernel density plot for HAZ distribution in children 24-59 months DHS 1992/93, MICS 2000, DHS 2005, 2017

The HAZ distribution for children between 6 and 23 months can be found in Figure 28. The greatest change in kurtosis can be observed from the 1992/93 curve to the 2000 curve. Narrowing can be observed in 2000 that indicates that more children are reaching the mean HAZ, though over this time period no change in mean HAZ occured. By 2005, the narrowed curve remains, though it has shifted rightward as the mean HAZ increases. At this point, more children are experiencing an improved HAZ of -0.78. By 2017, there is more narrowing of the curve, however there is also a slight leftward shift as the mean HAZ drops to -0.92. Overall, among the 6-23 month children's population, there has been an improvement in mean HAZ, as well as a narrowing of the distribution as more children cluster around the mean.

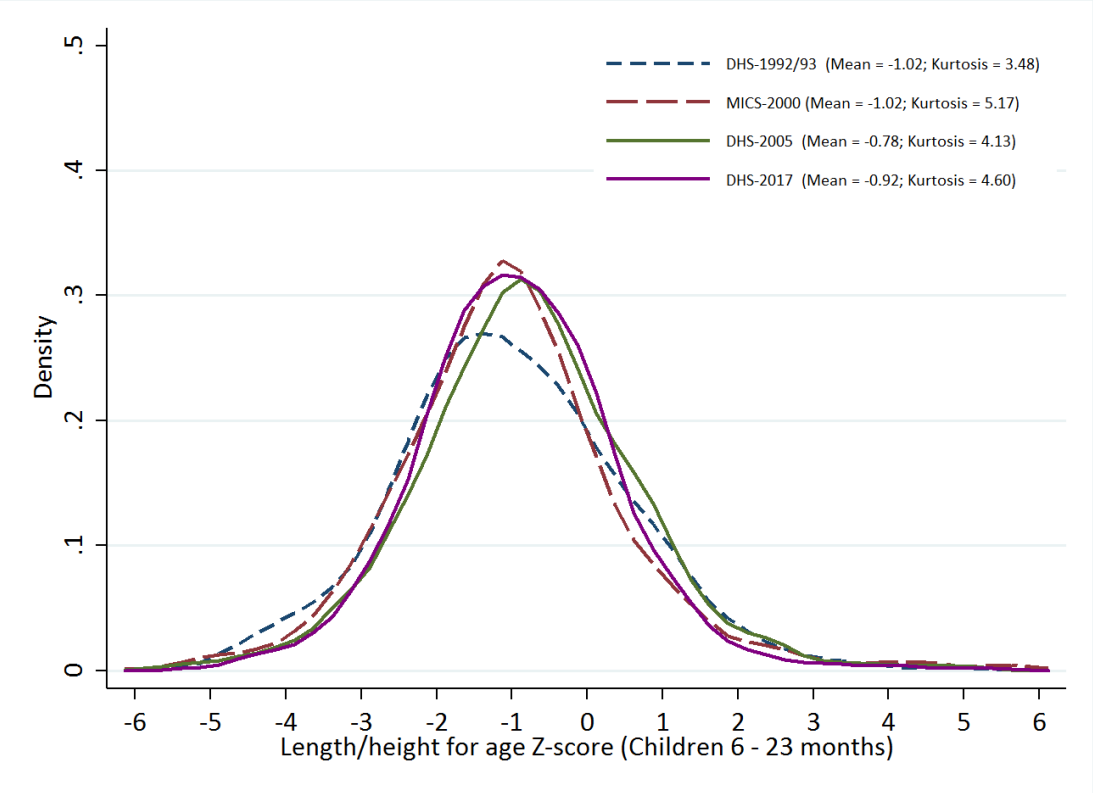


Figure 28: Kernel density plot for HAZ distribution in children 6-23 months DHS 1992/93, MICS 2000, DHS 2005, 2017

Figure 29 depicts the HAZ distribution curves for the under-6-month population. This series of curves is somewhat different from the rest, as there is no gradual improvement over time. In fact, there is a decline in mean HAZ from 2000 onward. Between 1992/93 and 2000, the HAZ curve shifted rightward, and by 2000, the mean HAZ had nearly reached the international reference population mean. There was also a narrowing of the curve (higher kurtosis). The 2000 curve has the highest mean, and also the highest kurtosis indicating that in this year, the under-6-month population had an improved mean HAZ, and also that they clustered around it. By 2017, the mean HAZ had shifted leftward to -0.40, as it moved away from the international reference mean. Overall, the HAZ distribution for the under-6-month children's population underwent a rightward shift in 2000, then a leftward shift by 2017, when mean HAZ was lower than it had been in 1992/93. The curve narrowed slightly over this time period, as more children clustered around the mean HAZ.

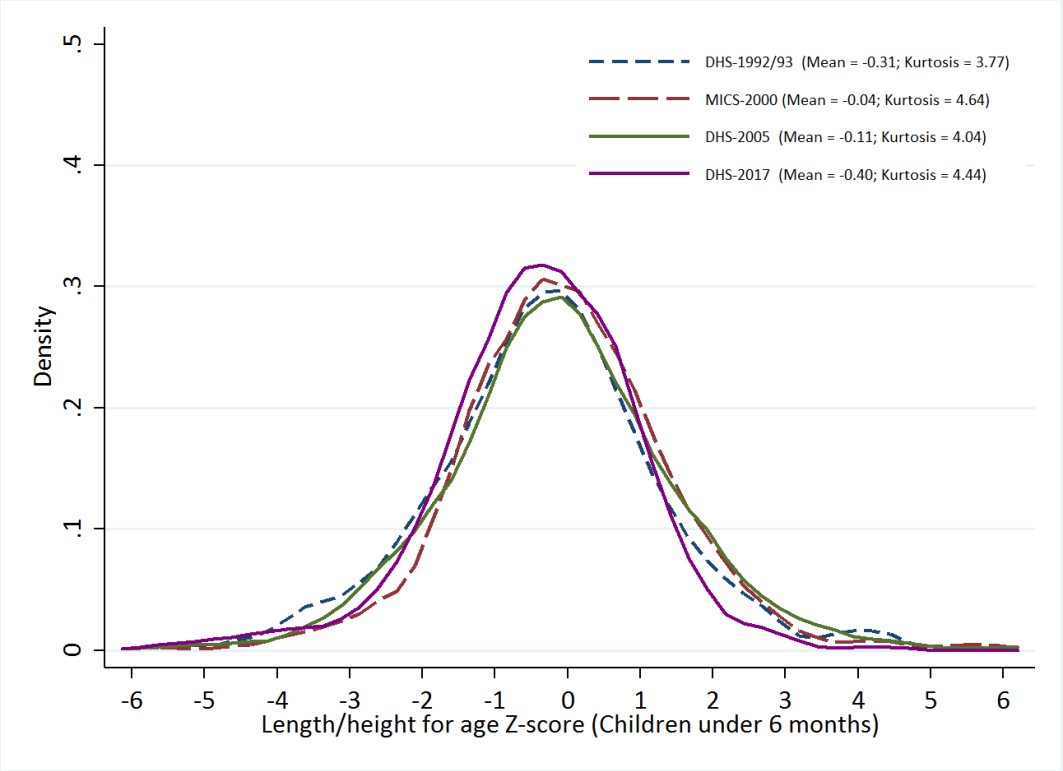


Figure 29: Kernel density plot for HAZ distribution in children <6 months DHS 1992/93, MICS 2000, DHS 2005, 2017

3.6.2: Child Growth Curves

As estimated by Victora et al (2010), Figure 30 shows growth faltering trends calculated from 54 countries globally. The graph on the right shows the mean WAZ, WHZ, and HAZ for all of the 54 countries studied. HAZ starts below the WHO standard and falters until 24 months, after which it levels out, and rises slightly. The graph on the left shows mean HAZ scores for all countries combined, organized by region. It shows that growth faltering can be observed in all 5 regions, though magnitude varies. Senegal falls under the AFRO region; a region that experiences high growth faltering and low HAZ scores.

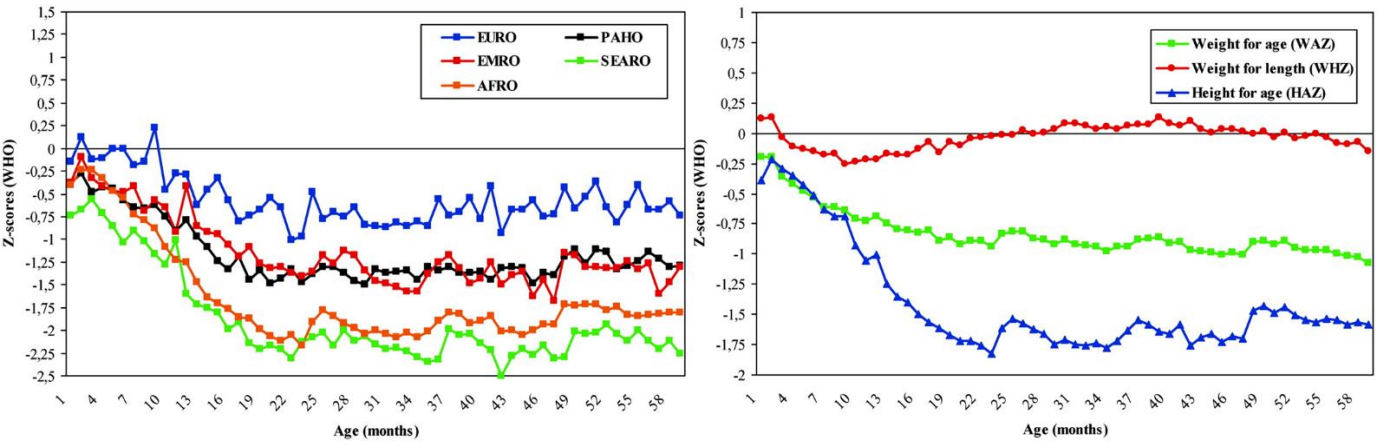


Figure 30: Mean HAZ z-scores by age, relative to the WHO standard, according to region (1-59 months) (left); Mean anthropometric z scores according to age for all 54 studies, relative to WHO standard (1-59 months) (right)
Source: Victora et al. (2010)

We estimated these child growth curves, or *Victora curves*, for Senegal. Figure 31 shows predicted child HAZ from smoothed local polynomial regressions plotted against child age. We overlaid the mean HAZ score for children under-5 from the WHO African region countries included in Victora's global analysis. We also overlaid the mean HAZ score for children under-5 from all 54 studies included in Victora's global analysis. Graphs with only two-year data plotted sequentially can be found in Appendix 13.

These curves allow for the examination of the growth faltering process from birth to 5 years of age among Senegalese children. There are two crucial features of child undernutrition that are revealed in the *Victora curves*: 1) The curve's intercept which reveals the inter-generational susceptibility of child undernutrition, or the extent to which a mother's nutrition leads to small babies at birth; and 2) the post-natal growth faltering process, which is usually steepest between 6 and 24 months, after which it tapers off. This encompasses a child's first 1000 days of life, during which they are most vulnerable to poor diet and disease (44).

Senegalese children's HAZ trajectory over the studied 25-year period shows significant stunting improvements. The 1992/93 curve intercepts the y-axis below the international reference population. This indicates that maternal nutrition throughout pregnancy and genetics may have been an important marker of the child's size at birth. This feature speaks to intergenerational transmission of disadvantage, and is related to maternal nutrition (proxies used: maternal height and BMI), and genetics (proxy used: maternal height). This curve also depicts a typical HAZ trajectory in that there is a steep decline between 6 and 24 months of age, which represents the growth faltering process. After 6 months, children are no longer exclusively breastfed, and food is being introduced, thus this is the point when children are most susceptible to the effects of a poor diet and unmet nutritional needs.

The 2000 curve begins at a higher point, and intercepts at the international reference population average. Intrauterine growth over this 7-year period has been improved, and this could be the result of improved health care and nutrition during pregnancy. There is also a clear decline depicting growth faltering, though the curve does not drop as low as the 1992/93 curve does. The steep decline indicates that growth after exclusive breastfeeding has ended remains hindered, though the gains made through improved intrauterine growth prevent the decline in HAZ from reaching 1992/93 levels.

The 2005 *Victora* curve intercepts at around the international reference population mean, similar to the 2000 curve; however, it has a flatter slope. This indicates that the growth faltering process was not as drastic, and that gains in child nutrition between 6 and 24 months have been made.

The 2017 curve has a y-intercept that is below that of the 2000 and 2005 curves, which signals that there could have been a decline in maternal nutrition or healthcare to result in smaller babies being born. The slope of the curve during the growth faltering process is the flattest to date, and despite starting at a lower point than the 2005 curve, it reaches the same lowest point. Though maternal nutrition may have seen some regression, there has been improvement in child nutrition over this period of time.

These trends suggest that overall gains in stunting reduction over the studied years can be attributed to both improved maternal nutrition, as well as improved nutrition for children. This can be seen through the trends of increased intercepts, as well as the flattening of the curve that depicts growth faltering. Although Senegalese children in 2017 were still born small compared to the international reference population, and they experienced growth faltering between 6 and 24 months of age, there have been improvements made in both trends over the studied period.

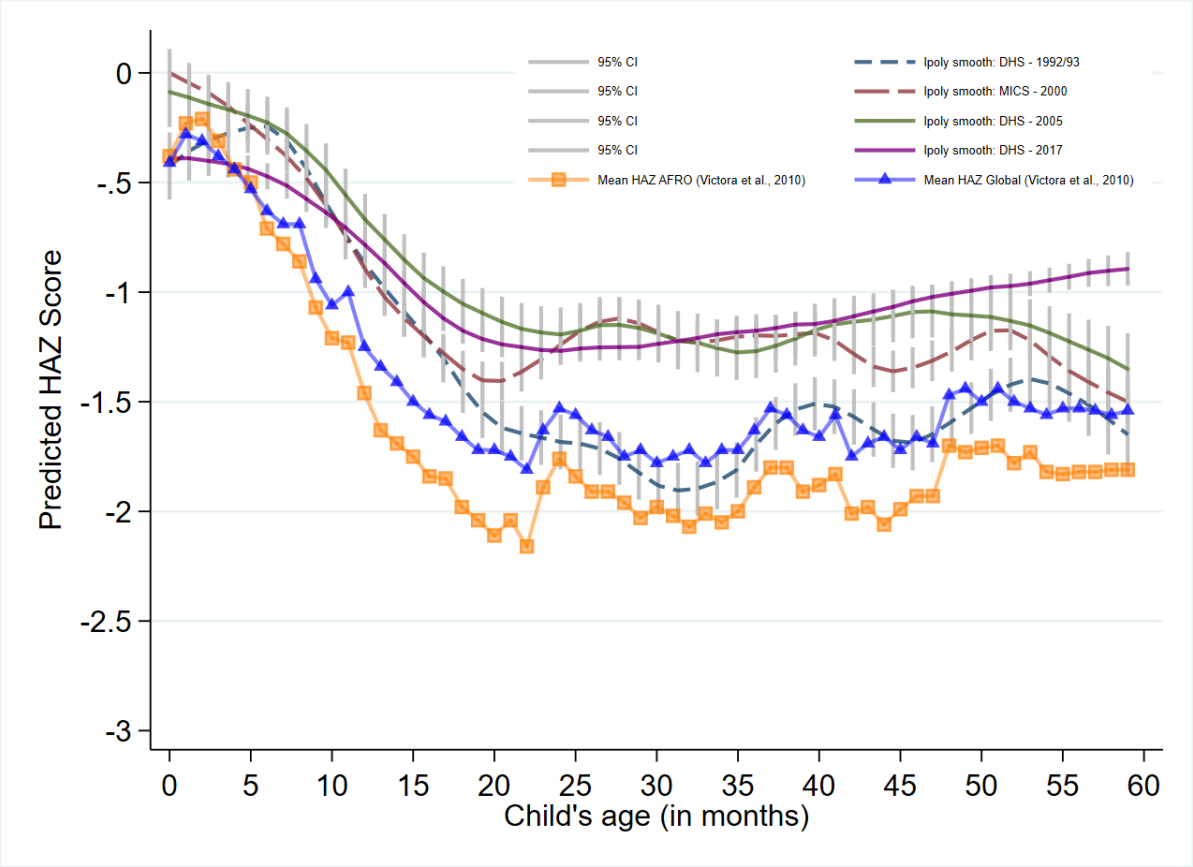


Figure 31: Victora curve using data from the 1992/93, 2000, 2005, 2017 surveys among children <5 years, including Global mean HAZ curve, and AFRO mean HAZ curve (Source: Victora et al., 2010)

In Figures 32-38, we have included statistical splines (as described in the methods) to quantify and objectively measure changes/trajectories in the Victora curves. In 1992/93 (Figure 32), HAZ rose by 0.028 SD per month (95% CI: 0.004; 0.053), from -0.4 at birth to -0.2 at 6 months. After 6 months, HAZ began to fall sharply by 0.089 SD per month to -1.6 at 20 months (95% CI: -0.108; -0.091). From 20 months onwards, the rate of decline slowed to less than a quarter, down to only 0.021 SD per month (95% CI: -0.031; -0.010). After reaching a low of -1.8 at 29 months, HAZ began to increase by 0.012 SD per month (95% CI: 0.009; 0.015), back up to above -1.5 by 60 months.

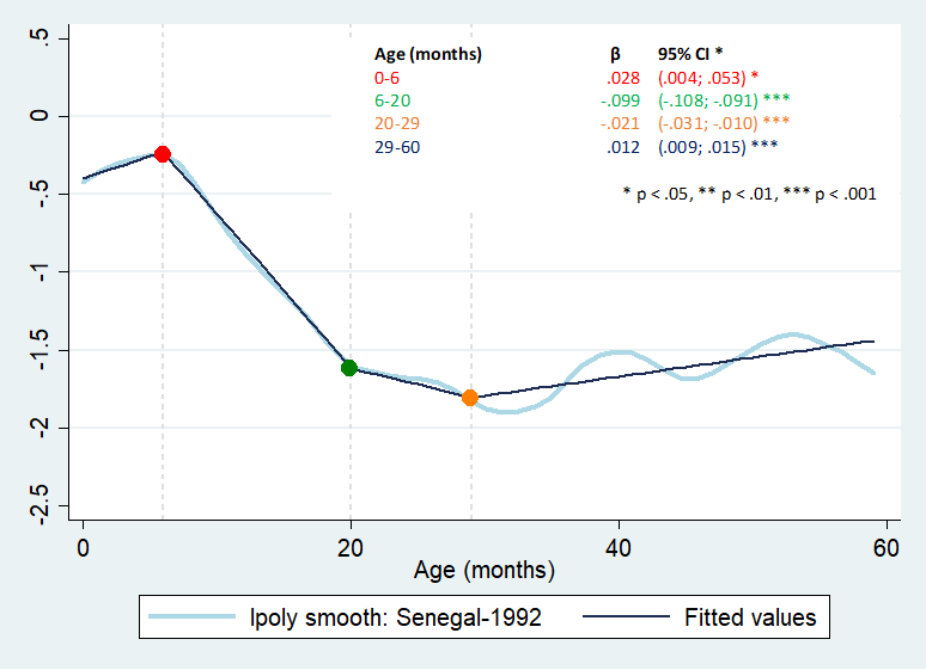


Figure 32: Victora curve using data from the 1992 survey, with splines

In 2000 (Figure 33), the relationship between child age and HAZ was characterized by a steady decrease in mean HAZ of 0.045 SD per month during the first 5 months of age (95% CI: -0.067; -0.023), from 0 to -0.2. At 5 months, the rate of decline increased two-fold between to 0.089 SD per months (95% CI: -0.096; -0.083). After reaching a low of -1.5 at 19 months, mean HAZ increased at a rate of 0.042 SD per month (95% CI: 0.033; 0.005) up to -1.1, before beginning a slow further decrease of 0.007 SD per month up to 60 months (95% CI: -0.010; -0.005).

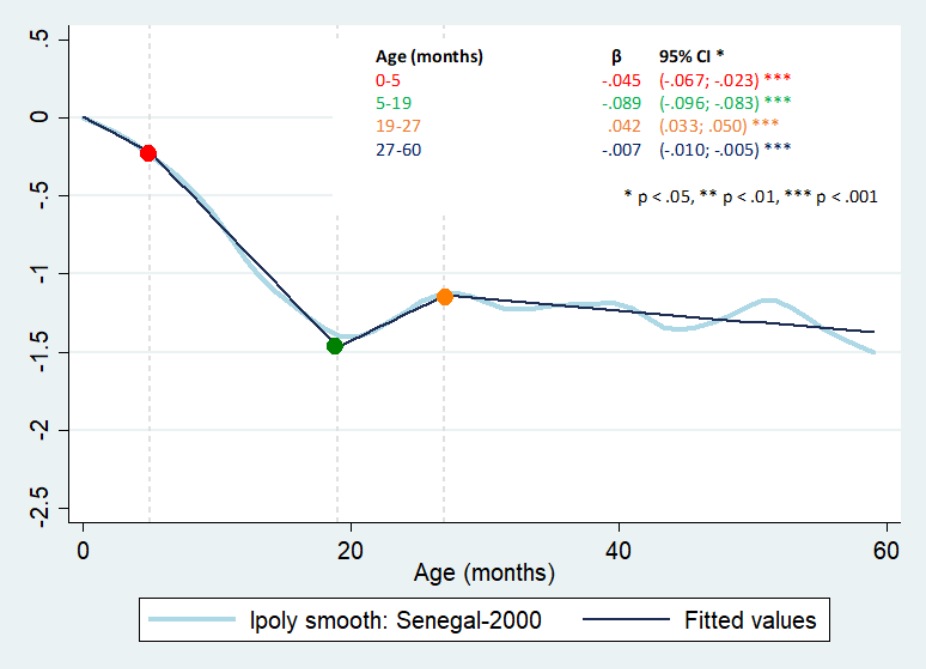


Figure 33: Victora curve using data from the 2000 survey, with splines

At birth, mean predicted HAZ was higher in 2000 compared to 1992 (0 vs -0.40) (Figure 34). By 6 months of age, mean HAZ was around -0.20 for both years. At 6 months, HAZ declined at a similar rate in both years but fell to only -1.5 in 2000 before beginning to increase. From around 20 months to 60 months, HAZ remained above -1.5 in 2000 compared remaining below -1.5 in 1992. However, during this latter period, HAZ experienced a steady decline in 2000 compared to a steady incline in 1992. By 60 months, HAZ was at a similar level in 2000 as it was for children of the same age in 1992. Average HAZ never fell below the -2 SD threshold for stunting during either time period.

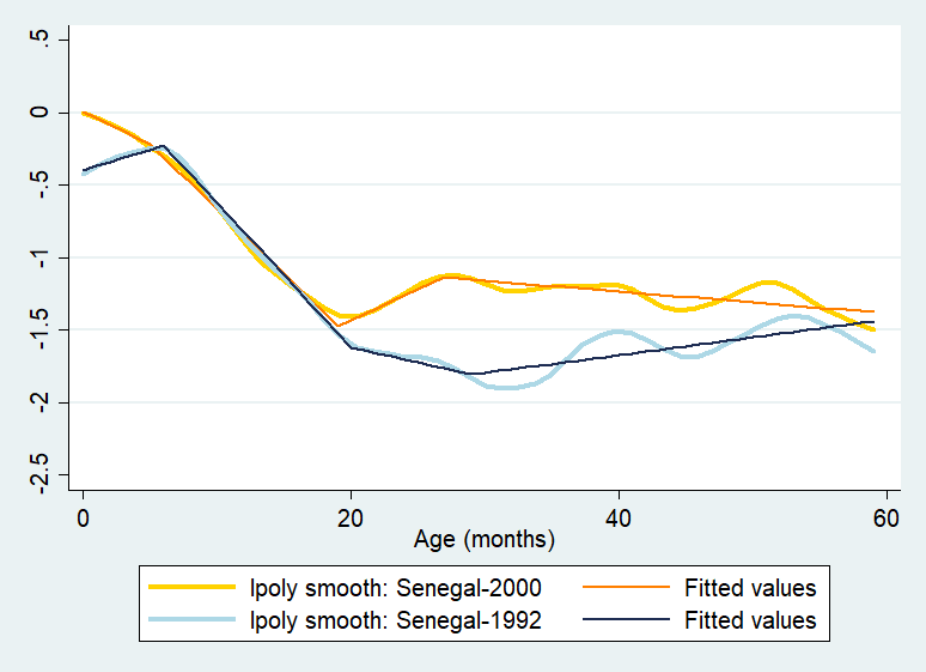


Figure 34: Victora curve using data from the 1992 and 2000 surveys

In 2005 (Figure 35), mean HAZ declined at a rate of 0.023 SD per month (95% CI: -0.038; -0.008), from -0.09 at birth to -0.25 at 7 months. At 7 months, the rate of decline increased to 0.081 SD per month (95% CI: -0.091; -0.071), with mean HAZ falling to -0.98 SD at 16 months. After 16 months, the decrease in HAZ slowed to 0.034 SD per month (95% CI: -0.046; -0.022), before levelling off at a mean of -1.2 around 22 months of age. Predicted mean HAZ remained unchanged to a statistically significant degree up to 60 months.

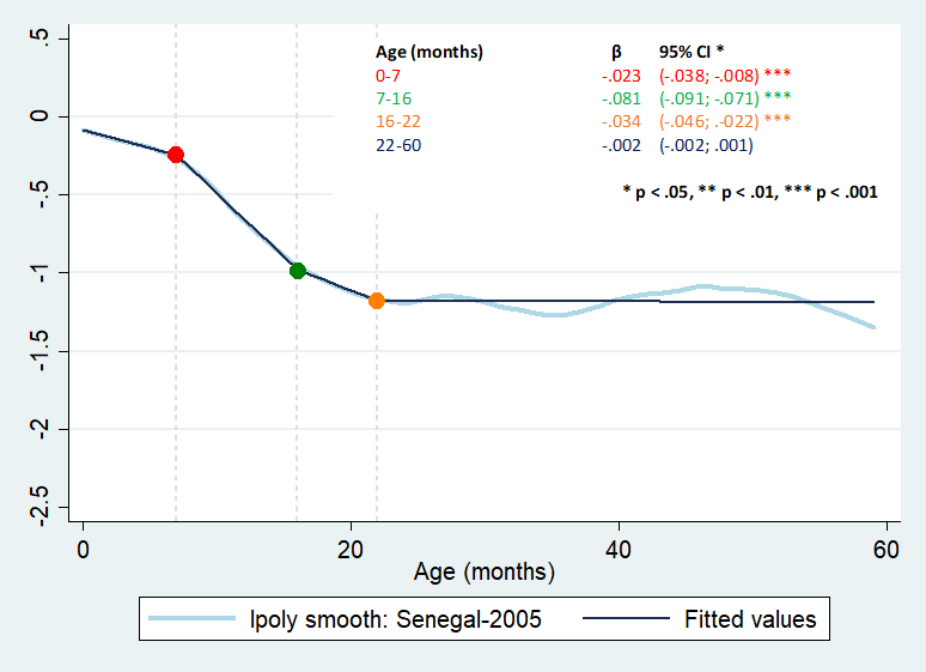


Figure 35: Victora curve using data from the 2005 survey, with splines

Trajectories for HAZ over the first 60 months of age were similar between 2005 and 2000 (Figure 36). However, the initial decline up to 6 months and the major period of decline after 6 months were both less severe in 2005 compared to 2000. HAZ fell to a low of only -1.2 in 2005 before levelling off, compared to -1.5 in 2000. Average HAZ never fell below the -2 SD threshold for stunting during either time period.

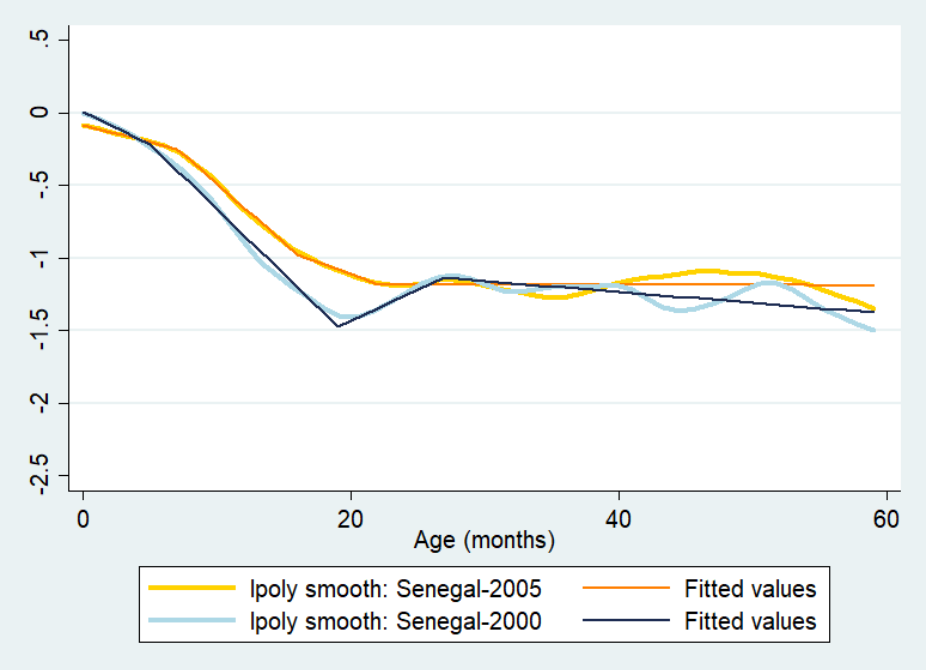


Figure 36: Victora curve using data from the 2000 and 2005 surveys

In 2017 (Figure 37), HAZ decreased slowly at a rate of 0.011 SD per month (95% CI: -0.017; -0.004), from -0.38 at birth to -0.45 at 6 months. After 6 months, the rate of decline increased to 0.58 SD per month (95% CI: -0.060; -0.057) and the predicted mean HAZ fell to a low of -1.32 at 21 months. From 21 months onwards, HAZ increased by 0.011 SD per month, rising to -0.90 by 60 months.

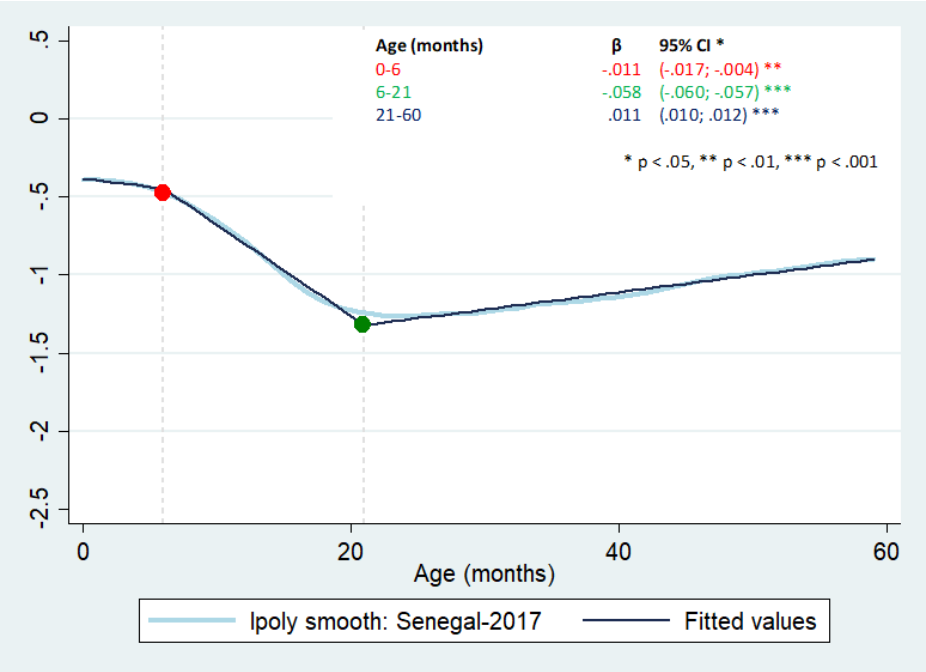


Figure 37: Victora curve using data from the 2017 survey, with splines

HAZ at birth was lower, on average, in 2017 (-0.38) compared to 2005 (-0.09) (Figure 38). Although the major rate of decline was less severe in 2017, mean HAZ remained at lower levels than in 2005. From 20 months of age onwards, HAZ steadily increased in 2017 in contrast to the decline seen in 2005 and contined to do so up to 60 months of age. Average HAZ never fell below the -2 SD threshold for stunting during either time period.

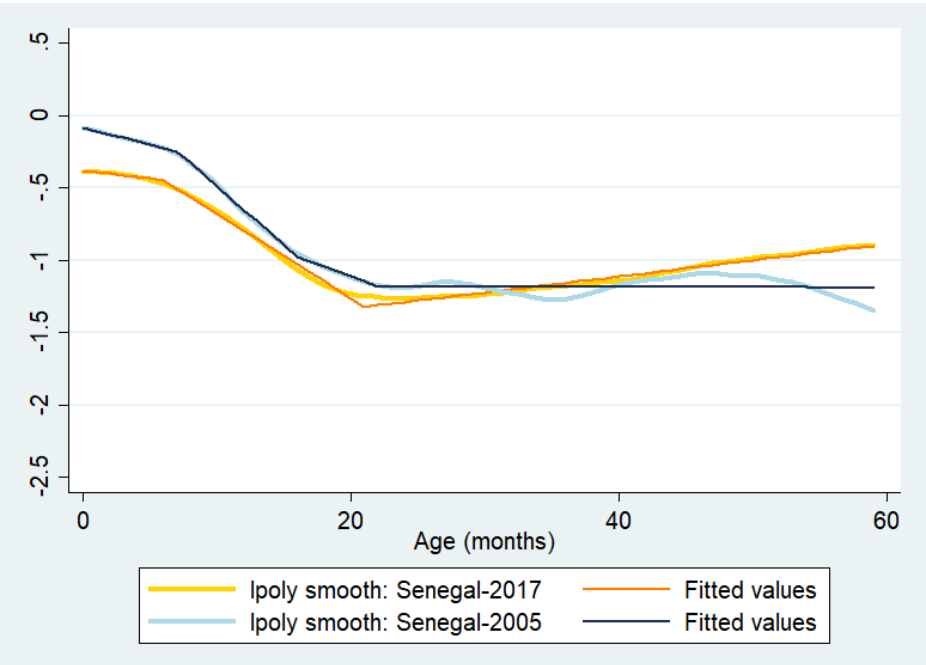


Figure 38: Victora curve using data from the 2005 and 2017 surveys

3.6.3: Explanatory Factors

Appendix Table 6 includes a list of quantitative indicators available for consideration as potential determinants of under-5 child stunting. Table 14 displays trends in the hierarchical determinants of child HAZ as estimated for children under 59 months of age from our sample datasets for 1992/93-2017. Data for the age stratified model of children 24-59 months can be found in Appendix Table 15.

Socioeconomic factors

At the distal level, household wealth index (ranked from 0-10, as provided in the DHS surveys) significantly increased from 1992/93 to 2017 from an average of 4.36 to 5.27 ($p<0.001$). Maternal and paternal education also improved significantly over the 25-year period, with maternal years of education rising by 1.69 years ($p<0.001$), and paternal education years rising by 1.35 years ($p<0.001$).

Inadequate feeding practices and food insecurity

The average duration of breastfeeding decreased from 13.03 months to 10.82 months from 1992/93-2017 ($p<0.001$). Early initiation of breastfeeding increased greatly as only 14.4% of infants were breastfed within an hour of birth in 1992/93, which rose to 48.0% by 2017. This 33.6% rise was statistically significant ($p<0.001$).

Inadequate care and health services

Childhood vaccinations: The percentage of infants who received 3 doses of the DPT vaccine rose by nearly 20% ($p<0.001$), while the percentage of infants who received measles vaccine rose by nearly 16% ($p<0.001$). By 2017, 91% of infants had received 3 doses of the DPT vaccine, while 75% of infants received the measles vaccine.

Reproductive and maternal health interventions: The percentage of women whose live births were attended by skilled birth attendants increased drastically from 51% in 1992/93 to 72% in 2017, representing an increase of 21% ($p<0.001$). The proportion of women who attended at least 4 antenatal care visits increased from 16% to 59% between 1992/93 and 2017, and this 43% increase is statistically significant ($p<0.001$).

Supplementation: Vitamin A supplementation was not measured in 1992/93, though it declined between 2005 and 2017 from 75% to 61% over this time period.

Unhealthy household environment

Households living in urban settings increased slightly from 40% in 1992/93 to 43% by 2017 ($p=0.042$). The percentage of the population engaging in open defecation dropped significantly from 39% to 15% ($p<0.001$), while the proportion of the population receiving their water from a piped source rose by 25% ($p<0.001$). The number of household members has not changed significantly, as it rose by 0.3% in the 25-year time period ($p=0.095$).

Disease

Infections: Incidence of ARI in children (in the past 2 weeks) was reduced by more than half as it dropped from 34% in 1992/93 to 22% in 2017 ($p<0.001$). Diarrheal infection incidence dropped slightly from 25% in 1992/93 to 22% in 2017 ($p=0.002$).

Child and maternal characteristics

The proportion of low birthweight children born rose from 8.6% to 11.8% between 1992/93 and 2017. This figure could be inaccurate due to poor reporting of this indicator in DHS surveys and change in reporting/recall over time. Average maternal age rose from 27.98 to 28.98 years from 1992/93 to 2017 ($p<0.001$). The proportion of mothers giving birth to the index child before 18 years of age decreased significantly over the years from 11.14% to 7.90% from 1992/93 to 2017 ($p<0.001$). The proportion of older mother births (>35 years) increased slightly from 13.75% in 1992/93 to 14.98% in 2017 ($p= 0.231$). Anemia during pregnancy was not measured in every year,

though it remained relatively consistent at 58% in 2005, and 52% in 2017. Average BMI (21.98 – 22.57 kg/m2) and height (160.36 – 162.93 cm) of mothers remained quite steady in 1992/93 and 2005, and was not measured in 2017. Average number of children per mother dropped from 4.08 to 3.31 between 1992/93 and 2017 (p<0.001). The interpregnancy interval increased from 46.5 months to 51.7 months in this time (p<0.001).

Table 14: Descriptive trends in stunting determinants in 1992/93 - 2017 in children <5 years

Domain/Indicator	DHS Survey Year				
	1992/93 (n = 1840)	2005 (n = 1355)	2017 (n = 5076)	(2017 – 1992/93) Change	p-value
Outcome					
Height for age z-score	-1.04	-0.70	-0.749	0.29	<0.001
Stunting % of children below -2sd	24.95	17.71	15.034	-9.91	<0.001
Child Demographic					
Child sex (male) % of males	48.64	51.66	52.261	3.62	0.013
Child age (in months)	18.80	19.21	22.542	3.75	<0.001
Distal level					
Basic causes & Income poverty					
Wealth Index (nine components using PCA) (0 - 10)	4.36	4.77	5.268	0.91	<0.001
Mother year of education	1.49	2.29	3.172	1.69	<0.001
Father year of education	1.71	2.50	3.061	1.35	<0.001
Intermediate level					
Inadequate feeding practices and food insecurity					
Duration of breastfeeding (in months)	13.03	13.55	10.817	-2.21	<0.001

Domain/Indicator	DHS Survey Year				
	1992/93	2005	2017	(2017 – 1992/93)	
	(n = 1840)	(n = 1355)	(n = 5076)	Change	p-value
Early initiation of breastfeeding (% infants)	14.40	32.10	48.001	33.60	<0.001
Inadequate care and health services					
DPT vaccine (% infants with 3 doses)	71.24	81.77	90.911	19.67	<0.001
Measles vaccine (% infants)	59.04	65.83	74.658	15.62	<0.001
Live births attended by Skilled birth attendants (% women)	51.30	55.34	72.470	21.17	<0.001
Antenatal care (% women with at least 4 visits)	15.72	41.99	58.971	43.25	<0.001
Vitamin A supplementation	-	75.17	61.494	-	
Unhealthy household environment					
Urbanization (% of urban population)	40.22	38.38	43.169	2.95	0.042
Open defecation (% population)	38.79	24.99	14.931	-23.86	<0.001
Water source - piped (% of population)	45.26	56.88	70.485	25.22	<0.001
Number of household members	11.14	11.14	11.437	0.30	0.095
Proximal level					
Disease					
ARI infection (% under-5 population within last 2 weeks)	33.64	31.90	22.072	-11.57	<0.001

Domain/Indicator	DHS Survey Year				
	1992/93	2005	2017	(2017 – 1992/93)	
	(n = 1840)	(n = 1355)	(n = 5076)	Change	p-value
Diarrhea infection (% under-5 population within last 2 weeks)	25.37	27.82	21.664	-3.70	0.002
Child characteristics					
Low birthweight* (%, index child)	8.60	11.73	11.774	3.17	0.019
Maternal characteristics					
Age (Mean, mothers 15-49)	27.98	28.18	28.984	1.00	<0.001
Index births within last 5 years (% mothers <18 years)	11.14	9.01	7.898	-3.24	<0.001
Index births within last 5 years (% mothers >= 35 years)	13.75	13.22	14.976	1.23	0.231
Anemia during pregnancy (% women 15-49 years)	-	57.96	52.140	-	
BMI level (Mean mothers 15-49 years)	21.98	22.57	-	-	
Height (Mean mothers 15-49 years)	162.36	162.93	-	-	
Parity (Total fertility rate)	4.08	3.49	3.312	-0.77	<0.001
Interpregnancy interval (in months)	46.54	49.45	51.655	5.11	<0.001

3.6.4: Relative Contribution

Using mean differences of explanatory variables and hierarchical coefficients from Equation 1, the Oaxaca-Blinder decomposition results are discussed below. We aggregated individual factors into broader policy-relevant domains as listed in Table 15. The coefficient products or predicted change in HAZ estimated from Equation 2 for each indicator were summed within domains.
We conduct the decomposition analyses for HAZ change for 1992/93-2017 (Table 16).

Table 15: Determinant policy-relevant domains grouped by distal, intermediate and proximal factors

Individual Factors	**Domain**
Distal Level	
Wealth index	Wealth accumulation
Mother education	Mother education
Father education	Father education
Intermediate Level	
Duration of breastfeeding	Breastfeeding practices
Reduced open defecation	Reduced open defecation
Water source - piped	Water source - piped
Urbanization	Urbanization
Household crowding	Household crowding
DPT3 vaccination	Childhood vaccinations
Measles vaccination	
Skilled birth attendants	Maternal and newborn healthcare
Antenatal care visits 4+	
Proximal Level	
Diarrhea within the last 2 weeks	Disease
Acute respiratory infection prevalence	
Maternal age	Maternal age
Adolescent births <18 years of age	Early age pregnancy
Older mother births ≥35 years of age	Late age pregnancy
Low birthweight	Low birthweight
Parity	Fertility
Inter-pregnancy interval (in months)	
Others	Child age, gender and region

Note: Maternal height, maternal BMI, maternal anemia, and vitamin A supplementation have been removed from analyses as there is insufficient data. Data is available for some study years, though it is missing for the endpoint in our analysis, thus rendering these variables unanalyzable.

Figure 39 displays decomposition results for the 1992/93 to 2017 period for the entire under-5-year-old age group. The vertical axis shows predicted change in HAZ and explanatory variables are ranked in descending order on the horizontal axis. The top explanatory factor of HAZ was maternal and newborn healthcare (measured via presence of skilled birth attendants, and 4+ antenatal care visits) which predicts an improvement in HAZ by 0.08 standard deviations. Wealth index conferred a 0.06 standard deviation increase in HAZ. Increases in maternal education, paternal education and having a piped water source each contributed a 0.02 standard deviation increase in HAZ. Reductions in early age of pregnancy account for a 0.01 standard deviation increase in HAZ. Maternal and newborn healthcare accounts for 27% of the total change in HAZ. Wealth index increases explained 19% of total HAZ change, followed by improvements in maternal education (7%), piped water source (8%), paternal education (7%), and early age of pregnancy (3%) (Figure 40). In total, these factors explain nearly 72% of the change in HAZ between 1992/93 and 2017 (Table 16). This model successfully explains the majority of the change in HAZ in Senegal for the under-5 age group, though it also shows that there are factors unaccounted for that also contribute to HAZ change.

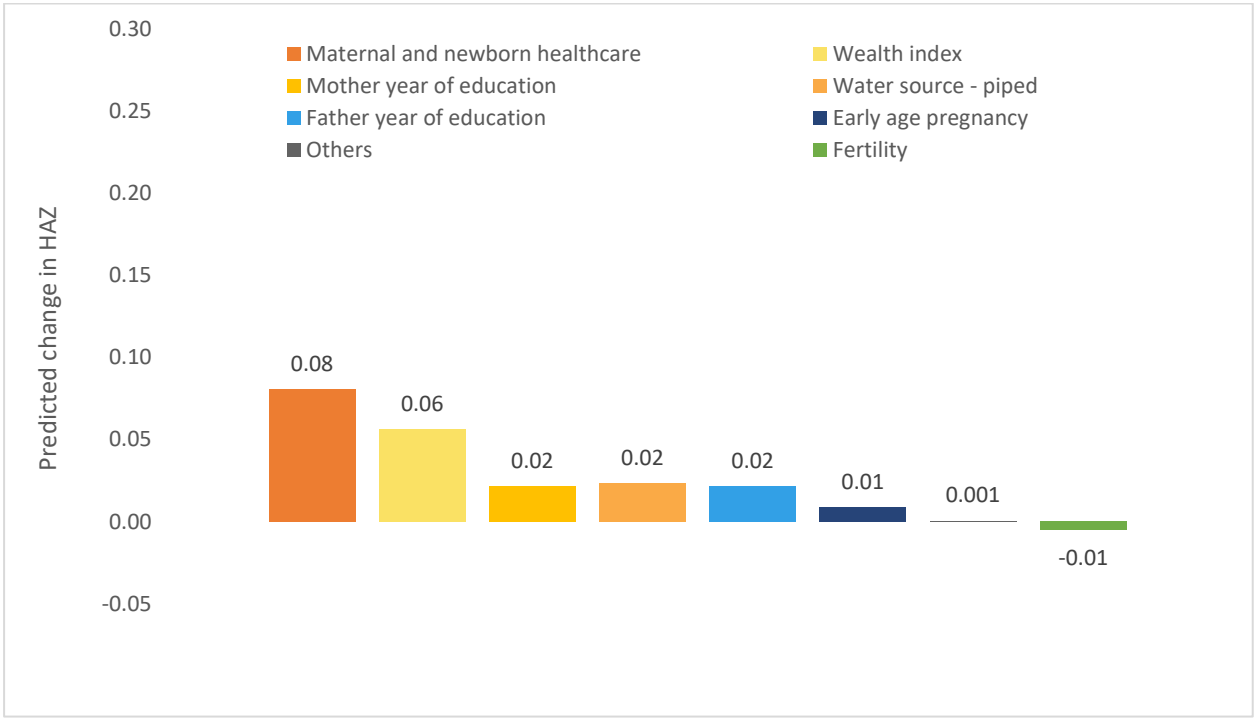


Figure 39: Decomposing predicted changes in HAZ (i.e. relative ranking of product coefficients for determinant domains), for children under-5, period 1992/93 – 2017

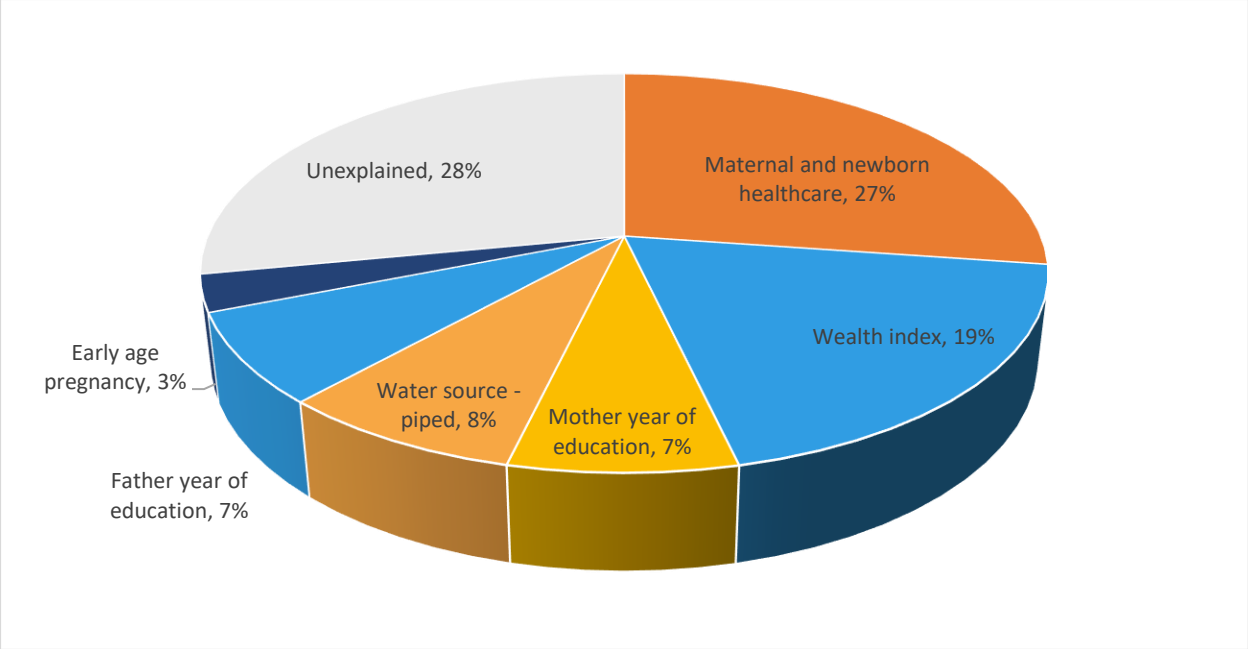


Figure 40: Decomposing predicted changes in HAZ outcome (i.e. % contribution of determinant domains), for children under-5, period 1992/93 – 2017

Table 16: Hierarchal approach Decomposition analysis for children under-5, period 1992/93 – 2017

Factors	Estimated coefficient	Mean difference (2017 - 1992/93)	Predicted change in HAZ	Share of predicted change in (%)	Share of total change in HAZ (%)
HAZ Score	-	0.29	0.21	72.0%	Unexplained (28.0%)
Wealth index	0.062	0.91	0.06	27.1%	19.5%
Mother year of education	0.013	1.69	0.02	10.4%	7.5%
Father year of education	0.016	1.35	0.02	10.3%	7.4%
Skilled birth attendants	0.069	0.21	0.01	7.0%	5.0%
Antenatal care visits 4+	0.152	0.43	0.07	31.7%	22.8%
Water source - piped	0.093	0.25	0.02	11.3%	8.1%
Early age pregnancy	-0.272	-0.03	0.01	4.2%	3.1%
Parity	0.019	-0.77	-0.01	-7.1%	-5.1%
Inter-pregnancy interval (in months)	0.002	5.11	0.01	4.6%	3.3%
Others	-	-	0.00	0.2%	0.2%

The adapted conceptual framework including all available indicators for the over 2-year age group is presented in Appendix 13.

Decomposition of predicted HAZ changes for the over-2 age group for the years 1992/93-2017 can be found in Figure 41. Similar to the under-5 age group, the factor that explains HAZ changes most is maternal and newborn healthcare, which confers a 0.13 standard deviation increase in HAZ. Wealth index and childhood vaccines account for a 0.07 standard deviation increase each. Reductions in open defection and increases in piped water sources each confer a 0.05 standard deviation improvement in HAZ score. Increased years of maternal education (0.03 SD), paternal education (0.02 SD), early age of pregnancy (0.02 SD), and decreased household crowding (0.003 SD) are the remaining factors that contribute to HAZ change in this model. Improvements in maternal and newborn healthcare comprise 18.6% of the total change in HAZ, followed by rising wealth index (10.0%), higher coverage of childhood vaccines (9.3%), reduced open defecation (6.6%), increases in piped water source (6.7%), increased years of maternal education (4.0%), paternal education (2.4%), decreases in early age at pregnancy (2.5%), and reductions in household crowding (0.4%) (Figure 42). This model predicts a 0.43 standard deviation increase in HAZ, which represents 60% of the actual HAZ increase (Table 17). This suggests that this model leaves 40% of the HAZ increase for over2-year-olds between 1992/93 and 2017 unexplained suggesting other factors impacted HAZ change over this time period that are not included in this analysis.

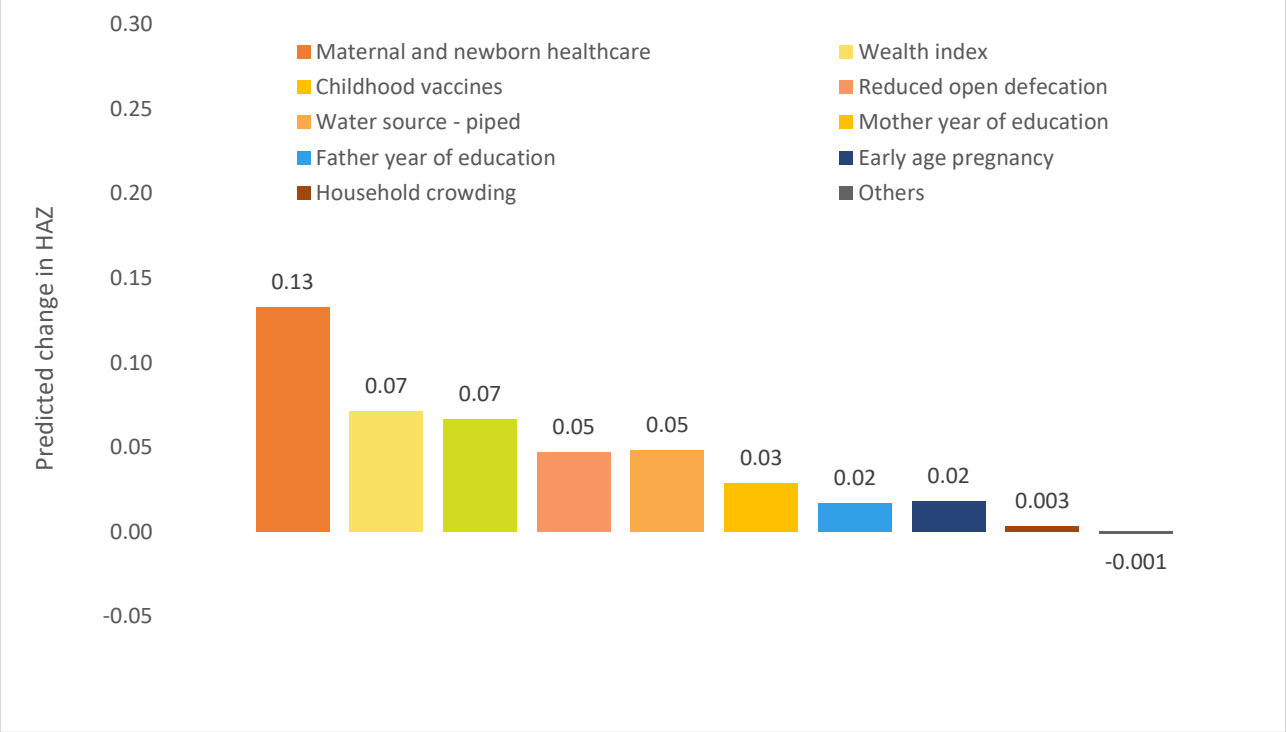


Figure 41: Decomposing predicted changes in HAZ (i.e. relative ranking of product coefficients for determinant domains), for children 24 months and above, period 1992/93 - 2017

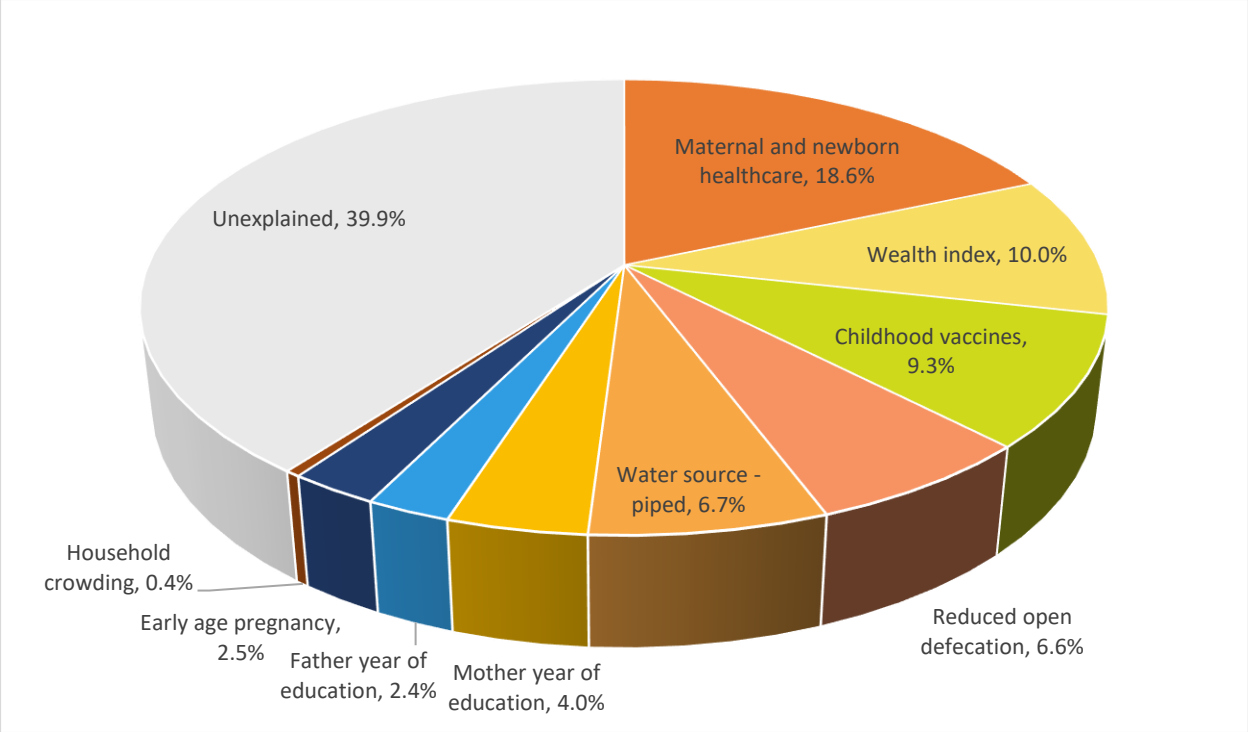


Figure 42: Decomposing predicted changes in HAZ outcome (i.e. % contribution of determinant domains) for children 24 months and older, 1992/93 – 2017

Table 17: Hierarchal approach Decomposition analysis for children 24 months and older, 1992/93 – 2017

Factors	Estimated coefficient	Mean difference (2017 - 1992/93)	Predicted change in HAZ	Share of predicted change in (%)	Share of total change in HAZ (%)
HAZ Score	-	0.717	0.43	60.1%	Unexplained (39.9%)
Wealth index	0.074	0.963	0.07	16.6%	10.0%
Mother year of education	0.019	1.517	0.03	6.6%	4.0%
Father year of education	0.015	1.154	0.02	4.0%	2.4%
DPT vaccine	0.616	0.108	0.07	15.4%	9.3%
Skilled birth attendants	0.151	0.162	0.02	5.7%	3.4%
Antenatal care visits 4+	0.241	0.450	0.11	25.1%	15.1%
Reduced open defecation	-0.203	-0.232	0.05	10.9%	6.6%
Water source - piped	0.209	0.230	0.05	11.1%	6.7%
Reduction in household crowding	-0.018	-0.170	0.003	0.7%	0.4%
Early age pregnancy	-0.333	-0.055	0.02	4.2%	2.5%
Others	-	-	-0.001	-0.3%	-0.2%

We conducted analyses for the 6-23-month age group, however, the model's results were unstable. The total mean HAZ change our model needed to explain was only a 0.21 standard deviation decline

in HAZ, which is not a large enough change to render our model's results meaningful. We also considered analyzing the under-6-month age group, however the sample size was too small to result in a useful model.

Chapter 4: Results – Qualitative Inquiry

Results from the in-depth interviews and focus group discussions are organized according to type of stakeholder, by national and community-level perspectives. Results are summarized according to key themes including basic (contextual) factors, nutrition-specific and –sensitive policies and programs, intermediate and immediate causes. Supporting evidence and quotes were selected to demonstrate a range of participants' diverse perspectives on the determinants, and policies and programs.

4.1: National Stakeholder Perspectives

In-depth interviews were conducted with 21 national key informants and stakeholders working in the health and nutrition sectors (Table 18). These State and non-State actors were identified and recruited based on their substantial expertise and experience working in nutrition-specific and –sensitive sectors, institutions and programs in Senegal and include multilateral, bilateral, government (national and subnational), academic/research, as well as local/international non-governmental organizations. Key informants' responses were categorized into several major drivers based on our conceptual framework including basic or distal causes, nutrition-specific or sensitive programs, intermediate causes, and immediate or proximate causes.

Table 18: Summary of national stakeholders

Participant #	**Organization**
Participant 1	Monitoring & Evaluation Officer, Cellule de Lutte Contre la Malnutrition, CLM (Unit Fighting Against Malnutrition)
Participant 2	Institute of Social Pediatrics
Participant 3	Direction of Maternal and Child Health, Ministry of Health
Participant 4	UNICEF
Participant 5	WHO
Participant 6	Retired Professor (Pediatrics & Nutritionist)
Participant 7	Professor of Pediatrics, Faculty of Medicine
Participant 8	Head of Nutrition Division, Direction of Maternal and Child Health, Ministry of Health
Participant 9	Medical Doctor, Cellule de Lutte contre la Malnutrition, CLM (Unit Fighting Against Malnutrition)
Participant 10	Sociologist, Hellen Keller International
Participant 11	Nutritionist, Hellen Keller International
Participant 12	Nutritionist, Hellen Keller International
Participant 13	Medical Doctor, Former Director of Hellen Keller International
Participant 14	Nutritionist, Intrahealth, Neema/ Intrahealth-Nema
Participant 15	Intrahealth-Neema
Participant 16	Nutrition International (Former Micronutrient Initiative)
Participant 17	Action against Hunger (ACF)
Participant 18	Institute of Food Technology (ITA)
Participant 19	Food Security Executive Secretariat
Participant 20	Director, Ministry of Woman, Family and Gender
Participant 21	Social protection and national solidarity Agency

Contextual Factors

Key contextual factors that facilitated gains achieved in the reduction of stunting include political stability and peaceful democratization, improved education/women's empowerment, urbanization, as well as moderate reduction of poverty and increased accumulation of wealth.

Social Political Context

The 1990-2000s period featured low economic and social conditions, with the majority of the population living below the poverty line. Further, in 1994, structural adjustment reforms resulted in the rapid devaluation of the CFA franc by the IMF, as well as inflation, decreased commodity (particularly agricultural/crop) prices, increased food insecurity and civil unrest in largely the urban regions, including Zinguinchor (49). Low-level internal conflict in the Casamance region (southwestern Senegal composed of Zinguinchor and Kolda) has been ongoing since 1982 and was initiated by the separatist *Mouvement des forces democratiques de la Casamance* (MFDC). An estimated 3,000-5,000 people have died during the conflict and the number of internally displaced persons during the peak of insurgency, during late 1980s, was estimated at over 60,000 individuals, largely from the Zinguichor region (21,22). Despite this longstanding internal conflict, key informants highlighted that low violence and general political stability have represented driving forces and provided a supportive policy environment for public investment in education, health and nutrition.

> *"Senegal has not experienced any major crises, war, or unrest, which has kept the country calm despite the political upheavals that have never prevented the country from functioning. The institutions are in place and fully operating and people live well; there is nothing comparable to a country in war. So when we have an environment of peace, of political stability in my opinion, the social indicators improve, children will go more to the schools, with the opening of the health structures, the populations have better access to healthcare, and with the efforts in the field of hydraulics, people have better access to drinking water and sanitation. These are advances that have led Senegal to huge improvements in nutritional status."* [Former Country Director of Hellen Keller International]

Poverty Reduction

Poverty has reduced somewhat in Senegal between 1991 and 2011, as the poverty headcount ratio at $1.90 a day was almost halved from 68% to 38%, respectively (50). The Multidimensional Poverty Index (MPI) in Senegal has also shown some improvement over time as it decreased from 0.440 in 2010 to 0.293 in 2017. However, substantial inequities in the MPI exist between rural (0.434) and urban (0.119) areas (51,52). National respondents indicated that high rates of poverty contributed to the initial burden of stunting, and that declines in poverty and improved standards of living were related to observed decreased chronic child malnutrition. Experts felt that poverty reduction was largely a result of investments by the State through initiatives, including the PNC and PRN, with integrated elements of social protection to support resilience during the economic challenges related to the currency devaluation.

> "*As you can see over the years there is some progress in some factors that actually...that actually impacted the level of stunting. Because there is a small evolution in the levels of knowledge; it has not remained at the same level because the level of education of the populations is increasing over time. The standard of living of some populations has also contributed in slightly affecting stunting. Indeed, a thorough analysis of stunting indicates that it is higher in the quintiles with the highest levels of poverty."* [UNICEF Representative]

Education & Women's Empowerment

Overall, net enrolment in primary school has increased from 49.2% in 1996 to 72.3% in 2016 (50). Disparities in education by gender have decreased, as the gender parity index of primary school comparing enrolment of girls and boys has increased gradually between 1971 and 2016 from 0.594 to 1.08, respectively. In addition, female literacy (aged 15-24 years) has increased from 41% in 2002 to 59% in 2011, however a decline to 51% in 2013 was observed (50). Further, the Gender Development Index (GDI) increased from 0.781 in 1995 to 0.911 in 2017, and a slight improvement in the Gender Inequality Index (GII) was achieved over the same time period from 0.644 to 0.515 (53). The proportion of seats held by women in the national parliament has increased dramatically since the late 1990s, from 11.7% in 1997 to 41.8% in 2017 (50), achieving substantial progress towards achieving gender parity in national decision making structures. Increased overall educational attainment and improved literacy were recognized by national respondents as driving factors in improvements in nutrition. In particular, targeted efforts in the education sector focusing on girls' education has led to a significant increase in the proportion of girls in the school population. Programs that focused on health and nutrition promotion also contributed to an increased knowledge among women relating to nutrition.

> "*The higher the level of education, the easier it is for the person to become aware, the more quickly they adopt the practice, according to what is noticed on the field. Accompanying women who have a fairly high level of education are much easier to raise awareness with whom it is easier to negotiate with the desired practices.*" [USAID Representative]

> *"And so this [PISEN] is a program that has really helped to educate women nutritionally, to teach them how to transform certain foods, what foods are rich, what foods can be put together to enrich the diet and especially they have been taught to fortify food."* [WHO Representative]

Urbanization

Senegal has experienced a consistent increase in urbanization over time, from 39.2% of total population living in urban areas in 1992 to 46.7% in 2017 (50). Despite this moderate increase in urbanization over time, this did not represent a key driver of stunting decline according to national respondents. Despite this moderate increase in urbanization over time, no national respondents identified urbanization as a key driver of stunting decline in Senegal.

Remittances & Labour Migration

Remittance inflows due to labour migration increased from $142 million USD in 1990 to $2,238 million USD in 2017 (54). Further, the inflows as a proportion of GDP have gradually increased over time from 2.5% of GDP in 1990 to 13.7% in 2017 (55). Key destinations for international migration from Senegal included France, Gambia, Italy, Spain and Mauritania (56), with the majority migrating for labour and employment opportunities (57). More than half of remittances received in Senegal are spent on food, education and health care (human capital) (58). Further, according to the Senegal 2009 Migration and Remittances Household Survey, households spent over 80% of remittances on food (59). Despite these trends, remittances and labour migration were not discussed by any national and community-level respondents as driving factors of nutrition or stunting improvements in Senegal.

Basic Causes: Intermediate I

National respondents indicated that several nutrition-specific and –sensitive policy efforts demonstrated political will and commitment towards improving nutrition in the country. Challenges faced during the implementation of initiatives were also outlined.

Nutrition-Specific Policies & Programs

Significant political will and commitment by the Government of Senegal to global targets (e.g., the MDGs), was identified by several national key informants as a critical driver to improvements in nutrition and the reduction of stunting.

> "*We must start by saying that these are political commitments that Senegal has made in relation to charters at the global level. At the global level too, there have been commitments that states have implemented to fight against malnutrition and all forms of malnutrition because people knew that it is this malnutrition that will lead us to adult chronic diseases. And so, with all these commitments that Senegal has ratified and to respond to all this at the political and hierarchical level, some policy documents and strategic plans have been developed, and a cell has been set up to centralize all the sectors of development for a better inclusion of nutrition."* [WHO representative]

Community Nutrition Project (PNC, Project de Nutrition Communautaire)

The PNC (1995-2002) was a pivotal initiative to address nutritional challenges in Senegal due to environmental conditions, as well as poor socioeconomic climate and poverty due to the structural adjustments and devaluation of the FCFA (60). Funded by the World Bank and implemented by the Agency for Public Works and Employment (AGETIP), this program targeted poor urban areas (49) and was piloted for 6 months in three cities and subsequently implemented in almost all urban areas nationally over five years (61). Key components of the PNC included a focus on information, education and communication, growth monitoring of children under-3 years, provision of food supplements, referrals for health services and home visits for participating children. Improved drinking water and food security were also targeted through the PNC (60). Despite substantial challenges to implementation including high costs, inadequate targeting of efforts and capacity building of stakeholders, as well as a lack of coordination and ownership of nutrition by the Ministry of Health, the PNC represented a catalytic initiative in the nutrition sector (49). The adoption of a community-based and multi-sectoral approach to address causes of stunting at grassroots level and moving away from a more curative approach was outlined by national respondents as a key contribution of the program. Further, the PNC was a critical effort to catalyze the prioritization of nutrition at the national level, and contributed substantially to the initiation to the establishment of the CLM.

> *"An approach where one really had to go to the community level, work with the community, to change nutrition behaviours. This is the difference with the PNC that was [not] just about distributing flour to the mother and child. It was much more about a development approach that involves working with communities to reduce stunting, developing knowledge and changing behaviors. There was a need for a multi-sectoral approach."* [UNICEF Representative]

> *"So when there was this community nutrition program; in 2000 this program was evaluated. Now we thought, after the evaluation of the program, we now have to move forwards for nutrition. This is how the CLM was created. And when the CLM was created the Nutrition Enhancement Program came ..."* [UNICEF Representative]

Nutrition Coordinating Body: Cellulue de Lutte Contre la Malnutrition (CLM)

In 1994, the *National Committee for the Fight Against Malnutrition* (*Commission Nationale de Lutte contre la Malnutrition, CNLM*) was initiated by a Presidential decree, largely to provide oversight for the implementation of the PNC (49). In 2001, the *Cellule de Lutte contre la Malnutrition* (CLM) was established (and replaced the CNLM) with the support of development partners, including the World Bank, USAID, UNICEF and WHO. The CLM represents a coordinating body for nutrition, and has been instrumental in catalyzing increased political will and prioritization of nutrition by decision-makers

over time, including increased financial allocation of resources (49). Key programs led by the CLM include the PRN, Universal Salt Iodization Project, Fortification Enhancement Program (PRF), Food Security Support Project for Vulnerable Households (PASAV), demand-based financing component of the health and nutrition financing project (PFSN), results-based financing project for maternal care, and projects focused on nutritional/food crises in Podor, Ranerou, Matam and Kanel (62). The CLM has substantially contributed to the institutionalization of nutrition through the establishment of a framework and implementation of efforts across all regions of the country. The positioning of the CLM in the Prime Minister's office, its concerted effort to coordinate nutrition across multiple sectors, increased financial resource allocation and prioritization of nutrition and the revision of the national nutrition policy represented critical achievements by the CLM to improve nutrition and stunting in Senegal. Several national respondents felt that the establishment of the CLM represented a substantial contribution towards ensuring nutrition represented a priority across sectors and levels.

"*...The government set up since 200[1] a structure to promote a multi-sectoral approach in the fight against malnutrition. This unit brings together all the technical ministries that have a role to play in the fight against the determinants of malnutrition. This structure is highly set up at the level of the Prime Minister's Office, which facilitates the coordination of sectoral interventions. So the state of Senegal has [from] very early [on] understood the advantage of this multi-sectoral approach to the fight against malnutrition, as each sector uses its comparative advantages to identify interventions to combat malnutrition. The other important element for me is that the State of Senegal has dedicated an important budget line to nutrition. And so the state regularly increases its share in the fight against malnutrition within their budget. Partners also support the state in its efforts to fight against malnutrition. I think these are very important elements, but additionally the Government recently revised its nutrition development national policy letter to involve more the other sectors, in particular the private sector in the fight against malnutrition through food enrichment and fortification of food; the government has also enhanced hydraulics, sanitation, and fishing to increase the availability of access to drinking water and the availability of aquatic products to fight against micronutrient deficiencies."* [CLM representative]

"I think it's mostly multisectoral policy! I think that the CLM, the community actors contributed a lot to that." [Institute of Social Pediatrics]

"Now it is in 2001 with the creation of the CLM, we said that nutrition is a question especially of several sectors. And so it's a matter of development itself." [UNICEF representative]

Nutrition Enhancement Program (Program de Renforcement de la Nutrition, PRN)

The PRN was implemented during 2002 to 2006, with a subsequent reform introduced in 2007 and ended in 2014. It employed a multisectoral approach and aimed to improve the nutritional status of vulnerable populations, particularly children under five years of age living in poor urban and rural areas, as well as pregnant and lactating women (63). The PRN represented a key program implemented by the CLM and also focused on strengthening institutional and organizational capacity to implement and evaluate nutrition interventions. National respondents felt that this paradigmatic shift in nutritional approaches and the institutionalization of nutrition across sectors and multiple levels of governance represented a key contribution of this nutrition program.

"*The context was favorable with a paradigm and orientation shift; a multisectoral approach, a large-scale preventive approach etc., and that's how we set up the PRN."* [CLM representative]

"The big difference the PRN has made is that nutrition is institutionalized, first at the sector level and then through working with the community to change behaviours." [UNICEF representative]

Mandatory Fortification of Salt, Flour & Oil

In 2009, the Government of Senegal issued a national decree, following the Accra Conference, requiring that imported and domestically produced refined vegetable oils (palm, cotton, palm kernel, peanuts, sesame, sunflower, canola, corn and soybean) be enriched with vitamin A. In addition, imported and domestically produced soft wheat flour must be enriched with iron and folic acid (64,65). In 1995, a Prime Minister's decree was established to set standards for iodized salt production and distribution. A Presidential decree initiated mandatory iodization of all edible salt in 2001. This program has been led under the CLM since 2006. The Government of Senegal adopted the universal strategy of salt iodization (66). National respondents felt that long-standing initiatives to iodize salt led by the CLM, represented an important national and private sector collaboration to improve nutrition, however the number of private salt producers continues to represent a challenge to achieving substantial progress in this area.

> *"It was the commitment of the state. It is because the state is committed that it has implemented the decree; for as long as it is not mandatory, it is difficult to work with the private sector. So, there was already a lot of enthusiasm among the partners who were very much in favour of this program implementation, but I think that the decisive factor was the decree that made the fortification mandatory. And therefore, the industrialists should and could only abide by this decree because enrichment was mandatory. I think that this was the first factor of success*." [UNICEF representative].

> *"…It is mainly the fact that the production of oil and flour is basically centralized: you have deal with a few producers. While for salt iodization you are dealing with thousand and one producers. And so these people are hard to say they do not deviate from the average."* [UNICEF representative]

> *"But also, within the framework of the CLM there is also the question of salt iodization, there is also the question of small agriculture within the framework of this program, there are also questions of fortification of food of this program and institutionally."* [UNICEF Representative]

Food Security Programs

Several key informants felt that the *Child Nutrition and Food Security Project (NESA, Project Nutrition Enfant et Securite Alimentaire)* introduced in 2009 represented a key contribution towards addressing extreme poverty and hunger, and meeting the MDGs in Senegal. This was achieved through the introduction of cash transfers and social safety nets for vulnerable households including women and children. Effective targeting of vulnerable regions and strong donor funding/support were identified by key informants as factors that enabled programmatic success. Another program identified by national experts included the *Integrated Education and Nutrition Program* (PISEN) – which aimed to improve the health and wellbeing of children and women through sustainable food and nutrition security, basic education and training, as well as delivery of a comprehensive package of quality health interventions. This initiative was implemented over 2012-2016 in four high-burden regions in Senegal (Sehiou, Kolda, Kedougou and Dakar) and represented a coordinated effort among multilateral donors (67).

> "*It's a program [PISEN] that has done two things: first, to get the operational level to work, to involve the operational level in the planning of priority interventions. Secondly, to involve communities, administrative authorities and local communities in taking into account their own health. And it has also made it possible jointly to evaluate the contribution of the United Nations system in the intervention zones.*" [WHO representative]

> *"The idea was to go beyond small curative projects...rather than reacting, we had to have a large-scale, multisectoral, preventive approach to malnutrition. So, the goal was to expand the coverage of community nutrition interventions in Senegal... but the idea was really to target the areas where*

the need was greatest, where there was the most prevalence of malnutrition. So, it is within this framework that this program has been implemented with several components and has had the participation of several departments in its steering committee and the implementation of activities by these departments." [CLM Representative]

One national respondent also highlighted agricultural transition as a potential underlying factor, including diversification of production including increased sources of animal protein.

"Since there are more and more efforts being made to diversify agricultural production. Diversification of agricultural production in all the sectors, eh? When I speak of the agricultural sector, agriculture strictly speaking - breeding, horticulture, aquaculture, fishing etc. everything is included in it." [Retired Professor in Pediatrics and Nutrition]

Nutrition-Sensitive Policies & Programs

Long-standing efforts to implement cross- and multi-sectoral collaboration are evident and nutrition has represented a national development priority across sectoral policy letters of ministries and directorates including health, agriculture, hydraulics and sanitation, and early childhood development. Improvements across other sectors including education, health and access to water have supported gains to addressing underlying determinants of chronic malnutrition among children. Several specific nutrition-sensitive policies and program efforts were discussed by national key informants.

"We now have nutrition-specific interventions, but there are as well sectors that develop nutrition-sensitive interventions. And as these nutrition-sensitive interventions address the determinants of malnutrition, I think, we can explain this decline by the increase of the volume or mass of nutrition." [CLM representative]

"The interventions to be implemented are first and foremost based on the multi-sectoral approach. Sectors need to have nutrition goals, get the right budget, and follow their nutrition goals. This means that today, the fishing sector must have nutrition objectives including the quality *of products and their greater distribution and accessibility. So first of all, the sectors must take ownership of nutrition issues and institutionalize them at the sectoral level. I think that if we succeed in so doing, we will have achieved a great deal to the extent that it is the sectors that will be in charge of everything. Now, in the meantime, we must also proceed with the programs that have been proven, namely, nutrition programs, health programs, vaccination programs, vitamin A supplementation programs, to be able to further reduce stunting and also to ensure prevention through a good nutrition of women, a good knowledge of nutrition, a good evolution in habits, a good evolution in beliefs and an elimination of a few barriers."* [UNICEF Representative]

Contributions of Community-Based Actors & Donors

National respondents recognized the role of strong community-based actors and stakeholders, as well as grassroots activities as drivers of success in nutrition efforts. Earlier successes of local level implementation of nutrition programs, as well as an increased number of nutrition-focused experts were specifically highlighted as contributing factors.

"What made the whole process easy is that in Senegal there was already a strong experience in nutrition at the community level. Indeed, there were already NGOs with their strong experience in program implementation in the nutrition intervention areas. We have a critical mass of nutrition stakeholders, people who were trained in that field as well as people who were trained in other fields but who were interested in nutrition, and nutritionists with an experience in getting people to act". [CLM representative]

In addition, the importance and contribution of diverse bilateral and multilateral donors in the implementation of nutrition-related efforts was recognized by national key informants.

> "*So I think it was an effort has allowed a little to improve this indicator. Both the contribution of the state which was decisive from the political point of view as well as from the financial point of view; the intervention of donors such as the World Bank, Canada, the United States but also the United Nations system which has ensured an important leading in particular. I want to mention a little UNICEF in the questions of nutrition and child health but also civil society organizations like Nutrition International, like Helen Keller International, Save The Children, Child Fund that have implemented ..., because even in some areas they are executing agencies of the CLM programs and all of these interventions projects and programs helped to move stunting."* [UNICEF Representative]

Challenges to Implementation

Several challenges were discussed by national key informants that may limit effective implementation of nutrition-specific and –sensitive efforts. These included:

- Inequitable coverage and access of programs;
- Competition and dynamics between actors and institutions;
- Limited monitoring and accountability of community actors to ensure accountability and implementation of nutrition programs;
- Limited involvement of local authorities limited sustainability;
- Inadequate support and training for nutrition experts;
- Challenges with health promotion and social behaviour change communication at community level (e.g., promotion of breastfeeding);
- Lack of focus of adolescent girls within nutrition programs;
- Sustainability of development initiatives; and
- Failure by donors to align with national priorities.

Underlying Causes

Underlying factors discussed by national key informants included moderate increases in access to basic resources including drinking water and sanitation facilities. The role of community health providers and the increased training and availability of nutrition experts were also underlying factors that may have facilitated improved access to health services.

Improved household environment

Modest improvements in access to improved drinking water were observed overtime, as the proportion of the population that obtains their drinking water from an improved source increased from 73.3% in 1992/93 to 78.5% in 2017. However, access to piped water did not vary substantially overtime. The proportion of the population with improved, non-shared toilet facilities increased from 22% in 1992/93 to 55.1% in 2017. These trends towards improve access to water and sanitation were also linked to improved nutritional status by key informants. Efforts to improve WASH were largely achieved through implementation of the multisectoral PRN program, and national respondents indicated that this has supported improvements in access to handwashing and open defecation

> *"So that changed, there was also a strong tendency to promote latrines in urban and rural areas. That also had an impact - I think that's the case! There were several initiatives on handwashing, on everything about water, hygiene and sanitation too. There have been many in Senegal and there is also the fact that we have improved drinking water supply."* [CLM Representative]

"*…with the efforts being made in the field of hydraulics, people have better access to drinking water and sanitation. These are what led Senegal to huge improvements in nutritional status.*" [Hellen Keller International]

"This is where the [PRN] program has a WASH component, so WASH is hygiene, water, sanitation. it is water, sanitation...so it's water-sanitation, a water-sanitation program that allows households to have water points so that they can wash their hands at critical moments; but also so that households no longer open defecation for whom they can have access to latrines." [CLM Representative]

"Efforts in sanitation, now it started a long time ago with the PRN, with the program of strengthening in nutrition and the other projects like YAJJENDE which have important parts the "set-setals", every week, the sanitation weeks, where we sweep the whole village or the neighborhood, that's effort. The fact, for example to put garbage out of the village, you also see it is aspects and even to build latrines to allow to end the defecation in the open air and it is very important these State and NGO efforts." [Helen Keller International Representative]

Increased access to health services

The availability of health providers in Senegal has increased with the number of physicians increasing from 594 to 1,066, and the number of nursing and midwifery personnel showing modest increases from 3,287 to 4,822 between 2004 and 2016 respectively. Despite this progress, as of 2016, the density per 1,000 for both physicians and nursing/midwifery personnel remains 0.068 and 0.309 per 1,000 population (68). These numbers are far below the WHO recommendation for countries to meet the minimum threshold of 1 physician per 1,000 population. Provision of health services at the community level has supported accessibility and use of promotional, preventive and curative services through matrons, community health agents (ASC, *agents de sante communautaires*) and home-base care providers (DSDOM, *dispensateurs de sante a domicile*). Community health providers including community volunteers (*relais communautaires*) and godmothers (*bajenu gox*) provide referrals, promotional and preventive health services (69). Although the estimated number of community health providers remains below the recommended numbers, national respondents indicated that these lower cadre health providers have facilitated health promotion and referrals for health services, particularly for maternal and child health.

"There was a very good collaboration between what is done between the health system and at the community level it is what has contributed more to the success of the project with the involvement of the communities, because that in each community leaders of the persons responsible for forming support groups, they facilitated the registration of children in the program so just after the birth there is the head of district or his representative or the bajenu gox will inform the relays you have to enlist such child in your programs, the child is enlisted the mother is followed in relation to home visits on exclusive breastfeeding and at 6months she starts to participate in the communication activities at the center of screening then she has his package of 30 bags of liquid based Nutrient Supplements (LNS)." [Representative from Micronutrient Initiative]

In addition, one national respondent felt that the introduction of advanced bachelor and masters level university programs focusing on nutrition have been introduced since 2009 and have helped to substantially increase the capacity, knowledge and availability of specialized human resources for health.

"I come back again to the question of the critical mass of nutritionists. Such programs need, say, highly qualified human resources, there is an insufficient critical mass of high level nutritionists to manage the overall implementation of the different activities." [Retired Professor of Pediatrics and Nutrition]

Overall, key informants indicated an improvement in availability of basic services including health.

> *"The evolution of basic social services such as education, health, also access to drinking water have been decisive elements that have helped to progress a little bit...stunting rates at the Senegal level and allowing a significant reduction in stunting in recent years."* [UNICEF Representative]

Improved food security & Feeding Practices

Food security represented a substantial concern in relation to stunting and nutrition overall, and one key informant indicated that improved food security was due to decreased poverty, environmental and climate shocks, seasonality, as well as increased education. No national respondents indicated changes or improvements in food security over time.

> *"The problem is the ability of poor households to access the market sufficiently to ensure diversified and varied food. There is a double barrier that arises - both the economic aspect, the ability of households to have money throughout the year to access this, we know that seasonally, there is a more difficult period than another, which is between the month of June and the month of September...the food use is the result of many factors, cultural, individual and factors of influence and education."* [Professor of Pediatrics and Nutrition]

Breastfeeding Promotion

Rates of exclusive breastfeeding among children under five months, demonstrated increases since 1985 from 4.6% to 42.1% in 2017. Further, early initiation (within one hour of birth) increased from 22.6% in 2005 to 33.6% in 2017. Despite the promotion of breastfeeding, the provision of a prelacteal feed (often *"tokantal"* or holy water) is a commonly reported cultural practice in Senegal, with moderate increases observed over time from 47.9% in 2005 to 52.3% in 2017 of children (70). Although rates of exclusive breastfeeding continue to be low, several national key informants indicated that efforts to promote exclusive breastfeeding have led to some improvements in chronic malnutrition and stunting.

> "*And breastfeeding is being promoted. Good reason that since anyway, more and more mothers are breastfeeding children. Because there is the age, until 6 years...until six months, yes. I think it's being respected. The promotion of exclusive breastfeeding is a major determinant in the fight against stunting and there has been a whole campaign for the promotion of exclusive breastfeeding that is benefit.*" [Maternal and Child Health Department, Ministry of Health

Immediate Causes

National respondents felt that decreased fertility, increased spacing between births and the reduction of communicable infections has supported gains in child nutrition. However, further efforts are needed to address micronutrient deficiencies, such as iodine deficiency and anaemia.

Maternal Characteristics

The gradual decline in fertility has contributed in some ways in reducing stunting in children. The total fertility, has decreased from 6.53 births per woman in 1990 to 4.77 in 2016 (50). Increased use of modern methods of contraception by women has increased inter-reproductive intervals or spacing. National key informants felt that this allowed women to prioritize children's health and to avoid competition for children's access to food resources.

> *"I'll say more or less, they played [a role] because family planning has advanced, interventions in relation to family planning have made progress in this country. Normally these are factors that impact on children malnutrition."* [Nutritionist, Helen Keller International]

"Among the malnutrition prevention elements it is the spacing of births through family planning that plays an important role because it allows mothers to space births, to have more time for themselves, and more time to devote to their children's diet." [Division of Reproductive Health, Mother and Child's Health, Ministry of Health Representative]

Reduced burden of child diseases

Overall, national key informants felt that infections, including diarrhea, measles, malaria, have decreased over time and that this reduction in childhood illness has benefited and supported gains in child malnutrition and growth. These trends observed by respondents are corroborated by published evidence on communicable diseases. According to data from the DHS the prevalence of children with diarrhea in the five years preceding the survey has decreased modestly from 20.4% in 1992/93 to 17.5% in 2017. Declines were also observed for malaria prevalence (according to microscopy) from 2.9% in 2010/11 to 0.4% in 2017 (70). Drastic achievements were made to eradicate measles in Senegal as the number of cases declined from 15,367 in 1992 to 11 cases in 2017 (71).

"As far as the other indicators are concerned, we must also take into account the global environment where there has been an improvement, especially in the area of health, in relation to the childhood diseases, which have had an impact in the past. Nutritional status of children including severe epidemic diseases such as measles and malaria...but have almost disappeared! There is no longer an epidemic of malaria, no more measles epidemic. So these are the factors that are there and even the...in fact apart from diarrhea I think that most of the childhood diseases that worsened the nutritional status of these children started to disappear or to have an effect less compared to what we had in the past years. The improvement of the care of these children and the prevention of the most deadly and morbid pathologies may help to improve this." [Professor/Academic]

Improved dietary intake

Substantial improvements in nutrition were associated with efforts and investments made by the State, with the support of donors, including international organizations and grassroots activities. National respondents did not discuss drivers of change relating to dietary intake directly. Despite progress, continuing nutritional challenges include high rates of anaemia among women and children, as well as iodine deficiency.

"The only concern is the lack of micronutrients, particularly anaemia...So we have fairly high levels of anaemia, and of course for children as well as women, it is almost 66% of 0 to 5 year-old children who are anaemic and that is a real problem. We also have some difficulties with iodine deficiency. Because we realized that there were only 37% of women of reproductive age in Senegal who have satisfactory iodine status." [CLM Monitoring Evaluation and Officer]

Child Characteristics

Child characteristics including birth weight and intergenerational factors were not highlighted by national key informants as contributing to stunting declines among children in Senegal.

4.2: Regional Stakeholder Perspectives

In-depth interviews were conducted with 19 key informants in Diourbel, Louga and Kaolack regions including community health workers, religious leaders, traditional leaders and chiefs, teachers and educators, nurses and midwives, and NGO representatives.

Table 19: Summary of regional stakeholders

Participant #	Organization
Diourbel Participant 1	Chair of Committee Health Post, Pattar
Diourbel Participant 2	Community health worker, Diourbel City
Diourbel Participant 3	Teacher, Kindergarten, Diourbel City
Diourbel Participant 4	Imam, Diourbel City
Diourbel Participant 5	Caregiver at Recovery and Nutrition Education Centre, Diourbel City
Diourbel Participant 6	Chief of Pattar Village
Diourbel Participant 7	Community health worker, Pattar health post
Louga Participant 1	Community health worker, Niomre
Louga Participant 2	Deputy Director, Kindergarten, Louga City
Louga Participant 3	Imam, Louga city
Louga Participant 4	Chief Project, Action Against Hunger (ACF), Non-Governmental Organization
Louga Participant 5	Midwife, Niomre Health Post
Louga Participant 6	Treasurer, Committee Health Post, Niomre
Kaolack Participant 1	Nurse, Sibassor health post
Kaolack Participant 2	Community health worker, Pattar Health Post
Kaolack Participant 3	Community health worker, ASBEF NGO (Senegalese Family Planning Association)
Kaolack Participant 4	Director, Kindergarten, Diourbel City
Kaolack Participant 5	Community health worker, Dialene Health Post
Kaolack Participant 6	Supervisor, ASBEF NGO

Basic/Contextual Factors

Poverty reduction and improvements in maternal education were distal factors recognized by regional respondents that have contributed to the reduction in stunting among children.

Poverty Reduction

One regional respondent felt that efforts to reduce poverty are necessary, in order to adequately address food security and availability, particularly protein. However, no respondents indicated that reductions in poverty were observed and implicated in the reduction of stunting.

> *"I am advocating for an improvement of the living conditions and especially the access to food because I know by experience that some people stay months without eating fish*." [Community Health Worker, Diourbel]

Education
Two regional key informants identified improvement in education and knowledge among mothers as a key factor that has driven improvements in nutrition and child mortality.

> *"There are many things that did not exist but exist now. There is a decline in child mortality. The education of mothers has also played a considerable role and there are now more competence."*[Assistant Director for the House of Toddlers, Louga]

> *"Most moms do not ask for advice about breastfeeding. This is due to their ignorance. On the other hand, young mothers start asking questions about exclusive breastfeeding, because they have a higher level of education."* [WHO?]

Nutrition-specific and –sensitive programs/policies
Nutrition-specific and –sensitive efforts in Diourbel, Louga and Kaolack are largely implemented by State and non-State actors (e.g., Plan International, Action against Hunger, the Red Cross, USAID, Caritas, etc.). Implementation of the PRN and other donor-led efforts were identified by regional respondents as contributing to the improvements in nutrition trends and reduction of child mortality. One respondent felt that efforts since the 2000s have been effective and supported gains in child growth.

> *"There is a Nutrition Enhancement Program (PRN) and Action Against Hunger that work for malnutrition at Niomeré. The results of the PRN are satisfactory but we noted a slow down last year but currently the results are satisfactory."* [Community Health Educator (PRN) of Niomeré].

> *"There are three programs intended for improving child malnutrition. There is Caritas, the Nutrition Enhancement Program and the Red Cross. There are very good results especially the Nutrition Enhancement Program."* [Community Relay of Pattar]

> *"Red Cross has a program that improves the child's nutrition and there is also the House of the Nuns."* [Imam, Louga]

> *"There is a very good trend because there has been a reduction in child malnutrition. The programs of the 2000s are better. There are indicators that explain the improvement of child malnutrition."* [Community Health Worker, Kaolack]

The CLM was also identified as an effort implemented at national level. However, one regional key informant could not evaluate the successes or contributions of this effort.

> *"There is the anti-malnutrition cell that is put in place by the state. I cannot give any results in relation to this program."* [ASBEF NGO Supervisor, Kaolack]

Underlying causes
Improved access to health services and hygiene practices at household level were identified by these individuals as underlying determinants of nutrition and stunting gains.
Increased access to health services
The increased availability of health facilities and services at community level was recognized by one regional informant.

> *"There are enough health posts now."* [Nurse, Sibassor Health Post]

"We recommend that mothers go to the health post for antenatal consultations…Yes, those recommendations have changed over the time." [Community Health Worker, Sibasor]

In particular, availability and distribution of vitamin A and other micronutrient supplementation (e.g., "plumpy nut") occurred at community health posts was also recognized by several regional respondents as contributing to improvements in child health and nutrition.

"I know the importance of vitamin A and in that sense there are bags that are given in health posts like plumpy nuts, it's very good for the child's growth." [Treasurer health committee of Niomeré, Teacher]

"Vitamin A is available as supplementation." [Caregiver at the recovery and nutritional education unit]

"There is vitamin A and possibility of de-worming for children." [Community health worker, Member of the health committee]

Continuing challenges for access to health services identified by regional respondents included long distances for women to travel to reach health posts, and some women may not receive adequate antenatal care.

Improved household environment

Improved hygiene practices among households, largely handwashing, were identified by several regional respondents as contributing to improvements in health and nutrition.

"They practice some rudimentary rules. They know all the rules of hygiene but do not apply them. Some give food to their children without washing their hands with soap and water." [Community Health Worker, Niomre, Louga]

"There are families who know and apply the rules of hygiene inside the house. There are others who apply little or no hygiene, but there have been changes in the meantime." [Health Post, Dialene, Kaolack]

"Some families respect the hygiene rules but others don't. It's either due to a lack of information or to negligence. There are families who practice good hygiene rules but others neglect it." [Community Health Worker, Sibassor Health Post, Kaolack]

Immediate Causes

Respondents felt that limited dietary diversity due to cultural norms and practices, poverty and affordability of food continue to impede nutrition gains. Regional respondents outlined specific recommendations regarding exclusive breastfeeding for women, however cultural traditions around prelacteal feeding also need to be addressed to ensure continued progress and improve low rates of exclusive breastfeeding.

Dietary Intake

Health providers described recommendations provided to communities regarding exclusive breastfeeding and complimentary feeding. Overall, recommendations appear to be in line with global guidelines as they emphasized exclusive breastfeeding for the first six months, early initiation, no provision of a prelacteal feeding and the introduction of complimentary foods after six months.

"The children can consume the three meals of the family." [Community health worker, Diourbel]

"The child should not consume anything from birth to 6 months except the breast milk, that is to say, the mother is asked to practice exclusive breastfeeding. From this age, the child receives rich and varied complementary foods such as porridge, beans and cow's milk." [Community health worker, Sibassor Health Post, Kaolack]

Limited variety in children's diets and a lack of protein, in particular, were highlighted by regional respondents as key challenges. In addition, several regional respondents felt that the affordability of food, high rates of poverty and/or lack of education/knowledge hampered adequate dietary intake practices.

"Most of the time, the children eat rice in the houses, there is no variation for the food. Meat is for adults, because it's not enough for the whole family. It is the lack of means that justifies this situation for children." [Community health worker, Member of the health committee, Diourbel]

"Children only eat rice with fish or couscous." [Chief of Pattar Village]

"Even their mothers do not eat enough meat, let alone children. As for fruits and vegetables, they receive their portions but not enough partly because most children do not like vegetables. To see a mother who buys bananas for her child is rare. It's because they do not have the means of providing for that and there is also a mentality problem. Perhaps they also believe that the child should not eat fruit."[Nurse, Sibassor Health Post, Kaolack]

"Children eat only what their parents can afford. They do not eat fruit. The consumption of meat depends on the size of the household and the means of the family. They eat enough vegetables. Families do not have enough money to provide good nutrition for children." [Chief of Pattar Village]

"There are cases when even mothers have difficulties to follow the recommendations. There are several causes for not following the recommendation such as poverty and the mother's level of education." [Physician, Project Leader at Action Against Hunger (ACF) NGO]

Many regional key informants highlighted recommendations given to women regarding exclusive breastfeeding including early initiation after birth, avoidance of a prelacteal feed and exclusively breastfeeding for six months, and generally these were in line with global recommendations. However, several also outlined that failure to adhere to these recommendations regarding exclusive breastfeeding occur frequently due to pervasive sociocultural practices and behaviours.

"We recommend that the mother give the breast to the baby right after its birth and practice exclusive breastfeeding, which is of paramount importance for the child because the colostrum contains vitamins that protect the child against a lot of infections. We also advise her not to give the child water and not to mix breast milk with other foods for up to 6 months. This protects the child against certain diseases. The child will have a normal weight and will have a rapid growth." [Community Health Worker]

"...We tell them to do exclusive breastfeeding for up to 6 months. Give the breast to the newly born baby within 30 minutes. This should not exceed 30 minutes. Midwives and matrons are used to these practices." [Community Health Educator (CHE), Niomre, Louga]

"Mothers are advised to provide food to their children starting at 6 months. This practice often faces socio-cultural issues that result in children receiving liquid and solid food before that age." [ASBEF NGO Supervisor, Kaolack]

The provision of prelacteal feeding, including holy water ("tokantal") is a custom practiced by many women and may represent a barrier to achieving high rates of exclusive breastfeeding.

> *"We recommend in our customs that the child be given holy water before the breast of its mother and that practice exists till now."* [Chairman Pattar Health Committee]

A focus on behaviour change to transform dietary and culinary behaviours represented a potential area requiring further focus in order to improve diet diversity and nutritional gains at community level. Overcoming cultural barriers that do not allow children to reach to the middle of the communal bowl where vegetables, meat and fish are found is needed as this is considered rude/impolite.

> *"In terms of food it is not everyone who comes from a rich family. The parents cannot satisfy the food needs of their children because of a lack of means."* [Imam, Louga]

> *"Parents often forbid their children to eat fish."* [Nurse, Head of Sibassor Health Post]

4.3: Mothers in Communities Perspectives

A comparison of older and young mothers across three regions was conducted to understand the nutrition transition in Senegal at household and community levels. Mothers with children under-5 born in 1992-1997 period were selected as this represented a period prior to substantial gains in stunting reduction. Mothers with children born in the five years preceding the study (2012-2017), contrarily had the opportunity to benefit from sustained political will, as well as several, focused and community-based nutrition-relevant initiatives in Senegal, particularly those implemented in communities. Key basic, underlying and immediate drivers of stunting reduction were analyzed and compared by community and whether women had children born between 1992-1997 or 2012-2017. During FGDs in both community settings, mothers recognized multiple driving factors of improvements to the health and nutritional status of their children, affirming the need for a multifaceted, multilevel approach to target nutrition in Senegal. Table 20 highlights a summary comparison of communities (rural/urban), and mothers with children between 1992-1997 and 2012-2017, highlighting key topics and trends across multiple drivers of change over time.

Table 20: Summary and comparison of mothers in communities

Location	Drivers	Mothers of children born in 1992-1997	Mothers of children born in 2012-2017
Diourbel Region (rural)	**Distal Causes** *(For example: political context/stability/conflict, poverty reduction, education, women's empowerment, urbanization, labour migration/remittances)*	• Poverty represents a concern	• Reduction of poverty was observed
	Basic Factors *(Nutrition-Specific & -Sensitive Policies & Programs)*	• Vaccination is widespread	• Vaccination is widespread

Location	Drivers	Mothers of children born in 1992-1997	Mothers of children born in 2012-2017
	Underlying Causes *(e.g., improved feeding practices and food security, improved care and health services, improved household environment/WASH)*	• Access to drinking water represents a concern • Poor crop/agriculture production • Lack of sanitation	• Improved food availability • Improved food quality • Existence of a health post (advice and packet of vitamins) has supported improvements
	Immediate Causes *(e.g., improved dietary intake (infant and young child, dietary diversity, etc.), disease, maternal characteristics (parity, interpregnancy intervals, maternal age, maternal height) and child characteristics (low birthweight)*	• Good knowledge of infant and young child feeding recommendations • 4 consultations on average • Introduction of complementary foods usually from 6 months • Weaning (or cessation of breastfeeding) between 18 and 24 months • Children consume 3 to 6 meals a day children • Vitamin A supplementation is common	• Women attend 2 to 3 prenatal visits • Weaning (or Cessation of breast feeding) between 18 and 24 months • Women prepare the child's diet separately • Children consume 3 to 4 meals a day • Vitamin supplementation and packet of powder (provided by health facilities) is common • Children drink primarily water and fresh milk
Diourbel Region (urban)	**Distal Causes**	• Poverty represents a concern • Salinization of the groundwater (impacts the cultivation of vegetables)	N/A
	Basic Factors (Policies & Programs)	• Vaccination • Existence of a nutrition center in the neighborhood • Food based on cereals	• Vaccination is widespread
	Underlying Causes	• Lack of sanitation • Import of food products	• Sanitation and hygiene continue to represent concerns • Improved food availability • Women attend at least 4 prenatal consultations

Location	Drivers	Mothers of children born in 1992-1997	Mothers of children born in 2012-2017
			• Separate meals are prepared for the child • Food based on cereals and vegetables in orange colors • Mineral water used as a drink
	Immediate Causes	N/A	• Improvement of diet in the last five years observed by women in communities
Kaolack (rural)	**Distal Causes**	• Poverty represents a concern	N/A
	Basic Factors (Policies & Programs)	• Vaccination is widespread	• Vaccination is widespread • The Family Safety Aid Program *(Programme des bourses de sécurité familiale)* has helped reduce poverty among families
	Underlying Causes	• Improved dietary intake • The existence of fluorosis • Access to drinking water represents a concern	• Separate preparation of meals for children • Availability of food products • Quality of care received at hospital • Advice provided by the health post
	Immediate Causes	• Women attend 3 to 4 prenatal consultations • Women practice early initiation into breastfeeding • Introduction of complementary foods from 4 months • Weaning (or cessation of breastfeeding) from 18 months • Feeding the child from the family meal 4 to 6 meals a day	• Women attend 3 to 5 prenatal consultations between 3 and 5 • Women practice early initiation into breastfeeding • Children consume 3 to 4 meals a day, vitamins and supplements with blue and red capsules • Children drink primarily water and fresh milk • Women expressed a good knowledge of child feeding standards

Location	Drivers	Mothers of children born in 1992-1997	Mothers of children born in 2012-2017
		• Vitamin A supplementation drink: water and milk	
Kaolack Region (urban)	**Distal Causes**	N/A	N/A
	Basic Factors (Policies & Programs)	N/A	• Vaccination is widespread
	Underlying Causes	N/A	• Improved food availability • Presence of the health post has supported improvements • Sanitation represents a concern
	Immediate Causes	N/A	• Introduction of complementary foods from 6 months • Weaning between 18 and 24 months Separate preparation for the child
Louga Region (rural)	**Distal Causes**	N/A	N/A
	Basic Factors (Policies & Programs)	• Lack of drinking water	• Vaccination of children • Fight against malaria (advice for sleeping under mosquito nets)
	Underlying Causes	• Talk with (or lecture by) bajenu gox	• Sanitation represents a concern • Increased availability of a health post and support by midwives • Improved education • Food availability
	Immediate Causes	• Number of CPNs between 3 and 4 • Very few post-natal visits • Food based on cereals Vitamin supplementation of the child	• Advice during antenatal visits about the importance of a rich and varied diet • Feeding the child based on cereals and vegetables • Improved diet in the last five years
	Distal Causes	N/A	• Poverty represents a concern

Location	Drivers	Mothers of children born in 1992-1997	Mothers of children born in 2012-2017
Louga Region (urban)	**Basic Factors (Policies & Programs)**	• Vaccination of children	N/A
	Underlying Causes	• Access to drinking water • Lack of sanitation	• Lack of sanitation • Improved food availability • Availability of health worker
	Immediate Causes	• Food based on cereals (porridge, sombi, etc.) • Vitamin supplementation via community relays • Few control on what the child eats • Decline in diet in the last five years	• Advice on breastfeeding Advice during prenatal visits • Varied diet with vegetables Recommendations for complementary feeds based on vegetables and local dishes (mbaxal packet of powder) • Availability of godmothers or bajenu gox • Improved child nutrition in the last five years

N/A = Topic/issue was not discussed by mothers in FGD

Contextual/distal factors

Mothers in both rural and urban regions, as well as of younger and older children outlined poverty as an important contextual/distal factor. Despite some mothers claiming that poverty reduction gains were made, they concur that it continues to represent a pervasive influence on nutrition and health among all mothers participating in the FGDs.

Poverty

Several women across regions and groups indicated that poverty had a substantial influence on nutrition and children's health, particularly as it relates to food availability and security. A few women noted poverty alleviation gains, however the majority highlighted that further efforts to reduce poverty are critical.

> *"…There is a problem with poverty that makes people precarious and impacts the health and nutrition of children."* [Mother FGD Louga, urban, 2012-2017]

> *"Food availability and poverty alleviation have impacted children's nutrition and health"* [Mother FGD Diourbel, urban, 1992-1997]

> *"The health post and the reduction of poverty have impacted nutrition and the health of children."* [Mother FGD Diourbel, rural, 2012-2017].

Underlying Factors

Some improvements in food security and feeding practices and the availability of health services at health posts were observed by women in communities. Mothers felt that these represented underlying contributors to improvements in health and nutrition. Diverse challenges relating to water, sanitation and hygiene were observed across all regions and subgroups, and may represent an area of future efforts to ensure continued progress in reducing child stunting.

Increased food security & feeding practices

Several mothers (e.g., women in Diourbel with children born 1992-1997) indicated that the availability of food has substantially influenced the health and nutrition of children in their communities. Variation of produce by geographic location and seasonality also reportedly impacted the availability and consumption of fruits and vegetables.

> *"For me hygiene and the availability of food have really impacted nutrition and children's health"* [Mother, FGD 1992-1997 Group, Diourbel]

> *"In each season there are foods that are available and must be given to the child that are available during the season."* [Mother, FGD 1992-1997 Group, Kaolack]

Many women reported receiving advice regarding exclusive breastfeeding and nutrition from midwives, family members (e.g., mother and mother-in-law) and local community health providers, specifically the bajenu gox (godmothers).

> *"I listen to the bajenu gox."* [Mother, FGD Kaolack, urban, 2012-2017]

> *"The midwife advised me to wash the breast very well before giving it to the baby and to begin with the right breast before giving the left breast and allow the baby to suck enough milk before stopping. They also advise to give the baby the breast exclusively for six months and avoid giving the baby water for the first six months and if the baby cries to first verify if it is hungry, clean and if the diaper is clean and dry."* [Mother, FGD 2012-2017, Louga Town]

> *"My mother-in-law gave me advice by telling me to give the child breast every time he cries and when he wakes up."* [Mother, FGD 2012-2017, Louga Town]

Despite this guidance from various health providers, many women across all regions and age groups reported providing newborns with a prelacteal feeding of tokantal (holy water) before breastfeeding, in accordance with local religious and cultural practice.

> *"I gave them holy water because these are writings from the Quran."* [Mother, FGD 1992-1997, Diroubel rural]

> *"I gave them holy water first, because my mother-in-law told me to wait until going back to the family home to give them holy water."* [Mother, FGD 1992-1996, Diourbel rural]

> *"I gave them the "tokantal" first because it's our tradition*." [Mother, FGD 2012-2017, Kaolack urban]

Improved access to health services

The availability of local health posts was highlighted by some women as an important contribution to health and nutrition of their children. Most FGD participants had attended more than four prenatal visits and received advice from health providers regarding their health and nutrition. Key nutrition-related recommendations provided by health provided included eating iron rich foods and vitamins,

eating fruits and vegetables (e.g., bananas, oranges, carrots), and to pay attention to food that is high in sodium. Further, advice on women's overall health and wellbeing were provided including resting, avoiding hard work and lifting heavy objects, sleep under an insecticide treated mosquito net, avoiding a lot of bending, avoid sitting for long periods of time and to establish walking as a habit.

> *"For me, sanitation and our health post have really impacted nutrition and the health of our children."* [Mother, FGD 2012-2017, Niomre, Louga]

> *"During my last pregnancy, I went for five times to hospital for antenatal consultations. The midwife advised me to avoid any heavy tasks, to take three pills and to eat iron-rich foods."* [Mother, FGD 2012-2017, Niomre Village, Louga]

The majority of women participating in all FGDs were assisted during delivery by skilled health providers, primarily midwives. However, several women (e.g., in Diourbel region women with children born 2012-2017) reported receiving assistance during delivery by non-skilled health providers including matrons, traditional birth attendants or bajenu gox.

> *"When my child had diarrhea I did not bring him to the hospital, I followed the advice of the bajenu gox who advised me to make a solution made of water, salt and sugar, I did it for two days and the diarrhea stopped."* [Mother Group Discussion of Mothers 2012-2017, Louga Town]

Household environment: Water, sanitation & hygiene

Concerns were raised by some women regarding the lack of adequate sanitation facilities and stagnant water and garbage in streets. The availability of safe drinking water varied by region, and many women in Kaolack region reported substantial challenges with access to water. In Diourbel region, the salinization of the groundwater was reported by women to be a concern and it also impacts the agriculture and crops.

> *"We really have problems with drinking water supply."* [Mother, FGD 1992-1997, Kaolack]

> *"The lack of public pit in the street, all the dirty water is poured into the street and our children play in the street and these waters contain microbes that give diseases to our children."* [Mother from 2012-2017 Group, Louga Town]

> *"We cannot have good health without good sanitation, also in terms of food it is difficult for us to find fruits and vegetables, garbage in the street is also a problem, it is difficult to find fruit. The salinization of water is [also] a problem in this region."* [Mother, FGD 1992-1997 Diourbel, urban]

Immediate Causes

Adhering to recommendations from health providers regarding children's diet and vaccination schedules were outlined by mothers in FGDs as potential immediate causes of improved nutrition among children.

Dietary Intake

Recommendations by health providers relating to children's dietary intake focused on encouraging nutritious and non-spicy food including mashed potatoes, "mbaxal", "lakhoubissap", ndambé, mbaxal kethiak, potato, fish, millet porridge and boiled carrots.

"*I visited the health centre the day after the baby's baptism and the midwife recommended that I give the child mashed potatoes, fish, "mbaxal saloum" because of the vitamins contained in the peanut that is an ingredient of the dish."*[Mother, FGD with Mothers 2012-2017, Louga Town)

"My child I prepare him to eat alone, I give him food such as mashed potatoes, vegetables and porridge that is to say all that the child must eat except rice. Yes I am very satisfied with the quality of the food I give to the child." [Mother, FGD 2012-2017, Louga urban]

Women reported introducing complementary food from three to five months, and few followed health providers' recommendations regarding exclusive breastfeeding for up to six months.

"I started giving my baby complementary food from three months beginning with the "rouye" (porridge) and adding carrots." [Mother, FGD 2012-2017, Louga Tow]

Decreased infection and diseases

Vaccination of children was widespread among FGD participants across regions and age categories, and women reported that immunization sessions represented an opportunity for sharing recommendations or guidance on nutrition for children.

"The diet has improved because during immunization sessions, you are advised the foods that must be given to the child." [Mother, FGD 1992-1997, Kaolack]

Conclusion

This qualitative analysis highlighted diverse contextual/distal, policy/program efforts, underlying and immediate causes of stunting decline according to national and community level respondents. At the national level, sustained political will in nutrition, including increased budgetary resources and the establishment of a high-level multisector coordinating body, were identified as substantial drivers to the stunting decline. In addition, the introduction of community-based efforts (e.g., PNC and PRN), as well as multisectoral collaborations have helped to institutionalize nutrition as a priority across levels and sectors. At the regional level, respondents emphasized improvements in poverty and education, as well as increased accessibility of health services at community level and provision of recommendations relating to nutrition to women. Mothers in communities highlighted some changes in terms of poverty reduction, access to health services, and widespread vaccination of children. Women reported continuing challenges with access to safe drinking water and adequate local sanitation facilities, including disposal of waste.

Chapter 5: Nutrition Policy and Program Timeline and Financing

In this chapter, we aim to address study objectives 3 and 4. That is:

- To generate a systematic landscape of the major stunting-relevant policies and programs in Senegal, with focus on both nutrition-specific and –sensitive initiatives; and
- To track and document nutrition-related investments in Senegal by government and partners (e.g. financial allocations, expenditures).

As detailed in the methodology, results tabulated here were informed by the literature review, qualitative and quantitative data, and expert consensus.

First, we present a timeline graphic of key nutrition-relevant policies and programs that were recognized as central to stunting reduction in Senegal (Figure 43). Next, basic summary information is provided on each initiative and arranged in chronological order. An in-depth review of each initiative including as much of the below information as we could track through literature and consultations with key stakeholders is provided in Appendix 14. These broad and specific areas are also formally defined in Appendix 14.

- Description
    - An overview of the major objectives of the program/policy
    - Area of the country where the program/policy was delivered
    - Population reached (number of people reached, setting)
    - Details of scale-up
- Delivery Platform: is the channel by which a nutrition-specific intervention reaches the population in need.
    - Fortification-based platforms
    - Financial incentive-based platforms
    - Community-based platforms
    - School-based platforms
    - Technology-based platforms
- Key stakeholders
- Initiation process
- Key components
- Monitoring and Evaluation of Implementation
- Funding
- Success factors/barriers

We subsequently provide an overview the type of delivery platform used for key policies/programs (Section 5.4). Finally, we summarize the obtainable data on financial allocations/ actual disbursements and budgets/expenditures of the various initiatives identified in the policy and program timeline. It should be noted that several data gaps may exist due to limitations in trackable/available information.

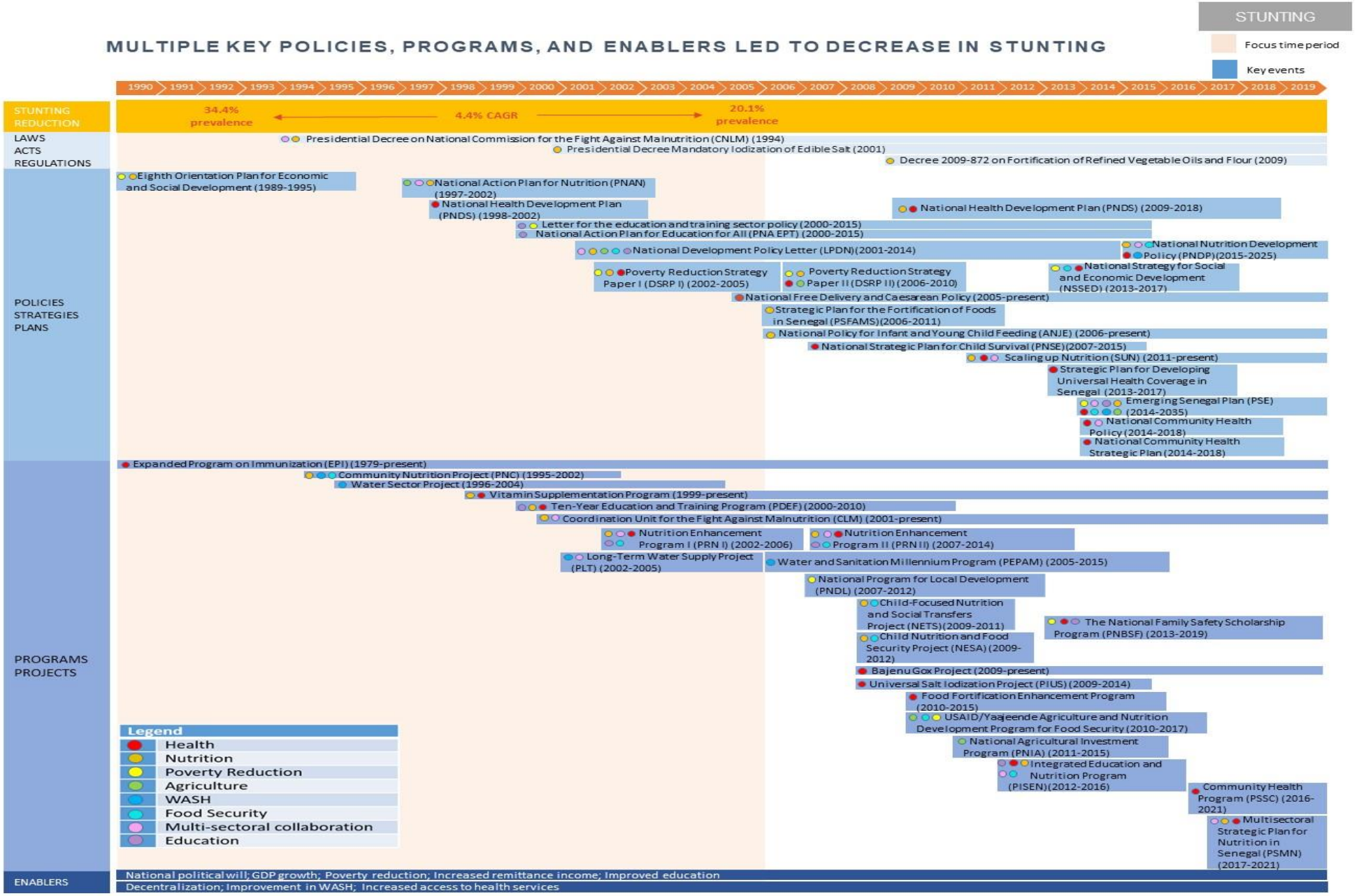


Figure 43: Overview of laws, policies, programs, and enablers between 1990-present in Senegal

5.1: Laws, Acts and Regulations

Further details on these laws, acts and regulations such as information on the initiation process, funders, and reforms can be found in Appendix 14.

ACTS/LAWS/REGULATIONS		
1. Presidential Decree: National Commission for the Fight Against Malnutrition / Commission Nationale de Lutte Contre la Malnutrition (CNLM) (1994-2001)	Description	Resulting from a Presidential Decree issued in June, 1994, the Commission for the Fight Against Malnutrition was in charge of identifying and implementing practical and effective solutions to address malnutrition in Senegal (72). This decree lead to the creation of the Community Nutrition Project (PNC) and was followed by the establishment of the Cellule de Lutte Contre la Malnutrition (CLM), the coordinating body for nutrition housed within the Prime Minister's office from 2001 onward.
	Importance	Very important as the Government's first attempt to implement a multi-stakeholder nutrition coordinating body
	Theme(s)	Multi-sectoral Collaboration
		Nutrition
2. Presidential Decree on Mandatory Iodization of Edible Salt (2001-present)	Description	Following the 1995 Prime Minister's Decree, which set standards for iodized salt production and distribution in Senegal, the Presidential Decree on Mandatory Iodization of Edible Salt was issued in 2001. The decree aims to ensure mandatory, universal iodization of all salt consumed in the country. This undertaking has been led by the CLM since 2006, in order to increase support/resources for universal salt iodization. By 2014, a GAIN-UNICEF study found that nearly 92% of salt distributed and 83% at production level met iodization standards, however the women of reproductive age sampled continued to be iodine deficient. Poor monitoring and enforcement of this legislation has limited progress, and the gap/discrepancy between quality of salt in production and that being consumed indicates that low-quality salt continues to be leaked into the local market by small salt producers (73,74).
	Importance	Likely not important for reducing child stunting
	Theme(s)	Nutrition
3. Decree 2009-872 on Fortification of Refined Vegetable Oils and Flour (2009-present)	Description	This decree requires that all imported and domestically produced refined vegetable oils (e.g., palm, cotton, palm kernel, peanuts, sesame, sunflower, canola, corn, and soybean oil) be enriched with Vitamin A (65). It also stipulates that all soft wheat flour (both domestically produced and imported) must be enriched with iron and folic acid. A 2013 survey found 96% of the flour samples collected contained added iron and 97% of the oil samples contained vitamin A (64).
	Importance	Recent initiative with insufficient evidence on its role in reducing child stunting
	Theme(s)	Nutrition

5.2: Policies, Strategies and Plans

Further details on these policies, strategies and plans such as information on the initiation process, funders, and reforms can be found in Appendix 14.

POLICIES/STRATEGIES/PLANS		
1. Eighth Orientation Plan for Economic and Social Development/ Huitème Plan d'Orientation pour le Développement Économique et Social (1989-1995)	Description	Starting in 1961, the Government of Senegal began issuing a series of consecutive 4 year plans known as the Quadrennial Economic and Social Development Plans (Plan Quadriennal de Développement Economique et Social, or PQDES). These plans were meant to define, outline and grow the central government's policies for developing the country. The Eighth Orientation Plan for Economic and Social Development presents an assessment of the Nutritional Protection of Vulnerable Groups/Protection Nutritionelle des Groupes Vulnerable (PPNS) and an evaluation of sanitation conditions. Two programs included in the Eighth Plan were: i) the Rehabilitation and Surveillance of Nutrition Program; and ii) the Maternal and Infant Health and Family Planning Health Program (49,60).
	Importance	Very important to understanding the country's historic and current nutrition strategies and establishing nutrition as a national priority in development agendas
	Theme(s)	Poverty Reduction Nutrition
2. National Plan of Action for Nutrition/Plan National d'Action Pour la Nutrition (PNAN) (1997-2002)* *PNAN was never actually implemented	Description	This plan was the result of international commitments made by Senegal during the International Conference on Nutrition and the World Declaration on Nutrition and following the aftermath of the devaluation of the CFA franc. This policy was Senegal's first effort for multi-sectoral action to address nutrition through improving food security. It was comprised of a set of short-term and long-term strategies, actions and accompanying measures aimed at reversing the alarming trends in indicators of children's nutritional status. These included: an increase in agricultural production to meet the food needs of the population and address the balance between supply and demand, implement a cereal processing policy to improve the purchasing power of both rural and urban populations, and improve the coordination, efficiency, and management of an alert and information system during emergencies. This policy however was never implemented due to inadequate resources(49,75).
	Importance	Likely important as Senegal's first effort for cross-sectoral collaboration for nutrition
	Theme(s)	Agriculture Multi-sectoral Collaboration Nutrition
3. National Health Development Plan/ Plan National de Developpement Sanitaire (PNDS) (1998-2008)	Description	In 1998, the National Health Development Plan (PNDS) dissolved the existing National Program on Family Planning (PNPF) and transferred responsibilities out of the Departmental Cabinet of Health into the Division of Reproductive Health in the Department of Primary Health Care (76). The main objective of the PNDS was to improve the health of the entire population of Senegal, with a priority given to reducing maternal, infant and child mortality and decreasing fertility. It aims to respond to health needs of the population by focusing on equal access to quality care. Key priority areas include: human resources, strengthening of the health system, promotion of prevention, improvement of access to quality health services for poor/vulnerable populations, strengthening and integrating priority health programs (e.g. reproductive health). The PNDS was implemented in two phases including the Five-Year Integrated Health and Development Program (PDIS) from 1998-2002, and the reformed PNDS Phase II from 2004-2008 (77).
	Importance	Very important as an effort to strengthen the health system

	Theme(s)	Health
4. Policy Letter for the Education and Training Sector/Lettre de Politique Generale pour le Secteur de l'Éducation et de la Formation (2000-2015)	Description	The Policy Letter for the Education and Training Sector aimed to achieve universal education in order to meet the Millennium Development Goals and address poverty in Senegal. Within this policy letter, elementary education was seen as the main priority for development, and improvement of education quality and decentralization represented key strategies for this development. A focus on vocational and technical training was also included, and aimed to improve the labour market, developing a skilled workforce that could help grow the economy (78).
	Importance	Likely important in improving the education system
	Theme(s)	Education
		Poverty Reduction
5. National Action Plan for Education for All/Plan National d'Actions de l' Éducation Pour Tous (PNA EPT) (2000-2015)	Description	Senegal hosted the World Forum on Education for All in Dakar in April 2000 where the Dakar Framework for Action was adopted. Later that year, the Ten-Year Education and Training Plan (PDEF) was introduced. The National Action Plan for Education for All (PNA EPT) aims to integrate and strengthen efforts of this Ten-Year Education and Training Program (PDEF). The PNA EFA represents a tool to achieve universal basic education and to implement Senegal's 2001 constitution regarding the right to education. The Plan has numerous objectives: Firstly, to meet the fourth objective of the Dakar Framework of Action on Education for All by ensuring equitable access to adequate programs for young people and adults in order to acquire knowledge and skills needed in daily life. Secondly, re-adjusting schooling dimensions of girls and capitalizing on political will for early child development. Thirdly, strengthening focus on excluded and marginalized populations. Fourthly, emphasizing basic education by mobilizing resources for different education components and supporting resource allocation. Lastly, it sought to reinforce and pilot structures established in the PDEF. The plan was successful in developing a concept for early childhood development and the establishment of new structures for toddlers, as well as preschool classes in elementary and day care centres; improving the gross enrolment ratio for primary and secondary education; and increasing training for staff. However, spatial and gender disparities in access to basic education and insufficient education structures remain.
	Importance	Likely important in reducing illiteracy rates
	Theme(s)	Education
6. Nutrition Development Policy Letter/Lettre de Politique de Développement de la Nutrition (LPDN) (2001–2014)	Description	This policy brief on nutrition aligns with Senegal's commitments at the global level, notably within the Scaling Up Nutrition (SUN) initiative. The Nutrition Development Policy Letter (LPDN) reflects a new approach in the fight against malnutrition, highlighting the multi-factorial nature of its causes. The key objectives of the LPDN aimed to address: immediate causes of malnutrition related to inadequate dietary intake and the health status of vulnerable groups; underlying causes related to household food insecurity, the level of sanitation of the living environment, and the level of functionality of health facilities; root causes related not only to the level of socioeconomic development within Senegal but also to the institutional aspects; and promotion of a multi-sectoral approach in the implementation of nutrition interventions (79).
	Importance	Very important as the first effort to define national nutrition policy and to outline specific strategies for programs and monitoring
	Theme(s)	Multi-sectoral Collaboration
		Nutrition
		Agriculture
		WASH
		Education

7. Poverty Reduction Strategy Paper I (PRSP I)/Stratégie de Reduction de la Pauvreté (DSRP I) (2001 – 2005)	Description	The goal of the Poverty Reduction Strategy Paper I (PRSP I) was to ensure adequate social, health and nutritional coverage for children from vulnerable families in Senegal. In its framework, the Government of Senegal was committed to developing and implementing a targeted nutritional policy for children living in the most vulnerable households. This included the establishment of cafeterias and latrines in schools located in poor areas, and awareness-raising activities geared towards parents, promoting oral rehydration therapy and nutritional interventions to prevent diarrheal diseases, drug addiction and growth delays (80).
	Importance	Likely important as the country's first multi-sectoral strategic movement towards addressing poverty
	Theme(s)	Poverty Reduction Nutrition Health
8. National Free Delivery and Caesarean Policy (2005-present)	Description	Similar to other such schemes in West Africa, the National Free Delivery and Caesarean Policy was created to prioritize select services for universal, free access. It aimed to reduce financial barriers for the use of public maternal health services, increase skilled attendance at birth, and reduce maternal/perinatal/neonatal mortality rates nationally. This policy was introduced in five of the poorest regions of country in January 2005, and in January 2006 extended to the remaining five regions (excluding Dakar). Implementation of this policy was focused at the regional hospital level. An evaluation of the policy found a significant increase in service utilization for normal deliveries (from 40% to 44%) and caesarean rates (from 4.2% to 5.6%) in target areas, though increases were not observed in national data (81).
	Importance	Likely not important to the stunting decline but was one of first major moves towards free maternal healthcare in the country
	Theme(s)	Health
9. Strategic Plan for the Fortification of Foods in Senegal/Plan Stratégique pour la Fortification des Aliments en Micronutriments au Sénégal (PSFAMS) (2006-2011)	Description	Following a meeting in Accra, Ghana in October 2002 organized by West African Health Organization, Micronutrient Initiative and Helen Keller International, recommendations were made for West African countries to develop a country-level fortification process. The Strategic Plan for the Fortification of Foods in Senegal (PSFAMS) aims to reduce the prevalence of micronutrient deficiencies (iron, vitamin A, iodine) in children under-5 years of age and women of reproductive age over a 5 year period. It aimed to reach these goals by taking the following actions: having the milling industries fortify 95% of wheat flour with iron and folic acid; having 100% of oil mills fortify edible oils with Vitamin A; and ensuring salt producers adequately iodize 90% of the salt consumed (82).
	Importance	Likely not important to the major stunting decline from the mid-1990s to 2005 due to its time of initiation
	Theme(s)	Nutrition
10. Poverty Reduction Strategy Paper II (PRSP II)/Document de Stratégie pour la Croissance et la Réduction de la Pauvreté (DSRP II) (2006-2010)	Description	The overall objectives of the Poverty Reduction Strategy Paper II (PRSP II) focus on the achievement of the MDGs (e.g. reducing poverty by half by 2015); strengthening human capital; reducing vulnerability and inequalities; improving the quality of public services; promoting good economic and judicial governance; and increasing/speeding up economic growth (e.g. achieving an average economic growth rate of 7-8%). PRSP II pursues a multi-sectoral nutrition policy as reflected in the Nutrition Development Policy Letter. The nutrition-related objectives for this period include: halving the prevalence of malnutrition in children 0-5 years old; sustainably eradicating disorders related to iodine deficiency and Vitamin A deficiency; reducing by one third the prevalence of anemia (especially iron deficiency anemia); and ensuring the availability and sustainability in access to food of sufficient quantity and quality for the entire population. The nutritional component of the DSRP is supported in the continuity of the Nutrition Enhancement Program (PRN) (83).

	Importance	Likely important as the country's multi-sectoral strategic movement toward addressing poverty (continuation from earlier policy)
	Theme(s)	Poverty Reduction
		Nutrition
		Health
		Agriculture
11. National Policy on Infant and Young Child Feeding (IYCF)/Politique Nationale sur l'Alimentation du Nourrisson et Jeune Enfant (ANJE) (2006-present)	Description	This policy is a result of WHO and UNICEF recommendations and the Global Strategy for Infant and Young Child Feeding. It aims to improve the nutritional status, growth, development and health of children and young people. It also aims to increase the rate of exclusive breastfeeding to at least 80% by 2015, achieve 95% coverage of Vitamin A supplementation and deworming of children 6-59 months of age, and reduce the prevalence of underweight children by 50%. This policy advocates the promotion of appropriate nutrition for infants and young children through: exclusive breastfeeding before 6 months; the introduction of complementary foods after 6 months; and fortification of complementary foods and nutrition supplementation (60).
	Importance	Insufficient evidence of its role in the stunting decline
	Theme(s)	Nutrition
12. National Strategic Plan for Child Survival/Plan National de Survie de l'Enfant (PNSE) (2007-2015)	Description	The adoption of a National Strategic Plan for Child Survival was part of a context of technical and political re-mobilization to achieve the MDGs, based on short, medium and long term planning. In Senegal, this plan focuses primarily on the care of pregnant women, parturient and newborn infants; infant and young child feeding (including micronutrient supplementation and deworming); malaria prevention and treatment; provision and promotion of immunization services to mothers and children; prevention of mother-to-child transmission of HIV; medical care for children exposed to or infected with HIV; and care for common childhood illnesses. It aimed to achieve these by: improving the availability and accessibility of the integrated package of quality interventions for maternal, newborn and child health; increasing demand and use of services by populations, especially among vulnerable groups; and creating institutional, regulatory and economically favourable environments for scaling up the intervention package (84).
	Importance	Likely not important to major stunting decline from mid 1990s to 2005 but relevant as a first major consolidated effort around MNCH and child survival
	Theme(s)	Health
13. National Health Development Plan (NHDP)/Plan National de Developpement Sanitaire (PNDS) (2009-2018)	Description	This is a continuation of the 1998-2007 National Health Development Plan (PNDS). The implementation of this plan is in line with the achievement of national and international health goals, including the objectives of the Poverty Reduction Strategy Paper and the MDGs. It specifically aims to: reduce the burden of maternal, infant and child morbidity and mortality; increase the sector's performance in disease prevention and control; sustainably strengthen the health system; and improve the governance of the health sector. This plan also includes a nutrition component, notably through the attachment of the government's Nutrition and Food Division to the Prevention Department (85).
	Importance	Very important as the country's current main policy on the health care system
	Theme(s)	Nutrition
		Health

14. Scaling up Nutrition (SUN) (2011 – present)	Description	Scaling Up Nutrition (SUN) is a global push for action and investment in order to improve maternal and child nutrition outcomes. Key strategic objectives include bringing people together, coherent policy and legal frameworks, aligning programs around a common results framework, financial tracking and resource mobilization. The main aim of SUN is engaging civil society organizations in advocating and sustaining political will for government action in scaling up nutrition. Senegal joined in 2011 and by 2017 has achieved 69% progress in the four indicators based on SUN scoring (86).
	Importance	Promising recent initiative, however likely not important to the major stunting decline from mid 1990s to 2005
	Theme(s)	Nutrition Health Multi-sectoral Collaboration
15. National Strategy for Social and Economic Development /Stratégie Nationale de Développement Economique et Social (SNDES) (2013 – 2017)	Description	This policy builds on the Poverty Reduction Strategy Paper II and aims for sustained growth, increased productivity and the creation of wealth in Senegal. Specifically, it aims to support food security by strengthening the food crisis prevention and management system and the early warning system, and strengthening the information system on agricultural markets. The specific objectives for nutrition and health include: improving the supply of health services, improving performance in disease prevention and control, improving the health of mothers and children, and improving health governance (29).
	Importance	Likely important as the country's multi-sectoral strategic movement toward addressing poverty (continuing efforts of the PRSP I and II)
	Theme(s)	Poverty Reduction Food Security Health
16. Strategic Plan for Developing Universal Health Coverage in Senegal (2013-2017)	Description	The Strategic Plan for Developing Universal Health Coverage in Senegal demonstrated substantial political will/commitment to Universal Health Coverage (UHC) following the election of President Sall in 2012. The proposed objectives focus on improved accessibility of health services among formal/rural sectors, protection against financial risks, and improved quality/satisfaction of services. Overall objectives of this plan include: equal access; financial protection of households; population satisfaction; expanded package of services provided/covered; governance and sustainability of UHC; equity in the health system and reduction of vulnerability through expansion of coverage (89).
	Importance	Likely not important to stunting decline but is a promising recent initiative toward Universal Health Care
	Theme(s)	Health
17. Emerging Senegal Plan/Plan Senegal Emergent (PSE) (2014-2035)	Description	The Emerging Senegal Plan (PSE) works to address the limited poverty reduction Senegal has experienced in recent decades. Three pillars will guide initiatives including: structural transformation of the economy through continued support to areas of growth, and development of new sectors to create wealth, jobs, and social inclusion; improvement in wellbeing of the population, and sustained efforts to combat social inequality; and finally strengthening security, stability, governance, the protection of rights and liberties, and a consolidation of the rule of law to create better conditions for social peace and fulfilment of potential (90).
	Importance	Likely not important but promising recent initiative toward strengthening state governance and development
	Theme(s)	Poverty Reduction Multi-sectoral Collaboration Agriculture WASH Education Nutrition

		Health Food Security
18. National Community Health Policy/ Politique Nationale de Santé Communautaire (2014-2018)	Description	This policy was initiated as part of the National Strategy for Social and Economic Development (SNDES). The main vision of this policy is participation of the Senegalese population to ensure a Senegal where all individuals, all households and all communities have universal access to health promotional, preventive and curative services. The three main objectives include: introducing a socio-sanitary, legislative and regulatory framework that emphasizes community health promotion; creating favourable conditions for the engagement and participation of all stakeholders in community health; and improving the planning process, monitoring and evaluation of the implementation of community health services. Key components of the policy focus on reinforcing community participation, capacity building of community actors, development of adapted service packages (including preventive and curative interventions), promoting multi-sectoral collaboration, increasing funding for community health, improved governance, motivating community health actors, and development of sustainability measures. (91).
	Importance	Likely not important to the major stunting decline from the mid 1990s to 2005 but is a promising recent initiative
	Theme(s)	Health Multi-sectoral Collaboration
19. National Community Health Strategic Plan /Plan Stratégique National de Santé Communautaire (2014–2018)	Description	The National Community Health Strategic Plan aims to overcome challenges including poor health service coverage; inequality in access to care; insufficient harmonization of service packages; poor integration of community health in the overarching health system structure; a lack of community health actor motivation; and ineffective supply systems for essential medicines and products. The three main objectives of the plan are to improve coverage and quality of community health services; to strengthen community participation in problem-solving of health issues; and to ensure sustainability of community health interventions. This plan includes a list of community health services and interventions that are in the process of being integrated into one package to be delivered at community sites, health huts, and health posts. The list specifies the types of community health provider responsible for each intervention, organized by health area, including MNCH, reproductive health, family planning, disease prevention, nutrition, HIV and AIDS, TB, WASH, and neglected tropical diseases. The Community Health Program (PSSC) is one of the flagship programs under this strategy. (92,93).
	Importance	Likely not important to the major stunting decline from mid 1990s to 2005 but is a promising recent initiative
	Theme(s)	Health
20. National Nutrition Development Policy Document /Document de Politique Nationale de Développement de la Nutrition (PNDP) (2015-2025)	Description	This is a reform of the National Nutrition Letter. The general objective of this policy is to ensure a satisfactory nutritional state for all, particularly children under-5 years, women of childbearing age, and adolescents. Intermediate objectives include: ensuring adequate coverage in essential nutrition services for children under-5 years, women of reproductive age and adolescents; improving access and use of quality health services; improving population nutritional knowledge for the adoption of favourable nutrition behaviours; promoting research and production of high nutritional value food; obtaining sufficient and long-lasting financing of nutrition interventions; and strengthening the coordination, monitoring and evaluation of nutrition interventions as part of the multi-sectoral approach. These objectives are to be reached through the following four pillars: production of food with high nutritional value, improving availability, food security and nutrition; processing, distribution and pricing of food; education, hygiene and sanitation; and essential health and nutrition services (94).

	Importance	Likely not important to stunting decline but it is a promising recent initiative around multi-sectoral nutrition planning
	Theme(s)	Nutrition
		Multi-sectoral Collaboration
		Food Security
		Health
		WASH

5.3: Programs and Projects

Further details on these programs and projects such as information on the initiation process, funders, and reforms can be found in Appendix 14.

PROGRAMS/PROJECTS		
1. Nutrition Protection Program of Vulnerable Groups /Programme de Protection Nutritionnelle des Groupes Vulnérables (PPNS) (1973-1988)	Description	In response to the Sahel drought from 1968-1974, the Nutrition Protection Program of Vulnerable Groups (Programme de Protection Nutritionnelle des Groupes Vulnérables, or PPNS) was Senegal's first large scale nutrition program. The main aim of the program was prenatal nutrition and growth, to be achieved through malnutrition prevention and nutritional recovery via supplementation. Food assistance as part of this program was to be provided by Catholic Relief Services (CRS), complemented by the Government's Health/Drought (Santé/Sécheresse) program, supported by WFP. Key components of this program included the delivery of nutrition services through health posts. Among these services were nutritional rehabilitation; distribution of food to malnourished children and pregnant and lactating women; pre- and post-natal consultations; growth monitoring of children under-5, and nutrition education (49,60).
	Importance	Not important because it is an early (though long-standing) food supplementation program that had many deficiencies
	Theme(s)	Nutrition
2. Expanded Program on Immunization (EPI) (1979-present)	Description	The main objective of this program is to ensure full immunization of children against preventable diseases, especially among children 0-15 months of age. In 1979, the Expanded Program on Immunization (EPI) program vaccinated against seven diseases. Additional vaccines were added over time, including polio (1988), yellow fever (1988), pentavalent vaccine (diphtheria, tetanus, pertussis, haemophilius influenza b and Hepatitis B) (2005), pneumococcus conjugated vaccine (2013), measles & rubella (2014), rotavirus (2014), inactivated polio vaccine (2015), and hepatitis B (2016). Despite the substantial costs to fund the program, achieving high coverage rates continues to represent a challenge in Senegal. In 2010, immunization coverage dropped to 70% in some districts (with some areas as low as 50%) (95).
	Importance	Likely important to stunting decline due to its role in vaccinating children
	Theme(s)	Health

3. Community Nutrition Project /Projet de Nutrition Communautaire (PNC) (1995 – 2001)	Description	The Community Nutrition Project (PNC) was created in response to the alarming nutritional situation in Senegal, which was seen to result from the cumulative negative effects of climate hazards, structural adjustment, the global economic crisis and the devaluation of the CFA franc. The three main objectives of this project included: (i) halting further deterioration in the nutritional status of children under-3 years of age, as well as pregnant and lactating women in targeted poor urban neighbourhoods; (ii) providing portable water to under-serviced neighbourhoods targeted under the nutrition programme; and iii) enhancing food security among the poor urban population and in targeted poor rural areas during critical periods of vulnerability. This program focused on the most vulnerable groups in the impoverished population, including districts within the country that had high rates of poor households. A total of 1.2 million people were targeted to benefit from this project. This included an estimated total population of 469,000 receiving nutritional interventions, such as 230,000 malnourished children under-3 years and 120,000 nursing and pregnant women receiving food , growth-monitoring and IEC services; and 119,000 mothers and children receiving only growth-monitoring and IEC services (96).
	Importance	Very important to stunting decline as an early & effective effort for consolidated community nutrition targeting
	Theme(s)	Nutrition WASH Food Security
4. Water Sector Project/ Projet du Secteur de l'eau (1996-2004)	Description	As part of an overarching movement to reform and improve management of the water supply sector in Senegal, this program was the first of three planned initiatives aimed at increasing coverage and organization of water and sanitation. The overall objectives of this first program included achieving: i) sustainability through improvements in management, pricing, and cost recovery and a reduction of the Government subsidy for industrial, domestic, and irrigation water; ii) poverty alleviation and improved health through increased access to safe potable water and adequate/more affordable sanitation for the urban poor; and iii) private sector participation, by engaging a private company to manage urban water supply. Overall, World Bank donor reporting indicates that this project was seen as a success, and Senegal was praised as a model for the implementation of public-private partnerships in sub-Saharan Africa (97–100).
	Importance	Likely important, WASH indicators improved modestly and reduction of open defecation was important to child stunting gains
	Theme(s)	WASH
5. Vitamin A Supplementation Program (1999-present)	Description	The main objective of this program is to deliver a high-dose of Vitamin A to children aged 6-59 months to reduce mortality and morbidity. Through Child Survival Days, a package of interventions is offered in Senegal twice annually, including: deworming, growth monitoring, screening and referral for severe malnutrition, screening and treatment for diarrhea, catch-up for vaccinations and civil registration for children under-5. Vitamin A supplementation coverage in the majority of Senegal is high with 98% coverage across 9 out of 14 regions in December 2015. In the remaining 5 regions using routine delivery in that same year, coverage was only 54% (101).
	Importance	Likely important but insufficient evidence on scale and impact
	Theme(s)	Nutrition Health

6. Ten-Year Education and Training Program/Programme Décennal d'Education et de Formation (PDEF) (2000-2010)	Description	Ten-Year Education and Training Program (PDEF) resulted from several international gatherings related to education, including the 1990 Jomtien Education Conference and the 2000 World Conference on Education for All in Senegal's capital Dakar. The main objective of the program is educational reform. Specific goals aim to increase access to universal quality education and training by 2010; introduce a relevant and high-quality education system at all levels; create a coordinating body for educational policies and programs; and rationalize mobilization and use of resources. Substantial achievements after just three years (as of 2004) were noted including achievements in standardized results for French/math, construction of classrooms, introduction of a minimum number of teaching hours (20 hours), improvements in the ratio of textbooks to students, and increased educational enrolment (102,103).
	Importance	Likely important
	Theme(s)	Education Health Nutrition
7. Coordination Unit for the Fight Against Malnutrition/Cellule de Lutte Contre la Malnutrition (CLM) (2001-Present)	Description	The Coordination Unit for the Fight Against Malnutrition (CLM) represents a coordinating body for nutrition in Senegal, housed within the Prime Minister's Office. The main objectives of the CLM include: providing technical assistance in defining and implementing national nutrition policy; examining and approving proposals for collaboration by ministries in the execution of the program; facilitating a consultative framework between technical ministries, stakeholders in charge of nutrition policies, NGOs, and community-based organizations; developing good synergy with other anti-poverty programs; promoting a policy of Behavior Change Communication and good practices in the fight against malnutrition; and supporting national capacity building for effective implementation of nutrition programs. The CLM has led to the coordination and engagement of multiple sectors including both nutrition-specific and –sensitive areas, resulting in increases in funding for nutrition. Current projects and programs under the CLM include: Nutrition Enhancement Program (PRN); Universal Iodization of Salt Project (PIUS); Fortification Enhancement Program in Senegal (PRF); Food Security Support Project for Vulnerable Households (PASAV); Demand-based financing component of the Health and Nutrition Financing Project (PFSN); Fight Against the Determinants of Malnutrition Project (PLDM) in the North-East of Senegal; a results-based financing project targeting demand for maternal care; and a project to improve the response of most vulnerable communities to nutritional and food crises in the areas of Podor, Ranerou, Matam and Kanel (104).
	Importance	Very important as the coordinating body overseeing the PRN and other nutrition-sensitive initiatives
	Theme(s)	Nutrition Multi-sectoral Collaboration

8. Nutrition Enhancement Programme /Programme de Renforcement de la Nutrition (PRN I) (2002-2006)	Description	Building on lessons learned from the Community Nutrition Project (PNC) which ran from 1995-2001, the Nutrition Enhancement Programme (PRN) focused on a commitment to improve nutrition in Senegal. It is a large-scale national program ran by the CLM. The two objectives of the PRN include: improving the nutritional status of populations, especially the growth of children under 3 years of age living in poor urban or rural areas; and strengthening the country's institutional and organizational capacity for nutrition for the implementation and evaluation of nutrition policy. It included the following community–based nutrition and growth promotion activities: monitoring and promotion of growth, with monthly weighing sessions and home visits to vulnerable children (who did not participate or showed insufficient weight gain); nutrition and health group education for dissemination of key messages; IMCI, including the promotion of healthy behaviors and the design and implementation of guidelines for the management of severe cases of malnutrition in health facilities; provision of basic health services, including basic commodities (micronutrients, deworming tablets, insecticide-treated mosquito nets and Oral Rehydration Salts) and promotion of antenatal care and other health services; and grants for community nutrition projects. Other components include capacity building and monitoring and evaluation, as well as project management and reporting (63,105).
	Importance	Very important as the main national nutrition program that used a multi-sectoral approach
	Theme(s)	Nutrition Multi-sectoral Collaboration Health Education Food Security
9. Long-Term Water Supply Project/Projet Eau à Long Terme (PLT) (2002-2005)	Description	The Long-Term Water Supply Project (PLT) was part of an overarching movement to reform and improve management of the water supply sector in Senegal. This was the second of three planned initiatives. This project aims to make sustainable improvements to the delivery of water and sanitation services in urban areas within Senegal, including under-served/low income areas of Dakar and other cities. In the areas covered by the project, 1,415,000 people benefited from access to drinking water (725,000 in Dakar and 690,000 in other urban centers of in the interior). This represented 141% of the initial target of 1 million people with access. Access to sanitation reached 103% of the target (144,500 people connected from an initial target of 140,000), and 146% achieved for the target of autonomous and semi-collective sanitation (583 000 people served from an original goal of 400,000) (106–110).
	Importance	Likely important, WASH indicators improved modestly and reduction of open defecation was important to child stunting gains
	Theme(s)	WASH Multi-sectoral Collaboration

10. Water and Sanitation Millennium Program/Programme d'Eau Potable et d'Assainissement du Millénaire (PEPAM) (2005-2015)	Description	The Water and Sanitation Millennium Program (PEPAM) was part of an overall plan to reform water and sanitation services in Senegal. It was the third of a set of three initiatives in this reform effort, following the Water Sector Program (1996-2004) and Long-Term Water Supply Project (2002-2005). It was the means by which the Government worked to achieve the MDGs related to water and sanitation, creating a global framework to coordinate interventions in the sector. The main objective was to increase access to sustainable water and sanitation services in selected rural and urban areas within Senegal. The key components were: improving rural water supply (i.e. access to drinking water in the regions of Saint-Louis and Matam, and the district of Bakel in the Senegal River basin); improving urban water supply; improving rural sanitation by increasing access to water sanitation services in the regions of Saint-Louis and Matam and the district of Bakel; improving urban sanitation; and institutional strengthening and capacity building by supporting activities associated with ongoing water sector reforms. According to the World Bank, this project was seen to be highly effective. This was due to factors including strong design and implementation, achievement or exceeding of set targets; and high efficiency within the program (111,112).
	Importance	Likely important, WASH indicators improved modestly and reduction of open defecation was important to child stunting gains
	Theme(s)	WASH
11. National Program for Local Development/Programme National de Développement Local (PNDL) (2007-2012)	Description	The purpose of the National Program for Local Development (PNDL) is to effectively, efficiently and sustainably promote the provision of basic services to the Senegalese population. It aims to set up a framework for participatory local government, decentralization, resource mobilization/transfer to local governments and communities in order for more effective service delivery in Senegal's rural and poorest areas. The objectives are to: increase access to basic social infrastructure and services through direct and indirect interventions by at least 50% over 5 years; increase the access of the poorest populations to financial resources for the development of income-generating activities, with the goal of at least a 25% improvement of the incomes of 75% of the poorest households within 5 years; strengthen the capacity of local actors, with at least 75% of the targeted local actors implementing their reinforcement plans at 70% after 5 years; and strengthen the State's capacity to implement the Poverty Reduction Strategy (113,114).
	Importance	Likely important as further effort for the decentralization of social services including health
	Theme(s)	Poverty Reduction
12. Nutrition Enhancement Programme II Programme de Renforcement de la Nutrition (PRN II) (2007-2014)	Description	The Nutrition Enhancement Programme II (PRN II) is a continuation of the first phase of the program, the PRN I. The objectives remain the same as the PRN I: to improve the nutritional status of the population, especially children under-5 years of age living in poor urban or rural areas; and to strengthen the country's institutional and organizational capacity for nutrition in the implementation and evaluation of nutrition policy. Program coverage was increased and additional project activities were scaled up to continue the work towards the objectives of the programme (63,115,116).
	Importance	Very important as the current main national nutrition program that uses a multi-sectoral approach
	Theme(s)	Nutrition Multi-sectoral Colloboration Health Education Food Security

13. Rapid Response Child-Focused Nutrition and Social Transfers Project/ Programme de Nutrition Ciblée sur l'Enfant et Transferts Sociaux (NETS) (2009-2011)	Description	This program provides benefits to mothers of children ages 0-5 years in poor areas of Senegal, in order to help offset the cost of rising food prices. The main objectives of NETS include: reducing the risk of nutritional insecurity for vulnerable populations by intensifying the Nutrition Enhancement Programme (e.g. community nutrition monitoring, promotion activities and other services leading to improved nutrition knowledge that will lead to changes in dietary practices and behaviors); and reducing the risk of nutritional insecurity for vulnerable populations by transferring cash to mothers of vulnerable children under-5, thereby improving their ability to access essential food and other investments for the well-being of their children. The program involved 50,000 mothers of children aged 0-5 living in a poor households (117).
	Importance	Likely not important to long-term stunting decline, but promising first-effort towards using cash/social transfer methods to target at risk populations (women and children)
	Theme(s)	Nutrition Food Security
14. Child Nutrition and Food Security Project/Projet Nutrition Enfant et Sécurité Alimentaire (NESA) (2009-2012)	Description	Child Nutrition and Food Security Project (NESA) was created following Senegal's experience with droughts in 2006 and 2007, as well as rising food prices. The main objectives of this project included: reinforcement of the capacities of local communities (especially vulnerable groups) as part of the fight against child malnutrition; implementation of the Integrated Management of Childhood Illness (IMCI) Program and Community and Acute Malnutrition Management in all target districts; reinforcement of Behavior Change Communication programming related to health, and improvement of the early warning system. This project was implemented in seven of the regions in Senegal most affected by the food crisis, including Tambacounda, Kolda, Matam, Diourbel and Louga, Kedougou and Sedhiou. It targeted a total population of 4,300,000 inhabitants, including: 817,000 children under-5 years old; and pregnant and lactating women (62,118).
	Importance	Likely not important to long-term stunting decline, but effective effort towards alleviating burden from short-term food shocks due to 2006/2007 drought
	Theme(s)	Nutrition Food Security
15. Bajenu Gox Project (2009-Present)	Description	This initiative was launched in 2009 by former Senegalese President Abdoulye Wade in order to combat the country's high maternal and child morbidity and mortality rates. The Bajenu Gox Initiative, whose name is derived from the term « godmother » in Senegal's Wolof language, works to train women to be leaders in reproductive health, supporting other women in the pre-natal, delivery and post-natal periods, as well as providing advice on care of children under-5. Bajenu Gox provide counselling services, home visits, and lead women's groups. They consult with women about utilizing health centres; giving birth in health facilities; the importance of attending pre-natal check ups; vaccinating their children; and family planning/birth spacing. According to the Government of Senegal, the Bajenu Gox initiative has contributed to reducing maternal deaths from 410 to 315 per 100,000 between 2008 and 2015, while infant deaths fell from 59 to 50 per 1,000 during the same time period (93,119,120).
	Importance	Likely not important to long-term stunting decline, but promising efforts towards expanding community-based health care within existing system
	Theme(s)	Health

16. Universal Salt Iodization project (PIUS)/Projet d'Iodation du Sel (2009-2014)	Description	To fight against iodine deficiency disorders, the Government of Senegal adopted the universal strategy of salt iodization which was led by the CLM beginning in 2006. However, following a 2010 national survey showed relatively low levels (47.7%) of appropriately iodized salt (≥15ppm) consumption in Senegal, renewed efforts were made by the CLM with support from Nutrition International, the Global Alliance for Improved Nutrition (GAIN) and UNICEF. This project has the goal of a sustainable elimination of iodine deficiency disorders, with the basic strategy of universal iodization of salt for human and animal consumption. Specific aims include: achieving the goal of 90% of households consuming iodized salt and increasing the annual production of iodized salt by small producers by 80,000 tonnes. It plans to reach these goals by targeting small salt producers (250,000 to 200,000), strengthening political commitment for salt iodization, supporting the management activities of artisanal salt farmers, and ensuring a functional monitoring system to guide the action of stakeholders (66,121).
	Importance	Likely not important to stunting decline
	Theme(s)	Health
17. Food Fortification Enhancement Program/Programme de Renforcement de la Fortification des Aliments (2010-2015)	Description	The CLM launched the Food Fortification Enhancement Program to combat micronutrient deficiencies. The main objective of this program is the fortification of all wheat, oil and flour consumed in Senegal in order to reduce micronutrient deficiencies within the population (122).
	Importance	Likely not important to stunting decline, but promising recent initiative around fortification
	Theme(s)	Health
18. USAID/Yaajeende Agriculture and Nutrition Development Program for Food Security/ Programme de Développement Agricole - Sécurité Alimentaire USAID-Yaajeende (2010-2017)	Description	This project is part of Feed the Future/USAID's new global strategy against hunger and food insecurity, which aims to work with host governments and development partners to address the root causes of hunger and poverty in the world. This project aligns with the National Health Strategy Plan and the National Agricultural Investment Plan. It aims to engage in a country-led integrated approach to accelerate the participation of 500,000 of Senegal's rural poor in growth, and to address malnutrition in children under-5 by reducing the rate of underweight and stunted children by 30% each. Project activities are divided into five major areas: increasing the availability of food by improving the diversity and sustainability of agricultural production and by promoting sustainable land management; increasing and diversifying revenues from agriculture by stimulating key agricultural markets and value chains; reducing undernutrition and ensuring a healthy diet through improved utilization of foods; improving capacity for local governance of food-related resources; and cross-cutting activities. The midterm evaluation shows that USAID/Yaajeende has been very successful at reaching its target groups and beneficiaries, i.e. the poor and the vulnerable, especially women but did not evaluate sustainability (123).
	Importance	Likely not important to long-term stunting decline, but effective donor funded project targeting the most at-risk populations under-5 in rural communities of select regions
	Theme(s)	Agriculture Food Security Poverty Reduction

19. National Agricultural Investment Program /Programme Nationale d'Investissement Agricole (PNIA) (2011-2015)	Description	Senegal developed National Agricultural Investment Program (PNIA) to translate into action commitments made under the Economic Community of West African States (ECOWAS) Regional Agricultural Policy for West Africa (ECOWAP), and the Comprehensive Africa Agriculture Development Program (CAADP). It also aligns with Senegal's current policy and strategy documents for agriculture. The PNIA aims to ensure modern, sustainable, productive and competitive agriculture in intra-community or international markets, based on the efficiency of family farms and the promotion of agricultural enterprises through involvement of the private sector. Its key components include reducing climate risk through water management; preserving and sustainably managing other natural resources; boosting production and enhancing natural resources; increasing production and greatly improving overall factor productivity; adding value to agricultural produce through processing; improving marketing of agricultural produce through better market access; strengthening research to generate and transfer new technologies in production, processing and marketing; significantly strengthening the capacities of the various stakeholders; and ensuring effective coordination and steering of investment program implementation (124,125).
	Importance	Likely not important to stunting decline from mid 1990s to 2005 but is a promising recent initiative
	Theme(s)	Agriculture
Integrated Education and Nutrition Program/Programme Integre Sante Education Nutrition (PISEN) (2012-2016)	Description	The Integrated Education and Nutrition Program (PISEN) aims to improve the health and wellbeing of the people of Senegal, with a specific focus on women, children and vulnerable groups. The key goals/outcomes for this program are to: improve the food and nutrition security of populations (both men and women) in a sustainable manner; ensure children, adolescents, adults and the most vulnerable populations receive basic education and quality training; and ensure that within intervention areas, mothers, children, and the most vulnerable benefit from a comprehensive package of quality health interventions. Services are delivered in four regions: Sedhiou, Kolda, Kedougou & Dakar (67).
	Importance	Likely not important to long-term stunting decline, but promising multilateral donor-funded project targeting the most at-risk women and children in select regions
	Theme(s)	Education Health Food Security Nutrition Multi-sectoral Collaboration
20. The National Family Safety Scholarship Program (PNBSF)/ Programme Nationale de Bourses de Sécurité Familiale (PNBSF) (2013-2019)	Description	The National Family Safety Scholarship Program (PNBSF) aims to contribute to the fight against poverty and social exclusion of the poor and vulnerable in Senegal. It provides conditional cash transfers for using education and health services, working to strengthen the development of human capital in children in order to stop the intergenerational transmission of poverty. The program has three main focus activities/areas: registering and maintaining children in school; immunization cards for children 0-5 years old; and registering children at the registry office. The total number of beneficiary households that have received cash transfers since the program began in 2013 is close to 200,000 households (50,000 households in 2013, 50,000 households in 2014 and 100,000 households in 2015). An evaluation in 2018 indicated that it had reached up to 300,000 (126,127).
	Importance	Likely not important to long-term stunting decline, but promising first efforts at national social safety program targeting at-risk families in the entire country
	Theme(s)	Poverty Reduction Health

		Education
21. Community Health Program (PSSC) (2016-2021)	Description	The Community Health Program (PSSC) is one of the flagship programs of the National Community Health Strategic Plan. It is a reform of the Senegal Health Project First Phase (2006-2011) and Senegal Health Project Second Phase (2011-2016). The previous projects focused on implementing a package of integrated services to impact the public health of the Senegalese population, focusing on family planning/reproductive health, maternal/child health, nutrition, malaria, TB, and HIV/AIDS (awareness) at community-based health huts. This new phase of the Community Health Program is focused on continuing to provide the package of services from Phases 1 and 2, but to a larger geographic area and with greater emphasis on sustainability. This component is working in all 14 regions and 72 health districts. It's objectives are to improve the health status of Senegal's population, make strategic investments to build country capacity, and have a sustainable impact on maternal, neonatal, and child mortality and other public health priorities (93,128).
	Importance	Likely not important but promising initiative for strengthening community-based healthcare
	Theme(s)	Health
22. Multisectoral Strategic Plan for Nutrition in Senegal/Plan Strategique Multisectoriel de la Nutrition du Senegal (PSMN) (2017-2021)	Description	The Multisectoral Strategic Plan for Nutrition in Senegal (PSMN) aims to operationalize the National Nutrition Development Plan (PNDN), which is focused on ensuring that Senegal is a country where every individual has an optimal nutritional status through the adoption of appropriate behaviours. It also aims to provide a situational analysis of nutrition in Senegal over the last five years and analyze key determinants of malnutrition, including regional disparities and contributions from diverse sectors. It would like to highlight key achievements and challenges for nutrition in Senegal and outline the vision towards 2025 and strategic objectives for nutrition. It contains five main axes: preventing malnutrition and non-communicable diseases related to nutrition; fight against micronutrient deficiencies (iron, folic acid, iodine, zinc and vitamin A); strengthen the availability and accessibility of diverse food with high nutritional values; research and innovation; and governance of nutrition(129).
	Importance	Recent promising initiative for multi-sectoral nutrition action
	Theme(s)	Multi-sectoral Collaboration Nutrition Health

5.4: Delivery Platforms

5.4.1: Delivery Platforms for Nutrition Specific and Sensitive Interventions

Delivery platforms for nutrition-specific and -sensitive interventions are often of 5 types that have proven to be most impactful, including: fortification-based, financial incentive-based, community-based, school-based and technology-based platforms (Table 21).

Fortification-based platforms focus on improving the nutritional value of staple foods, which can be done at four levels: mass/universal fortification, targeted fortification, household fortification and bio-fortification. Mass/universal fortification is done in conjunction with food production industries (e.g. flour fortification); targeted fortification is done for particularly nutritionally vulnerable populations or in emergency situations (e.g. micronutrient powders); household fortification involves the fortification of particular foods consumed especially by women and children (e.g. fortified lipid spreads); and bio-fortification involves increasing key nutrients within food crops (130,131).

Financial incentive-based platforms include the delivery of cash transfers (either conditional or unconditional), vouchers or food stamp interventions, as well as the removal of user fees in order to eliminate financial barriers and enable individuals to better their health (131,132).

Community-based platforms include the delivery of interventions by health care workers through outreach channels at the community-level, as well as the implementation of interventions which are driven by community groups themselves (131,132).

School-based platforms focus on the delivery of targeted school feeding programs, and the promotion of health and nutrition information to children while they are attending school (132).

Technology-based platforms include the delivery of nutrition information and communication-based interventions using mass or social media as well as mobile health (also known as mHealth), via mobile phones (e.g. SMS messaging) (132).

Table 21: Delivery Platforms for Nutrition Interventions

Platform	Intervention	General Examples	Papers
Fortification-based	Mass/universal fortification	Salt iodisation, flour fortification with iron and folate	Gillespie et al., 2013 Keats et al., 2018
	Targeted fortification	Nutrient-fortified complementary food for children 6-24 months, micronutrient powders, fortified foods/food-based supplements	
	Household fortification	Micronutrient powders, small quantities of food-based fortified lipid spreads for women and children	
	Biofortification of food crops	Increasing iron, provitamin A, zinc, and folate contents in staple foods	
Financial incentive-based	Conditional cash transfer, vouchers, unconditional cash transfers, food stamps	For participation in health education and attendance to health visits	Gillespie et al., 2013
	Removal of user fees	For access to health services	Bassani et al., 2013
Community-based	Community Health Workers	Providing skilled birth attendance, immunization and micronutrient supplementation, promotion of breastfeeding and complementary feeding, child growth monitoring, treatment of common childhood illnesses	Haines et al., 2007 Bhutta et al., 2013 Lassi et al., 2010 Lewin et al., 124 GHWA, 2010 Shakir, 2010
	Women's/Mother's Groups	Infant and Young Child Feeding	Kushwaha et al., 2014
	Community Campaigns	Child Health Days, providing an integrated package of essential health and nutrition interventions, including: • Micronutrient supplementation (e.g. Vitamin A), Immunization, Deworming, Insecticide-treated bednets	Doherty et al., 2010 UNICEF, 2011 UNICEF, 2017 Oliphant et al., 2010
	Integrated Management of Childhood Illness (IMCI) Program	"Whole child" health approach, focusing on: • Improved case management by health workers and strengthening the overall health system capacity • Providing basic care to communities with poor access to health facilities • Improve home-based and community nutrition practices	Gove, 1997 Ahmed et al., 2010 Schellenberg et al., 2004 Arifeen et al., 2009 Costello & Dalgish, 2016
School-based	School feeding programs	Promotion of school enrollment (Note: evidence of nutrition benefits scarce)	Kristjansson et al., 2009 Gillespie et al., 2013
	Promotion of health and nutrition	For older children and adolescents , linked to school health programs	N/A
Technology-based	Mobile Health (mHealth)	Greater connectivity between health care workers and remote communities More accurate and timely child growth monitoring	Källander et al., 2013 Barnett et al., 2016 Marcolino et al., 2018
	Mass/social media outlets	Broad dissemination of health information Discussion of health-related topics Social marketing	N/A

5.4.2: Successful Delivery Platforms Used in Senegal

The policies and programs indicated to have played a role in reducing stunting in Senegal between 1992-2017 can be tied to many of the aforementioned delivery platforms (Table 21). By far the most commonly used approach seen in Senegal is the community-based delivery platform (see Tables 22 and 23).

Several policies and programs considered to be critical to Senegal's stunting reduction success, including the Community Nutrition Project (1995-2001), Nutrition Development Policy Letter (2001-2014), the Coordination Unit for the Fight Against Malnutrition/CLM (2001-present), the Nutrition Enhancement Program I & II (2002-2014), and the National Health Development Plan (2009-2018), all utilize a community-based approach. Specifically, these 6 seminal initiatives and other noteworthy and longstanding programs such as the Expanded Program on Immunization (1979-present) and the Vitamin A Supplementation Program (1999-present), have focused on developing the capacity and reach of local actors such as Community Health Workers or *relais* to deliver essential health and nutrition interventions. Along with this, several important initiatives developed over the last few decades such as the National Action Plan for Education for All (2000-2015); the Poverty Reduction Strategy Papers I and II (2001-2005; 2006-present); the National Strategy for Social and Economic Development (2013-2017); and the consecutive Water Sector Project (1996-2004), Long-Term Water Supply Project (2002-2005) and Water and Sanitation Millennium Project (2005-2015) have all focused on cultivating community-centered initiatives to create the systems, infrastructures and behaviours necessary to improve outcomes in such as education, poverty alleviation and WASH.

Another commonly used approach seen in Senegal is the fortification-based delivery platform. Beginning in the early 2000s, several formative government-led nutrition initiatives such as the Nutrition Development Policy Letter, the CLM and the Presidential Decree on Mandatory Iodization of Edible Salt (2001-present) started promoting mass/universal micronutrient fortification of staple foods such as wheat, oils, flour and salt into their key aims and objectives. This continued to be carried forward in later programming such as the Nutrition Enhancement Program I and II, the Strategic Plan for the Fortification of Foods in Senegal (2006-2011), and the Decree on Fortification of Refined Vegetable Oils (2009-present), among others. Following from the Community Nutrition Project, which targeted fortification for pregnant/lactating women and children 6-36 months in vulnerable households, in recent years, fortification programs have begun to take a more targeted approach. For example, the National Policy on Infant and Young Child Feeding (2006-present) advocates for the fortification of complementary foods for infants along with other nutritional supplementation (60), and the Food Fortification Enhancement Program (2010-2015) focused specifically on women and children under-5 years, alongside efforts for the general population. Innovation in food fortification is also being pursued in such programs as the USAID/Yaajeende Agriculture and Nutrition Development Program for Food Security (2010-2017), which includes among its interventions bio-fortified crops to improve nutrient consumption (123). It should be noted, however, that our work does not posit micronutrient fortification as a major determinant of stunting decline in Senegal – though the utilization of this platform is widespread.

Though much less common compared to the community-based or fortification-based approaches, the school-based delivery platform has also been seen as a useful way to deliver health and nutrition interventions to Senegal's youth over the last few decades. Following a series of international gatherings on education such as the 1990 Jomtien Education Conference in Thailand and the 2000 World Conference on Education for All in Senegal's capital Dakar, the government began rolling out a number of programs focused on improving both the quality of and access to education in the country. Many large-scale education initiatives that began at this time incorporated health and nutrition activities and key messaging within the school setting. For example, within the Ten-Year Education and Training Program (2000-2010), canteens financed by the World Food Program were set up in schools, alongside iron supplementation, deworming and

awareness programs on the importance of proper nutrition and hygiene practices (102,103). School canteens in impoverished areas were also set up through programming rolled out under the Poverty Reduction Strategy Paper I, while the Nutrition Enhancement Program supported deworming and iron supplementation in schools (60,63,115,116,133,134). Meanwhile, several other initiatives created through the Nutrition Development Policy Letter and the Presidential Decree on Mandatory Iodization of Edible Salt focused on embedding nutrition education into the school curriculum.

Somewhat less commonly used in Senegal is the financial incentive-based delivery platform. Generally speaking, interventions delivered via financial incentives in Senegal have focused on improving the access of poor households, and especially the children within these households, to nutritious foods. Under the CLM, the Rapid Response Child-Focused Nutrition and Social Transfer Program (2009-2011) was created, which provides cash transfers to mothers of children ages 0-5 in poor and/or rural areas in order to offset the rising cost of food prices. These transfers were also accompanied by a communication campaign on the importance of maternal and child nutrition (63,117). Similarly, under the USAID/ Yaajeende program outlined above, vouchers were provided to the poor in rural parts of the country so that they could access nutritious foods and nutrition-related services (123). In an attempt to improve access to maternal health services, beginning in 2005 the government also launched the National Free Delivery and Caesarean Policy, removing user fees for women with normal deliveries at a health post or health centre in five of the poorest regions in the country, and all caesareans at level II health centres and regional hospitals (81). Most recently, the government has created the National Family Safety Scholarship Program (2013-2019) which provides vulnerable families with grants for accessing education and health services (126,127).

Finally, technology-based delivery platforms have also been used by only a small number of programs in Senegal. The majority of initiatives utilizing this approach, such as the Nutrition Development Policy Letter, Presidential Decree on Mandatory Iodization of Edible Salt, Nutrition Enhancement Program I and II, and the Community Health Program have focused on mass/social media campaigns in order to spread messaging around health and nutrition.

5.4.3: Future Areas of Focus

From our analysis of the most impactful policies and programs implemented in Senegal to reduce stunting between 1992-2017, the major focus seems to be on those that utilized a community-based delivery platform. Key nutrition-specific programs such as the Community Nutrition Project, Nutrition Development Policy Letter, the Coordination Unit for the Fight Against Malnutrition/CLM, the Nutrition Enhancement Program I & II, and the National Health Development Plan have worked to broaden the accessibility of health services by incorporating local actors to deliver health and nutrition interventions at the community-level. Several other programs focused on improving nutrition-sensitive indicators in the areas of education, poverty and WASH have also worked to harness the power of community through locally-centered initiatives.

As there has also been a concerted effort towards utilizing fortification and school-based delivery platforms to target nutritional outcomes among key populations across the country in recent decades, future areas of focus could work to expand the use of financial incentive and technology-based interventions. Over the last several years, the Government of Senegal has launched efforts towards achieving universal health coverage, s the Strategic Plan for Developing Universal Health Coverage in Senegal (2013-2017). As it appears this objective has yet to be achieved, it continues to present an area of significant opportunity for improving the health and nutrition. By removing user fees for essential health services, more equitable outcomes could be within reach for a large segment of the Senegalese population who continue to live below the poverty line.

In terms of technology-based interventions, while these have been used in a small number of the more recent programs in Senegal such as the Nutrition Enhancement Program and the Community Health Program, efforts largely centre around the use of mass communication campaigns such as advertising on social media, billboards, television and radio. Mobile health (mHealth) initiatives could be a potentially useful way to connect much of Senegal's remote and rural populations to health services, presenting an important opportunity for overcoming barriers to accessing care.

Table 22: Senegal-Specific Delivery Platforms for Nutrition-Specific and -Sensitive Interventions

Delivery Platform	Intervention	Senegal-Specific Examples	Implementation Examples
Fortification-based	Mass/universal fortification	**Strategic Plan for the Fortification of Foods in Senegal (2006-2011)** aims to reduce the prevalence of micronutrient deficiencies in women of reproductive age and in children under-5.	• Enrichment of wheat flour, oil and salt with iron-folic acid, vitamin A and iodine (82).
		Decree 2009-872 on Fortification of Refined Vegetable Oils and Flour (2009-present) placed micronutrient fortification requirements on both domestically produced and imported refined vegetable oil and soft wheat flour.	• All imported and domestically produced refined vegetable oils (e.g., palm, cotton, palm kernel, peanuts, sesame, sunflower, canola, corn, and soybean oil) are to be enriched with Vitamin A., and all soft wheat flour must be enriched with iron and folic acid (64,65).
		Universal Salt Iodization Project (2009-2014) has the goal of a sustainable elimination of iodine deficiency disorders.	• Achieving the goal of 90% of households consuming iodized salt and increasing the annual production of iodized salt by small producers (66,121).
	Targeted fortification	**Food Fortification Enhancement Program (2010-2015)** aims for the fortification of all wheat, oil and flour consumed in Senegal in order to reduce micronutrient deficiencies within the population.	• With a specific target of Women and children under-5 (as well as the general population), improvements in the capacity to produce, distribute and promote fortified wheat, oil and flour (122).
	Household fortification	N/A	N/A
	Bio-fortification of food crops	N/A	N/A
Financial incentive-based	Conditional cash transfer	**National Family Safety Scholarship Program (2013-2019)** aims to contribute to the fight against poverty and social exclusion of the poor and vulnerable in Senegal.	• Provide 250,000 vulnerable families with Family Security Grants of 100,000 CFA franc per year to strengthen their livelihoods and educational and productive capacities (84).
	Removal of user fees	N/A	N/A
Community-based	Community Health Workers	**Nutrition Protection Program of Vulnerable Groups (1973-1988)** was Senegal's first large-scale nutrition program, created in response to the Sahel drought from 1968-1974.	• Delivery of nutrition services was carried out through health posts. Among these services were nutritional rehabilitation; distribution of food to malnourished children and pregnant and lactating women; pre- and post-natal consultations; growth monitoring of children under-5, and nutrition education (60).
		Expanded Program on Immunization (1979-present) aimed to ensure full immunization of children against preventable diseases.	• Immunizations are delivered through local community health posts and community health workers (95).

		Vitamin A Supplementation Program (1999-present) aimed to deliver a high-dose supplementation of Vitamin A to children aged 6-59 months, in order to reduce mortality and morbidity.	• Delivery of a package of services over a period of 4 days, every six months to households, largely conducted by community health volunteers/relais (101).
		National Strategic Plan for Child Survival (2007-2015) aims to reduce maternal, neonatal and child mortality in Senegal.	• Capacity building of the community and community actors for the proper implementation of the Maternal, New-born and Child Health (MNCH) package (84).
		National Program for Local Development (2007-2012) aims to set up a framework for participatory local government, decentralization, resource mobilization/transfer to local governments and communities in order for more effective service delivery in Senegal's rural and poorest areas.	• Implementation of this program occurred through rural/poor urban communities, local authorities/structures (113,114).
		National Health Development Plan (2009-2018) is based on a vision of universal access to quality promotional, preventative, curative and adaptive health services.	• Collaboration with communities, developing mechanisms and frameworks to ensure community participation, ownership and accountability in the implementation and evaluation of activities (85).
		Bajenu Gox Initiative (2009-present) aims to train women to be leaders in reproductive health, supporting other women in the pre-natal, delivery and post-natal periods, as well as providing advice on care of children under-5.	• This initiative is delivered by respected local women, known as Bajenu Gox (93,119,120).
		National Community Health Policy (2014-2018) aims to ensure a Senegal where all individuals, all households and all communities have universal access to health promotional, preventive and curative services.	• Focus on improving community participation in health, including capacity building and motivation of community actors, increasing funding, and development of adapted service packages (preventive and curative interventions) (91).
		National Community Health Strategic Plan (2014–2018) includes three main objectives: to improve coverage and quality of community health services; to strengthen community participation in problem-solving of health issues; and to ensure sustainability of community health interventions.	• Working towards an integrated package of health services to be delivered at community sites, health huts, and health posts (92,93).
		Multi-sectoral Strategic Plan for Nutrition in Senegal (2017-2021) highlights key achievements and challenges for nutrition in Senegal and outline the vision towards 2025 and strategic objectives for nutrition.	• This program has several axes of intervention in order to improve nutritional outcomes, including activities around improved access and quality of nutrition-sensitive health interventions, management of malnutrition, and management of non-communicable diseases related to nutrition (129).
	Women's/Mother's Groups	**Integrated Education and Nutrition Program (2012-2016)** aims to improve the health and wellbeing of the people of Senegal, with a specific focus on women, children and vulnerable groups.	• Women's groups are included in program activities, with a focus on improving literacy and empowering participants towards income generating activities that can result in increased access to quality foods (67).
	Community Initiatives	**Water Sector Project (1996-2004)** is part of an overarching movement to reform and improve management of the water supply sector in Senegal. This first initiative focused on	• Components of this project related to improvements in coverage of water and

		sustainability, increased access to water and sanitation for the urban poor to improve health and poverty alleviation, and private sector participation.	sanitation took place at the community level (97–100).
		Long-Term Water Supply Project (2002-2005) is part of an overarching movement to reform and improve management of the water supply sector in Senegal. This was the second of three planned initiatives, with the focus of this project aimed at improving access to water and sanitation services within urban areas of the country such as the capital, Dakar.	• Increased access to water and sanitation addressed at the community level (106–110).
		Water and Sanitation Millennium Program (2005-2015) is the third of three consecutive initiatives undertaken by the Government of Senegal to reform the country's water and sanitation sector. It aimed to achieve the Millennium Development Goals related to water and sanitation, creating a global framework to coordinate interventions in the sector.	• Among its core components, this program focused on increasing access to water and sanitation for rural and urban households and communities (111,112).
		Child Nutrition and Food Security Project (2009-2012) aims to reinforce the capacities of local communities in the fight against child malnutrition; implement IMCI, reinforce health-focused behavior change communication, and improve early warning systems for food insecurity.	• Supported the development of local production units of infant dietary flour based on a recipe of millet, corn, cowpea, peanut vitamins and mineral salts. • Provided capacity building for communities (mothers, and grandmothers) through sensitization and training activities for the management of malnourished children
		National Agricultural Investment Program (2011-2015) aims to ensure modern, sustainable, productive and competitive agriculture in intra-community or international markets, based on the efficiency of family farms and the promotion of agricultural enterprises through involvement of the private sector.	• The focus of this investment program is on family farms and intra-community markets (124).
		National Strategy for Social and Economic Development (2013-2017) focuses on improving health and nutrition in order to improve human capital and achieve sustainable development.	• Focuses on the promotion of childbirth in accredited health facilities, free care of pre- and post-natal consultations, promotion of family planning and improvement of nutritional status and child immunization coverage (87,88).
	Integrated Management of Childhood Illness (IMCI) Program	N/A	N/A
School-based	School feeding programs/ Promotion of health and nutrition	**Ten-Year Education and Training Program (2000-2010)** is focused on reform of the education system, including access to universal, quality education and training.	• This program included in-school iron supplementation and deworming, canteens financed by World Food Program, and raising awareness about nutrition and hygiene practices (102,103).
Technology-based	Mobile Health (mHealth)	N/A	N/A
	Mass/social media outlets	N/A	N/A

Table 23: Senegal-Specific Delivery Platforms for Multi-Component Nutrition-Specific and -Sensitive Interventions

Multi-Component Platform	Delivery Platforms	Delivery Interventions	Implementation Examples
Community Nutrition Project (1995-2001) was created to respond to malnutrition among children and pregnant or lactating women.	*Community-based*	Community Health Workers	• Services were provided in specific buildings called Community Nutrition Centres by community members, supervised by physicians employed by the project.
	Fortification-based	Targeted Fortification	• Each beneficiary attending the centers received 700 grams of supplementary food per week. over 6 months. This included locally produced cereals, cowpeas, and groundnuts formed into a dry-blended food by World Food Program, and fortified with imported vitamins and minerals (60,61,96,135).
National Action Plan for Education for All (2000-2015) represents a tool to achieve universal basic education and to implement Senegal's 2001 constitution regarding the right to education.	*School-based*	Promotion of health and nutrition	• Seeks to raise the primary gross enrollment rate to 100% by 2010, improve the level of learning among students, and integrate/ strengthen efforts of the Ten-Year Education and Training Program (136,137). • Included in the Ten-Year Education and Training Program is in-school iron supplementation and deworming, canteens financed by World Food Program, and raising awareness about nutrition and hygiene practices (102,103).
	Community-based	Community Initiatives	• Development of a concept for early childhood development and establishment of new structures for toddlers, as well as preschool classes in elementary and day care centres (136,137).
Nutrition Development Policy Letter (2001-2014) is the first effort to define national nutrition policy and to outline specific strategies for programs and monitoring (49).	*Community-based*	Community Health Workers	• Strengthening of the community approach to nutrition programs, including the package of integrated nutrition activities and Integrated Management of Childhood Illnesses. • Focus on developing a Senegalese Network of Nutrition Practitioners.
	Fortification-based	Mass/universal fortification	• Development of the agriculture sector to improve the production and consumption of locally growth agricultural products, with the aim of impacting food fortification programs.
	Technology-based	Mass/social media outlets	• Communication tools and strategies developed based on the policy's nutrition targets.
	School-based	Promotion of health and nutrition	• Focus on integrating nutrition modules into school literacy programs and adapting information, education and communication regarding nutrition for the school environment (49,79,87).
Coordination Unit for the Fight Against Malnutrition (2001-present) represents a coordinating body for nutrition in Senegal, with a vision to a country where each individual enjoys optimal nutrition by adopting adequate behaviours.	*Community-based*	Community Health Workers	• Utilization of Community Health Workers/relais in the implementation of the Nutrition Enhancement Program (PRN), which falls under the umbrella of the Coordination Unit for the Fight Against Malnutrition.
	Financial incentive-based	Unconditional cash transfers	• Cash transfers provided through Rapid Response Child-Focused Nutrition and Social Transfer Program (NETS), which falls under the umbrella of the Coordination Unit for the Fight Against Malnutrition.
	Fortification-based	Mass/universal fortification	• Fortification of all wheat, oil and flour consumed in Senegal via the Food Fortification Enhancement Program, which falls under the umbrella of the Coordination Unit for the Fight Against Malnutrition (104,138).
Presidential Decree on Mandatory Iodization of Edible Salt (2001-present) was created to ensure mandatory, universal	*Fortification-based*	Mass/universal fortification	• Iodization of all edible salt.
	Technology-based	Mass/social media outlets	• Mass media community awareness and sensitization campaigns held quarterly, as well as social mobilization events.

iodization of all salt consumed in Senegal.	*School-based*	Promotion of health and nutrition	• Ministry of Education raised awareness regarding iodine deficiency disorders (IDD) in school curriculum and supported activities to increase knowledge among students/teachers particularly in salt producing areas (139).
Poverty Reduction Strategy Paper I (2001-2005) aims to ensure adequate social-health and nutritional coverage for children from vulnerable families.	*School-based*	School feeding programs	• Included the provision of schools in poor areas with in-school canteens and latrines via the Nutrition Development Policy Letter (LPDN).
	Community-based	Community Initiatives	• Sensitization activities, particularly with parents, and the promotion of oral rehydration and nutritional activities against diarrheal diseases, malnutrition, drug addiction and stunting via the Nutrition Development Policy Letter (LPDN)(80).
Nutrition Enhancement Programme I (2002-2006) aimed to support the achievement of the first Millenium Development Goal, i.e. the eradication of extreme poverty and hunger.	*Community-based*	Community Health Workers	• Community health initiatives included growth monitoring, monthly weighing and home visits, nutrition and health education sessions, IMCI, provision of basic health services and grants for community-based nutrition projects.
	School-based	Promotion of health and nutrition	• In collaboration with the Ministry of Education the project supported distribution of deworming medicine and iron supplementation.
	Fortification-based	Mass/universal fortification	• The National Committee for Food Fortification, a sub-committee of the CLM supported in the fortification of oil with vitamin A and wheat flour with iron.
	Technology-based	Mass/social media outlets	• Communication campaigns were used to promote fortified foods and enriched oil/wheat flour (60,63,133,134).
National Free Delivery and Caesarean Policy (2005-present) aims to reduce financial barriers for the use of public maternal health services, increase skilled attendance at birth and reduce maternal/perinatal/neonatal mortality rates nationally.	*Community-based*	Community Initiatives	• Provision of delivery kits with basic supplies for vaginal deliveries at health posts and health centres, to replace user fees at point of delivery.
	Financial incentive-based	Removal of user fees	• Hospitals paid per caesarean section and provision of kits for caesarean sections in health centres (81).
National Policy on Infant and Young Child Feeding (2006-present) defines a framework for accelerating behavior change to raise the rate of exclusive breastfeeding to at least 80% and promote adequate complementary feeding by 2015.	*Community-based*	Community Initiatives	• Within the policy, which is incorporated into in the Nutrition Enhancement Program, focus is on follow-up and promotion interventions for the growth of children up to two years of age, as well as promotion of the key behaviours of Integrated Management of Childhood Illnesses-Community (IMCI-C) and the IYCF strategy.
	Fortification-based	Targeted fortification	• The policy advocates for fortification of complementary foods and nutrition supplementation (60).
Poverty Reduction Strategy Paper II (2006-present) focuses on achievement of the MDGs (e.g. reducing poverty by half by 2015); strengthening human capital; reducing vulnerability and inequalities; improving the quality of public services; promoting good economic and judicial governance; and increasing/speeding up economic growth.	*Community-based*	Community Initiatives	• Community interventions delivered through the Nutrition Enhancement Program, which worked to achieve the objectives of the Poverty Reduction Strategy Paper.
	Fortification-based	Mass/universal fortification	• Micronutrient fortification delivered through the Nutrition Enhancement Program, which worked to achieve the objectives of the Poverty Reduction Strategy Paper (83).

Nutrition Enhancement Program II (2007-2014) aims to improve the nutritional status of the population, especially children under 2 years of age living in poor urban or rural areas; and to strengthen the country's implementation and evaluation of nutrition policy.	*Community-based*	Community Health Workers/ Community Initiatives	• Community health initiatives included growth monitoring, monthly weighing and home visits, nutrition and health education sessions, IMCI and promotion of disease prevention, IYCF, provision of basic health services and promotion of food security through the development of small livestock herds, backyard gardening and village grain banks.
	School-based	Promotion of health and nutrition	• In collaboration with the Ministry of Education, the project supported distribution of deworming medicine and iron supplementation.
	Fortification-based	Mass/universal fortification	• The National Committee for Food Fortification, a sub-committee of the CLM, supported in the fortification of oil with vitamin A and wheat flour with iron.
	Technology-based	Mass/social media outlets	• Communication campaigns were used to promote consumption of fortified foods and enriched oil/wheat flour (63,115,116).
Rapid Response Child-Focused Nutrition and Social Transfer Program (2009-2011) provides benefits to mothers of children ages 0-5 years in poor areas of Senegal, in order to help offset the cost of rising food prices.	*Community-based*	Community Initiatives	• Community-based IMCI, nutrition monitoring, micronutrient provision and promotion, and other nutrition knowledge enhancing activities.
	Financial incentive-based	Unconditional cash transfers	• Beneficiaries, which included mothers of young children 0-5 years in vulnerable families, would receive small bimonthly payments (CFA franc 14,000) for six months, for a total of CFA franc 42,000. The cash transfer would be accompanied by a strong communication campaign emphasizing messages about maternal and child nutrition and close monitoring of process and effect (63,117).
USAID/Yaajeende Agriculture and Nutrition Development Program for Food Security (2010-2017) aims to engage in a country-led integrated approach to accelerate the participation of 500,000 of Senegal's rural poor in growth, and to address malnutrition in children under-5 by reducing the rate of underweight and stunted children by 30% each.	*Community-based*	Community Initiatives	This program included many community-based interventions, including: • Supporting innovative local initiatives via a grants and enterprise fund • Helping to transition community nutrition volunteers to community-based solution providers focused on the sale of nutrition-oriented products and services, • Develop community land-use plans, enhance civil society's ability to work with government to manage food security issues • Improve local government capacity to manage and monitor food security at the local/regional level.
	Financial-incentive based	Vouchers	• A voucher system was created for the very poor in order to allow them access to nutritious foods and nutrition services.
	Fortification-based	Bio-fortification of food crops	• Among the activities included in this program was the introduction of technologies and techniques to increase the production of highly nutritious crops, including bio-fortified crops (123).
Community Health Program (2016-2021) aims to improve the health status of Senegal's population, make strategic investments to build country capacity, and have a sustainable impact on maternal, neonatal, and child mortality and other public health priorities.	*Community-based*	Community Health Workers	• At all health care points, this program aims to provide an integrated package of services consisting of family planning, safe motherhood, and child health.
	Technology-based	Mass/social media outlets	• Utilized social media, billboards, television and radio advertisements, talk-shows, and group information sessions (93,128).

5.5: Summary of Budget Expenditure Data for Nutrition Specific and Sensitive Initiatives

The results of budget data for nutrition specific and nutrition sensitive programs can be found in Table 24. It includes information on the name of the program and policy, duration of funding, and funding source. When funds were not listed in USD, they were converted from their local currency (CFA franc) using an online tool described below.

The Government's budget for the Poverty Reduction Strategies has been steadily increasing each year from 2003 to 2010, but has remained relatively stable from 2013 to 2017. From 1998 to 2018, the Government allocated $1.9 billion USD to their major health system strengthening program, the PNDS. From 2014-2018, 48.1 million USD was planned to be spent on improving community health services through the National Community Health Strategic Plan. As Senegal lacks universal health coverage, only $0.88 million USD has been allocated for the Caesarean-Section Program in 2015. However, child immunizations have been provided since 1989 with an estimated $207 million USD spent on the EPI program between 2012 to 2016. Government expenditure on other nutrition-sensitive programs such as WASH, agriculture, and social security/cash transfer can be found in Table 24.

Funding for large-scale nutrition-sensitive programs has become more cost-effective. A major barrier to the longevity of the first successful national nutrition program, the PNC, was its cost of $51 million over 6 years of implementation. The replacement program, the PRN, has reduced its cost by nearly half at 48.1 million between two phases over a total implementation period of 12 years. The largest funders of the PRN are the World Bank and the Government of Senegal.

Despite GDP growth from 2000 to 2015, Government expenditure allocated towards healthcare, measured as the percent of GDP, has not varied greatly (Figure 44). From 2000 to 2015 it has remained between 3.8% to 5.6%. However, current health expenditure per person has fluctuated throughout the years, peaking at $47 USD in 2008 and increasing overall from $22 USD in 2000 to $36 USD in 2015. Out-of-pocket health expenditure greatly decreased between 2004 to 2006 (56% to 38%) and was 44% in 2015.

Table 24: Available data on cost for nutrition sensitive and specific programs

Program or Policy	Funding Source	Time period	Amount Spent (USD)	Source
Social and Economic Programs				
Poverty Reduction Strategy Paper I (PRSP I)/ Stratégie de reduction de la pauvreté (DSRP I)	Government of Senegal	2003	$331.8 million	(80)
		2004	$405.5 million	
		2005	$461.7 million	
		Total	$1.2 billion	
Poverty Reduction Strategy Paper II (PRSP II)/ Document de stratégie pour la croissance et la réduction de la pauvreté (DSRP II)	Government of Senegal	2006	$1.0 billion	(83)
		2007	$1.5 billion	
		2008	$1.8 billion	
		2009	$ 1.5 billion	
		2010	$1.7 billion	
		Total	$8.7 billion	

Program or Policy	Funding Source	Time period	Amount Spent (USD)	Source
National Strategy for Social and Economic Development (NSSED)/ Stratégie nationale de développement économique et sociale (SNDES)	Government of Senegal	2013	$4.4 billion	(88)
		2014	$4.9 billion	
		2015	$4.5 billion	
		2016	$4.3 billion	
		2017	$4.5 billion	
		Total	$22.6 billion	
Water Sector Project/ Projet du Secteur de l'Eau	World Bank, Government of Senegal, KFW, AFD	1996-2004	$223.21 million	(100)
Long-Term Water Supply Project/ Projet Eau à Long Terme (PLT)	World Bank, Government of Senegal, EIB, KfW, SONES, AFD, UNDP, SIDA, AfDB, AFD, NDF	2002-2005	$254.61 million	(110)
Water and Sanitation Millennium Program/Programme d'Eau Potable et d'Assainissement du Millénaire (PEPAM)	World Bank, Government of Senegal, AFD, EIB, BOAD	2005-2015	$52.83 million	(111)
National Program for Local Development/ Programme National de Développement Local (PNDL)	World Bank	2007-2012	$452.5 million	(113)
National Agricultural Investment Program/ Programme Nationale d'Investissement Agricole (PNIA)		2011-2015	$4.0 billion	(124)
USAID-Yaajeende Agriculture and Nutrition Development Program for Food Security in Senegal/ Programme de Développement Agricole - Sécurité Alimentaire USAID-Yaajeende	USAID	2010-2017	$49.8million	(123)

Program or Policy	Funding Source	Time period	Amount Spent (USD)	Source
Emerging Senegal Plan/ Plan Senegal Emergent (PSE)	Government of Senegal	2014-2035	$20.4 billion	(90)
Rapid Response Child-Focused Nutrition and Social Transfers Project/ Projet de Nutrition Ciblée et Transferts Sociaux (NETS)	World Bank (IDA Credit and Multidonor Trust Fund)	2009-2011	$18.2 million	(63)
The National Family Safety Scholarship Program (PNBSF)/ Programme nationale de bourses de sécurité familiale (PNBSF)	World Bank	2013-2019	$25.7 million	(140)
Broader Health Sector Programs				
National Health Development Plan (NHDP)/ Plan National de Developpement Sanitaire (PNDS)	Government of Senegal, development partners, and local communities and population	1998-2008 2009-2018 Total	$381.5 million $1.5 billion $1.9 billion	(85)
National Free Delivery and Caesarean Policy	Government of Senegal	2005-present	$0.88 million	(81)
National Strategic Plan for Child Survival/Plan National de Survie de l'Enfant (PNSE)	Government of Senegal, NGOs	2007-2015	$1.1 billion	(141)
Expanded Program on Immunization (EPI)	Government of Senegal, GAVI, UNICEF, WHO	2012-2016	$207 million	(142)
National Community Health Strategic Plan	Government of Senegal and Donors	2014	$6.7 million $8.0 million $10.2 million $9.6 million $13.7 million $48.2 million	(92)
Nutrition Specific Programs				
Community Nutrition Project/ Programme de Nutrition Communautaire (PNC)	World Bank, KfW, WFP, Government of Senegal	1995-2001	$51 million	(135)

Program or Policy	Funding Source	Time period	Amount Spent (USD)	Source
Nutrition Enhancement Programme/ Programme de renforcement de la nutrition (PRN I)	World Bank, Government of Senegal, International Development Association, KfW, UN Children's Fund, World Food Program	2002-2006	$23.1 million	(134)
Nutrition Enhancement Programme/ Programme de renforcement de la nutrition (PRN II)	Government of Senegal, World Bank, MDG Achievement Fund (supported by Spain), GAIN, UNICEF, WFP and the Micronutrient Initiative (supported by Canada)	2007-2014	$25.0 million	(115)
Strategic Plan for the Fortification of Foods in Senegal/ Plan Stratégique pour la Fortification des Aliments en micronutriments au Sénégal (PSFAMS)	Government of Senegal, GAIN, Helen Keller International, USAID, Micronutrient Initiative, UNICEF, PAM	2006-2011	$7.0 million	(82)
Integrated Education and Nutrition Program/ Programme Integre Sante Education Nutrition (PISEN)	Government of Senegal, WHO, UNICEF, UNFPA, UNESCO, FAO, PAM	2012-2016	$15.1 million	(67)
Multisectoral Strategic Plan for Nutrition in Senegal/ Plan Strategique Multisectoriel de la Nutrition du Senegal (PSMN)	Government of Senegal, International Partners	2017-2021	$330.5 million	(129)

Notes: [1]Data that were originally in CFA franc were converted to USD using average annual exchange rates for the applicable opening year of the program/policy, https://www.oanda.com/currency/average.

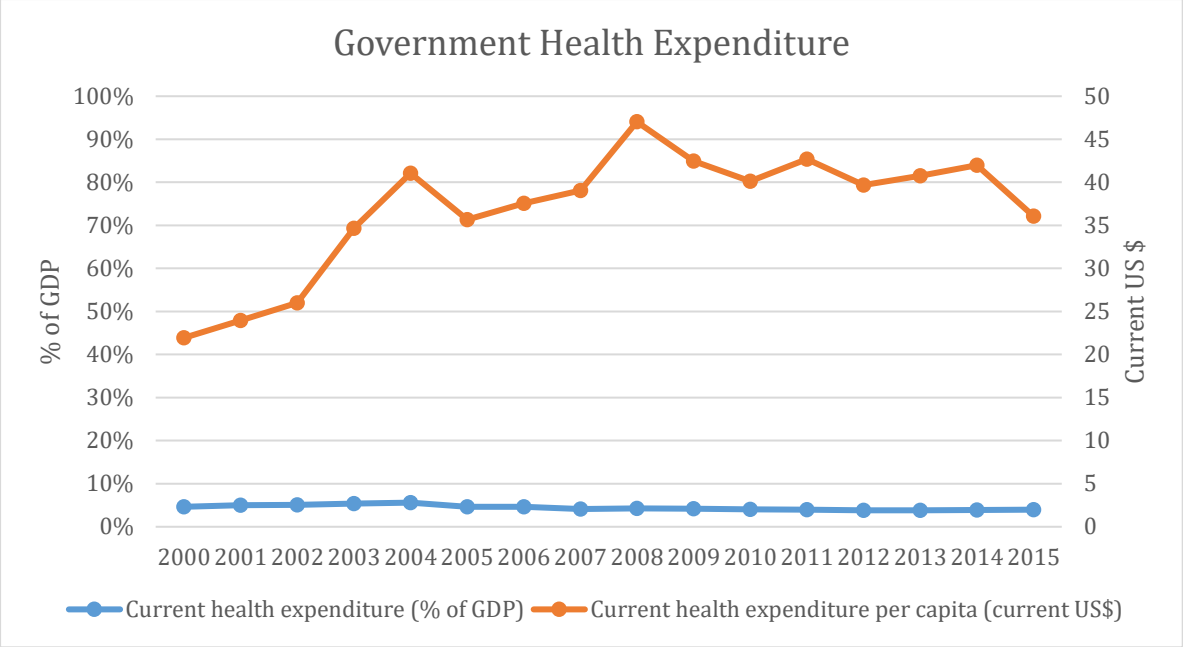


Figure 44: Government health expenditure from 2000-2015

Chapter 6: Discussion

6.1: Summary of Main Findings

Our synthesis of results from diverse quantitative and qualitative approaches highlight a combination of drivers have contributed in the accelerated under-5 stunting reduction in Senegal from 1992 onwards. Below, we narrate a story of multifactorial determinants that influenced child nutrition, which have been put into practice at a country level in Senegal. We contrast and contextualize our findings with existing literature. A detailed synthesis and review of literature on key drivers of stunting reduction in Senegal is available in Appendix 17.

To preface the subsequent detailed synthesis of the pathways to achievements in health, nutrition and stunting reduction in Senegal, we have summarized major findings below:

Summary of Key Takeaways

- Overall, stunting prevalence decreased by nearly 10% points and mean HAZ improved notably across 1992/93 to 2017. The fastest gains in child growth were achieved between 1992/93 and 2005, with more modest gains achieved after this time.
- Economic recovery and decreased poverty were observed after the implementation of structural adjustment programs and the devaluation of the CFA franc in 1994. These distal factors improved food security and may have contributed to an increase in public investment in social services due to improved national financial and budgetary conditions.
- Improvements in health, nutrition and stunting were achieved despite several decades of internal conflict and displacement in the southwestern Casamance region.
- Education levels (overall and among girls and women) improved substantially over the last several decades through initiatives targeting universal, basic education. This has supported women's empowerment, lower fertility rates, decreased adolescent pregnancy and decreased early marriage; each of which have important links to reducing child undernutrition.
- Increasingly decentralized social services (including health) since the 1970s, including the 1996 Local Government Code and 2006 National Program for Local Development, have helped to improve autonomy and decision-making power of local authorities (e.g., community health committees) in an effort to meet the MDGs and reduce poverty.
- Mandatory and voluntary health insurance schemes have been implemented for over two decades, and represent important initiatives to address the financial barriers of accessing health services and national progress towards achieving universal health coverage in Senegal.
- Provision of an Essential Package of Health Services (e.g., immunization and vitamin A supplementation) to key populations, including women and children, have drastically improved coverage of interventions addressing immediate determinants of stunting, including reduction of communicable diseases among children.
- Multiple cadres of community health workers and volunteers have supported improved accessibility and uptake of health services, particularly at community level.
- Sustained substantial political will and commitment to nutrition has been ongoing, through demonstrated efforts to institutionalize nutrition and the introduction of a multisectoral approach. These initiatives included the Presidential Decree to establish the *Commission on the Fight of Malnutrition (CNLM)* (1994), introduction of the *Nutrition Policy Letter* (2001) and the establishment of the *Cellule de Lutte Contre la Malnutrition (CLM)* as the high-level coordinating body for nutrition.

- Nutrition-specific efforts, particularly the *Community Nutrition Program (PNC)* and the *Nutrition Enhancement Program (PRN)* represent pivotal, catalytic national programs that have evolved to target vulnerable populations through a multisectoral approach. Nutrition-sensitive efforts delivered through community-based platforms have focused on largely on improvements in water, hygiene and sanitation, as well as universal basic education.
- Many recent nutrition-specific and -sensitive efforts have emphasized multisectoral collaboration and represent promising initiatives to further improve stunting in Senegal going forward.

Key Enablers

Contextual factors in Senegal have acted as critical enablers for the achievements in reduced child chronic malnutrition.

- These improvements occurred amidst ***peaceful political and democratic transitions and stability***, as well as decades of ***regional conflict and internal displacement*** in the Southern region of the country.
- Senegal has made substantial efforts to meet ***international targets including the MDGs*** relating to WASH, maternal and newborn health and education.
- Since 1961, Senegal has established long-term strategic plans for ***broad national development*** through the implementation of the *Plan Quadriennal de Development Economic et Social, PQDS).*
- Further, long-term health plans (e.g., PNDS), the prioritization of nutrition specifically through the adoption of the *National Nutrition Letter* (2001) and the establishment the CLM (2001), a high-level national coordinating body for nutrition, as well as two decades of implementing national and community-based multisectoral efforts, demonstrate ***ongoing political commitment to improving the health and nutrition of the population in Senegal***.
- Overall, some investments in health system are observed including efforts to provide community-based health services through the establishment of health posts (health huts), introduction and training of a multi-level cadres of community health workers and rural bajenu gox (godmothers) for health promotion and preventive health services, and investments in public health services (e.g., immunization, vitamin A supplementation). Increased efforts to target vulnerable populations through the provision of health services to women and children, including provision of free deliveries and caesarean sections
- Since the late 1990s there has been an increased focus on ***decentralized social services*** and subsequent 2006 reforms further disseminated responsibility for nine key areas to regions including health.
- Progress towards achieving universal health coverage are ongoing, including efforts to introduce both mandatory (state and private sector) and ***voluntary health insurance schemes "mutuelles"***, with a renewed focus since 2012.

These efforts are summarized in the ***Timeline of Key Events*** in Senegal, which our work posits as central to child stunting reduction from 1992/93 to 2017 (Figure 45).

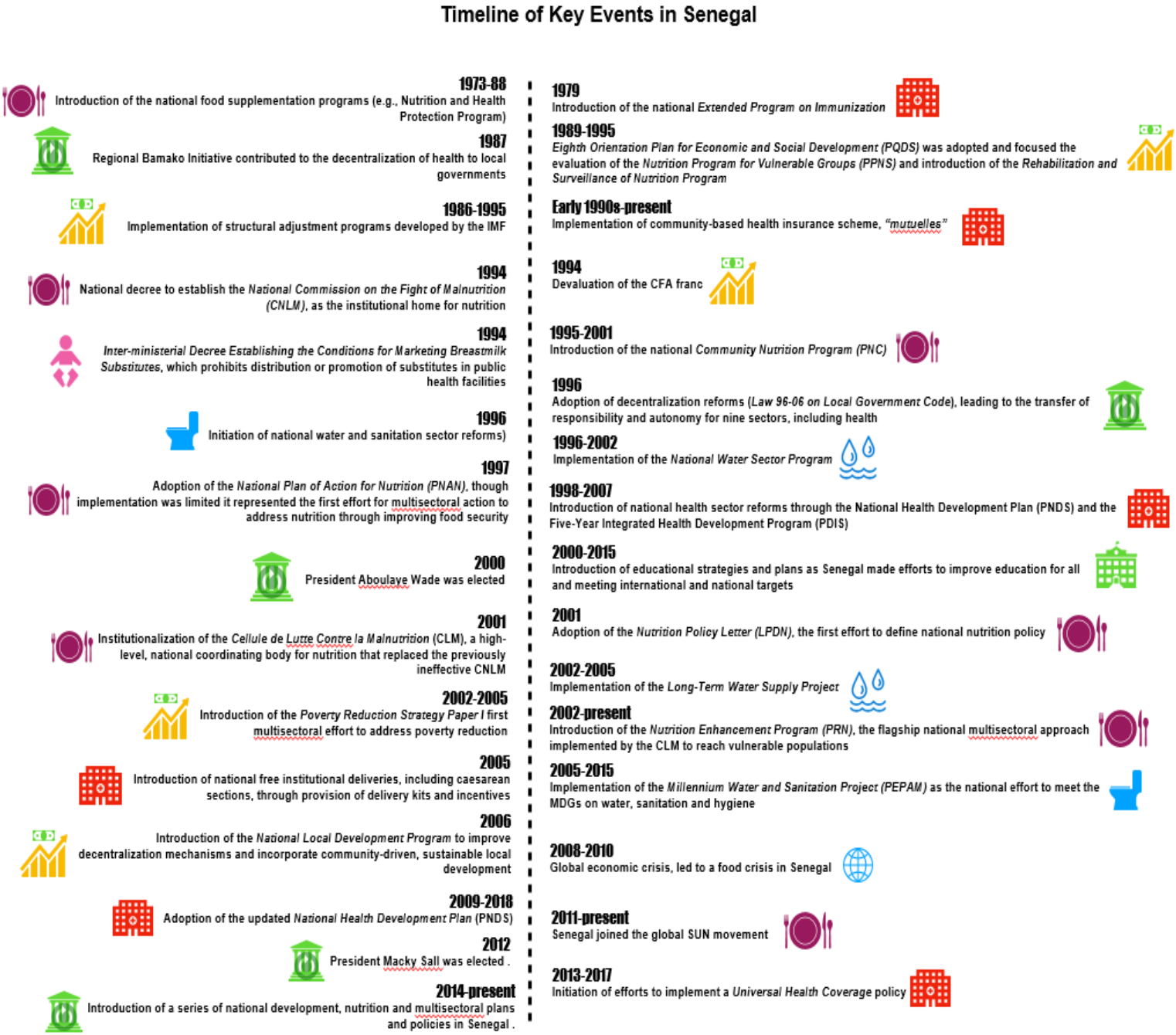


Figure 45: Timeline of key events in Senegal

Political Context & Conflict

Since 1982, Senegal has experienced a ***longstanding internal conflict in the Casamance region*** (southwestern Senegal, composed of Zinguinchor and Zolda regions). This conflict was initiated by the separatist *Mouvement des forces democratiques de la Casamance* (MFDC). It is estimated that 3,000 to 5,000 people have died during the conflict and that the number of internally displaced persons during the peak of insurgency (late 1980s) was estimated at over 60,000 individuals, largely from the Zinguichor region (21,22). Southern regions that were involved in conflict experienced high

food insecurity (Zinguichor, Kolda and Kédougou) (143) and stunting prevalence (144,145). The Casamance conflict also led to declines in agricultural production, destruction of infrastructure and livelihood assets, as well as increased poverty (143). Despite experiencing four decades of conflict, national key informants in our qualitative inquiry felt that Senegal was a peaceful nation and the lack of major crisis, war and unrest have created a conducive policy environment for public investment in social services. Over 40 years since independence from colonial ruling, peaceful democratic transitions between Governments, and recently generally "open and fair" elections recognize Senegal as a ***regional success story for democratization*** (146).

Economic Conditions & Poverty Reduction

Stunting prevalence reduced in Senegal despite periods of ***economic structural adjustment and currency devaluation***. In 1986 and 1995, Senegal adopted a series of structural adjustment programs developed by the International Monetary Fund (IMF) in order to introduce a framework to improve economic growth (147). While these structural adjustments (that took place throughout sub-Saharan Africa) aimed to reduce national deficits, to improve allocation of resources to productive sectors, to decrease national Government costs, and to mitigate social costs through employment generation and targeted social protection programs for vulnerable populations (147), the initial change sent a shock of economic instability through Senegal that has adverse trickle down impact to civilians.

Economic growth in Senegal over the last several decades was categorized by three phases including: i) a period of economic instability (until 1984); ii) structural adjustment (1985-1993); and iii) an economic boom after the devaluation (1994 onwards). In January 1994, the Senegalese currency, the CFA franc, was devalued by 50% in relation to the French franc along with other countries in the CFA franc zone including Benin, Burkina Faso, Cote d'Ivoire, Mali, Niger and Togo. In West Africa, anticipated benefits of devaluation included economic growth, reduction of imports and substitution with local products. This led to initial drastic declines in prices of Senegalese international exports and commodities for trade, increased prices for imports, and declines in tax revenues for investment in health, education and infrastructure (148).

After the devaluation, an initial period of rapid inflation led to lower crop prices, which was compounded by several years of inadequate rainfall, thus increasing poverty among the rural poor. The devaluation of the CFA franc in Senegal may have also contributed to significant wage cuts in the formal sector, and increased poverty in urban areas, similar to experiences in Cote d'Ivoire and Niger (149). High food insecurity and increased urban unrest were also observed after the devaluation (49). Analysis of the post-devaluation boom indicated long-lasting effects that may have catalyzed a period of substantial ***public investment due to the improved national financial and budgetary situation***. As a result, increased investment has supported poverty reduction and improvements in standards of living nationally, including among rural populations (149). However, more recently, the 2008 global economic crisis also led to increased prices for both domestic and international food commodities and exacerbated food insecurity (150).

Despite these periods of economic upheaval and uncertainty, the Senegal national ***GDP per capita increased*** from $1,802 in 1992 to $2,471 in 2017 (PPP constant 2011, international $) and GNI per capita increased from $1,758 in 1992 to $2,374 in 2017 (PPP constant 2011, international $) (Table 2). ***Poverty also declined*** over the past several decades in Senegal; the poverty headcount ratio at national poverty lines ($1.90 per day) decreased markedly from 68% to 38% between 1991 and

2011 (50), and the multidimensional poverty index (MPI)[2] in Senegal showed some progress, decreasing from 0.440 in 2010 to 0.293 in 2017 (51,52). Our work suggests that ***poverty reduction and economic growth were important drivers of stunting reduction in Senegal***. Specifically, we found that improved asset index explained 19% of total change in HAZ for children under-5 years and 10% in children aged 2-5 years from 1992/93-2017. Additionally, national experts felt that poverty reduction happened and was largely a result of investments by the State through initiatives, such as the PNC and PRN, with integrated elements of social protection to support resilience during the economic challenges related to the currency devaluation. Some mothers in communities also corroborated improvements in poverty, though many felt much scope for improvement remained. Our equity analysis of stunting prevalence further supports this; we found substantial gaps between the poorest and richest groups, which continue to widen as stunting decreases more rapidly among the rich. Earlier studies using many of the same household datasets found similar results (24,151–153).

Poverty reduction represents a national priority in Senegal, and the Government has demonstrated ongoing commitment to strengthening national and local development through the implementation of the ***Poverty Reduction Strategy Paper I (DRSP I) (2002-2005)***, the ***Poverty Reduction Strategy Paper II (DRSP II) (2006-2010)*** and the ***National Strategy for Social and Economic Development (DPES) (2013-2017)***. Our work supports the importance of these initiatives towards overall poverty reduction in Senegal, however ***they may not have been responsible for the major stunting decline in Senegal from the early 90s to mid-2000s***. Recent promising efforts to introduce conditional cash transfer programs are observed including the implementation of the ***Rapid Response Child-Focused Nutrition and Social Transfers Project (Project de Nutrition Ciblée et Transfers Sociaux, NETS)*** (2009-2011) and the recent ***National Family Safety Scholarship Program (Programme National de Bourses de Sécurité Familiale, PNBSF)*** (2013-2019). Although these more recent efforts were unlikely drivers of long-term and overall stunting declines, they represent promising initiatives to utilize cash and social transfer delivery platforms to target at-risk populations, largely women and children, and support further improvements in health and nutrition.

Poverty reduction in Senegal is more likely linked to the improved financial conditions of households as a result of remittances received from labour migration. Remittances represent an ***increasingly important component of Senegal's economic growth*** due to international labour migration over the last several decades. Inflows from remittances due to labour migration has drastically increased over the last two decades from $142 million USD in 1990 to $2,238 million USD in 2017 (54). The proportion of GDP represented by remittances has also increased from 2.5% of GDP in 1990 to 13.7% in 2017 (55). Despite these trends, the emigration rate has experienced declines over the last two decades from 48.9 per 1,000 population in 1990 to 35.3 per 1,000 in 2017 (154). In 2013, France, The Gambia, Italy, Spain and Mauritania represent the most popular destinations for international migration from Senegal, largely for employment purposes (56,155). Evidence from the *2009 Migration and Remittances Household Survey* indicated that Senegalese households largely use the remittances received towards purchasing foods (59). Other literature suggests that more than half of ***remittances from migration are spent on basic amenities including food, education and healthcare*** (58). Further, evidence indicates that remittances have helped ***increased household resilience and food security*** due to climate and environmental related events (156). Despite these trends, remittances and labour migration were not identified by community, regional or national respondents as contributing factors to stunting decline in Senegal***. Our study, nonetheless, posits that the influx of remittances from labour migration have been***

[2] MPI is a quantitative measure (ranging from 0 to 1) that considers indicators health, education and living standards for calculation of a poverty index.

pivotal to household poverty reduction, food security and overall standard of living in Senegal. Further evidence and trends on labour migration and remittances in Senegal are detailed in Appendix 18.

Infrastructure Development & Urbanization

Senegal's urban population has grown only slightly from 39% in 1992 to 47% in 2017, an increase of 7.5% (50). Our study and previous literature support that those living in urban areas in Senegal have lower stunting prevalence than rural areas due to many factors (144,157,158).

Historically, Senegal has a policy on slum evictions, which was carried out between 1960 and 1987; however, this policy was financially expensive and socially unaccepted (159). The urban upgrading and land legalization policy was thus established in 1987, and was applied on a national scale in 1991 (159). In order to manage uncontrolled urbanization, the government established social housing projects, provided services in urban extension zones, and upgraded and legalized informal settlement areas (159). It has since been sustained and regularly applied. This approach has encouraged some of the observed urbanization.

Urbanized populations may also have increased in Senegal as a result of the majority (>70%) domestic migrants moving to urban areas (as opposed to rural areas) for work (160). This internal rural-urban migration has been linked to the general lack of food, adverse climate conditions, and high unemployment rates in rural areas (157). Urban growth in Senegal has mainly driven by urban hubs, especially Dakar. Senegal's urban centres produce 65% of its GDP, with Dakar contributing 55% on its own (161). Despite existing policies, Senegalese cities struggle with a chronic deficit of urban infrastructure and poor service delivery (161). Consequently, our work, both quantitative and qualitative, ***did not find any meaningful contribution of urbanization on the stunting decline*** from 1992/93-2017 in Senegal.

Improvements in Education

Improvements in education, particularly maternal education, is important to child health and nutrition. Pathways between education and improved outcomes are well understood and are detailed in Appendix 19. Our equity analysis also sheds light on putative pathways to improved child HAZ among educated mothers in Senegal. Children of these mothers are more likely to be exclusively breastfed, to be vaccinated, to receive care for diarrhea and ARI, and to live in conditions with improved water and sanitation conditions. Some improvement in primary and secondary enrolment and decreased gender inequity in education are observed in Senegal. Net enrolment in primary education increased from 49% in 1996 to 72% in 2016 (50). Modest improvements were observed across both adult and female literacy between 2002 to 2017, increasing from 39% to 52% and 29% to 40%, respectively (Table 2). Several existing studies have found the relationship between decreased child stunting and improved parental education in Senegal (24,151,158,162), though a few subnational studies disagreed (163–166). Our decomposition analysis found that both maternal and paternal education contributed to HAZ improvement in under-5 (7% and 7%) and 2-5 year old Senegalese children (4.0% and 2.4%), respectively. These findings were corroborated by national and regional stakeholders who suggested that improved ***overall education and literacy (particularly of girls and women) could have been important to child health and nutrition gains*** in the country. Our ***study overall supports this conclusion***. Several national efforts could have been responsible for these gains, including the ***National Action Plan for Education for All (PNA EPT)*** (2000-2015), the ***Letter for the Education and Training Sector Policy*** (2000-2015), and the ***Ten-Year Education and Training Plan (PDEF)*** (2001-2010), were introduced in order to meet global

and national objectives to ensure universal basic education; though it should be noted, that these were introduced only post 2000.

Women's Empowerment

Linked to maternal education, ***women's empowerment has improved in Senegal as seen through proxies such as education, decreased fertility, increased age at marriage, and a lower age of first birth*** (Appendix 19). Gender equity indicators for Senegal have shown some improvement since 2000. The Gender Development Index (GDI) increased from 0.781 in 1995 to 0.911 in 2017, and a slight improvement in the Gender Inequality Index (GII) was also achieved over the same time period from 0.644 to 0.515 (53). The proportion of seats held by women in the national parliament has increased dramatically since the late 1990s, from 11.7% in 1997 to 41.8% in 2017 (50), achieving substantial progress towards achieving gender parity in national decision making structures. Our systematic review did not capture any studies that explored the role of women's empowerment on nutritional gains or stunting among children in Senegal. Some evidence highlights ***a potential link between growth and women's empowerment***, as increased women's bargaining power was associated with increased children's nutritional status (as measured by the circumference of their upper arm) (167). Results from our qualitative inquiry did not specifically highlight substantial gains in relation to women's empowerment by national or regional experts or mothers in communities. Nonetheless, the importance of women's empowerment could be inferred through the maternal education and other proxies that were examined in our study and were found to have notable impact on stunting reduction.

Environmental Context & Agriculture

Agriculture in Senegal has had numerous changes over the 20-year study period. Food exports and imports have risen between 1996 and 2016 by $261 million USD and $309 million USD, respectively. Livestock production, food production, and cereal production all grew between the years of 1992 and 2016. The food production index, which covers edible food crops that contain nutrients, increased by 75 points from 1992 to 2016, signaling that overall food production has grown. In 2012, 17.1% of Senegal's land was arable, while 0.3% had permanent crops (168). Senegal's arable land has increased by 0.15% annually between 2000-2012 (168).

There has been an overall 5% decrease between 2000 to 2015 in the share of Senegal's population that works in agriculture. ***Agriculture, however, remains the main means of livelihood in Senegal***, and in 2010, 70% of the workforce worked in the agriculture industry (160). Recently agriculture productivity is facing a significant slowdown due to vulnerability from climate shocks, lack of safe access to water irrigation, and volatility of prices, particularly in rural areas (169). Correlations between climate and food price are not altogether straightforward, as markets can be non-local. In Senegal's case, imported rice prices are affected by climate in other countries, as well as global price trends (143). Millet, in contrast, is produced locally, and national scale millet production is strongly positively correlated with precipitation, while millet prices are negatively correlated with precipitation. This suggests that insufficient rains translate to a bad harvest, and higher cost of food (143). ***Across rural Senegal, people depend highly on income from climate-sensitive activities*** such as subsistence agriculture, cash crops, livestock, vegetable growing, and daily agricultural labor (143). To mitigate the risk of depending on climate-sensitive income sources, rural households diversify their income generating activities, with the majority of rural households depending on at least two activities.

Senegal has experienced a ***multitude of climate and environmental shocks including floods, droughts, oil and food crises***. Figure 46 summarizes the key environmental events between 1990 and 2017. Since 2010, three floods and three droughts have affected hundreds of thousands of

Senegal's citizens. People experienced increased food prices, and rising food insecurity as a result of these climate shocks. The 2011/12 drought-induced food insecurity, and the subsequent floods of 2012 in the Sahel demonstrated the impacts of climate change on food insecurity in Senegal (143). In the coming years, ***climate change is expected to continue to lead to erratic rainfall, rising sea levels and more extreme weather events***, thus it is critical to enhance Senegal's resilience to these climate shocks (143).

To improve resilience, the FAO suggests that public policies should focus on development of better infrastructure for basic services, increasing availability of infrastructure in rural areas, improving education levels, and increasing the focus on agriculture development (160). Senegal's ***National Food Security and Resilience Strategy*** in 2002 aimed to implement an appropriate framework for the coordination of food security and resilience policies; to provide broad strategic directions for food security and resilience, and to engage in immediate, medium-, and long-term actions; and to protect the livelihoods of rural populations by strengthening their capacities, and their resilience against shocks (157). The ***National Agricultural Investment Program (2011-2015)*** sought to make agriculture a source of growth of the economy, to strengthen food security, and to ensure a more balanced distribution of agricultural activities (170). This investment program included the following objectives: reducing climate risks through water control; preservation of national resources; increasing production and productivity; enhancing the value of agricultural products through processing; improving access to agricultural products in markets; strengthening agriculture research, and development of processing, and production technologies (170). In 2014, Senegal invested 1.15% of its agricultural output on research, which was up from 0.63 percent in 2012 (171).

Despite these advances and given the ongoing climate/environmental shocks in Senegal, ***our work did not find any strong impact of improvements in the agricultural sector on the observed child stunting decline in Senegal***. We did not find any quantitative literature drawing such links, nor did our qualitative inquiry support this as an important theme.

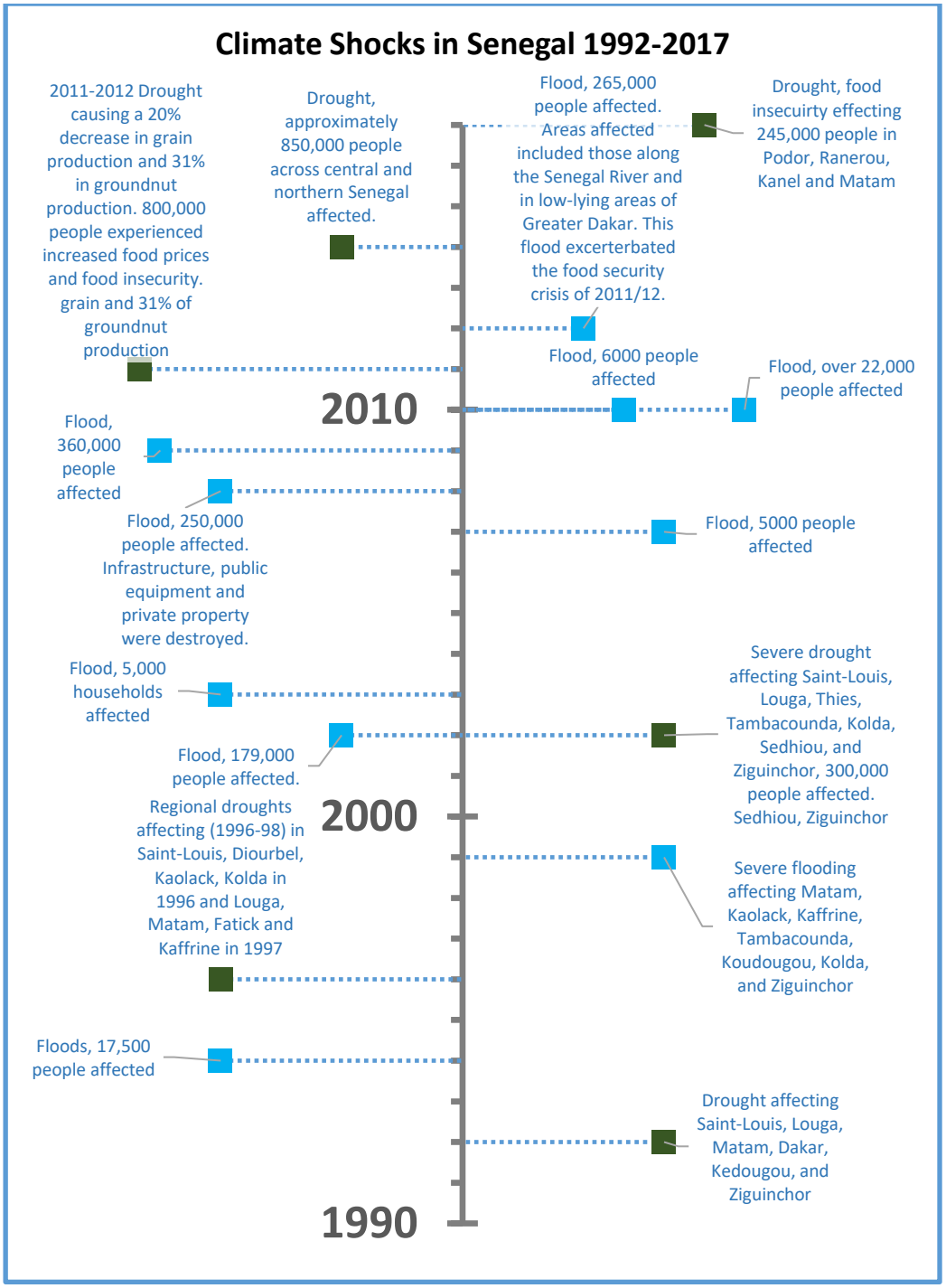


Figure 46: Economic and climate shocks in Senegal 1990-2017 (143,172–174)

Increased Food Security

Senegal is a highly food insecure country, ranking 66 out of 119 countries on the 2018 Global Hunger Index (175). Although there is no single measure used for food security, proxy indicators used include diet quantity and diet quality. While some regions may have access to sufficient caloric intake, this may come from a single food source, and thus may not provide sufficient dietary diversity. ***Food security is linked to poverty***, and in Senegal, the regions that have the highest prevalence of food insecurity are also the ones with high rates of global chronic malnutrition, and high poverty incidence (143).

Food availability has increased modestly over the last two decades with the average protein supply increasing from 63 to 72 (g/capita/day) from 1999-2001 to 2011-2013 (176). ***Food insecurity is inequitable across Senegal***, as the most food insecure regions are the southern and central parts, which include Ziguinchor, Kolda, and Kédougou (143). Similarly, regional variations in stunting prevalence exist, and our subnational variation analysis shows that stunting was highest among the southern regions of Senegal. Regional variations persist, as Kolda, Sedhiou, and Kedougou were the three regions with the highest stunting prevalence in 2017, ranging from 26-32% stunting prevalence. Southern Senegal has a less variable and wetter climate as compared to the rest of the country, suggesting that in terms of climate it is amenable to agriculture. Despite this, food insecurity prevails, as the long-term Casamance conflict has led to declines in agricultural production, destruction of infrastructure and livelihood assets, and increased poverty in Ziguinchor. Central Senegal is referred to as the "groundnut basin", and is largely dependent on the agricultural economy. Unfortunately, this region is susceptible to climate shocks, with climate change leading to years with lower rainfall, leading in turn to decreased crop production, and increased food insecurity (143). During lean seasons, households reduce the number of meals they consume in a day and this decline in food consumption continues after the lean season, indicating that households are affected for long periods (143).

Efforts to reduce the burden of droughts and floods in regions around the Senegal river included an irrigation system built in 1989, and two dams (177). The irrigation system allowed for people to control water for agriculture and human use, and led to increased food production, such as rice. This decreased the amount of food purchased, and increased the amount of food produced by modern irrigated agriculture (178). The connection between these efforts and stunting prevalence was explored in a study which found that found the prevalence of stunting decreased slightly the first two years since irrigation began and then increased again after 1993 and did not greatly change overall from 1990 to 1995 (23.5% vs. 21.5%) (177).

Similar to overall agriculture, our ***work did not identify any strong relationship between food security initiatives or contingencies at national scale that could be linked to child stunting gains over the time*** period of interest in Senegal. While in qualitative analysis, mothers in communities did feel that there were some improvements in food frequency and diversity, the remaining challenges around food procurement were by far trumped these gains.

Health System Strengthening & Reforms

The provision of community-based health services through a multi-tiered system of public and private health providers, multiple cadres of community health workers and volunteers, national support for longstanding mandatory and voluntary community-based insurance schemes, as well as subsidized services targeting vulnerable populations represent substantial efforts to strengthen the health system and delivery of health services in Senegal.

The total health expenditure as a proportion of GDP in Senegal has decreased marginally from 4.63% in 2000 to 3.97% in 2015. Further, the domestic general government health expenditure as a proportion of GDP has shown a marginal decline from 1.7% in 2000 to 1.3% in 2015 (50). However, over this same time period individuals' out-of-pocket expenditure as a proportion of total health expenditure has also decreased from 54.0% to 44.2% (Table 2). The introduction of ***a nutrition-specific line in the national budget*** and increased investments in this area over the last two decades demonstrate the substantial political will and intensification of Government commitments to the nutrition sector in Senegal (49).

The ***National Health Development Plan (PNDS) (1998-2007)*** represented the first effort to introduce legal and institutional reforms in the health sector and was implemented through the ***Five-Year Integrated Health Development Programme (PDIS)*** over two phases from 1998 to 2002 and 2004-2008. These policies aimed to improve the financial management and sustainability of the public health system and integrated reproductive health services, including family planning into the health system to lower fertility rates and address concerns regarding population growth (77,179) . Recent updates to the health sector policy include the ***2009-2018 National Health Development Plan (PNDS)***, which aims to address the burden of maternal and infant mortality and morbidity and increase the health sector's performance, sustainability and governance (179).

Longstanding national commitment and efforts to ensure ***decentralization of decision-making to local governments*** aim to address local demands for basic amenities, including health facilities. Early decentralization efforts in the 1970s, as well as the adoption of decentralization reforms in 1996 (the *Law 96-06 on Local Government Code*) have led to the transfer of financial resources, responsibility and autonomy for nine policy areas, including education and health (23,180). Further decentralization reforms were outlined in the ***National Program for Local Development (Programme National de Developpement Local, PNDL) (2007-2012)*** and aimed to achieve objectives outlined in the global MDGs, as well as national development and poverty reduction plan (PRSP). Efforts to decentralize health services have increased the provision and availability of care in communities to include the provision of antiretroviral treatment, diagnosis and treatment of tuberculosis, as well as maternal and newborn healthcare (181). However, inequitable or inadequate distribution of financial resources may continue to limit effective decentralization and transfer of power to local governments (23).

Introduction of ***health financing mechanisms through mandatory and voluntary health insurance and subsidized health services*** for vulnerable populations cover approximately 23-28% of the population (23). Mandatory health insurance schemes provide services for public sector employees, retired persons, students, as well as private sector employees and together cover approximately 16.2% of the population (23). A ***voluntary community-based health insurance (CBHI), called "mutuelles"*** provides risk pooling and coverage for health services for individuals working in more informal sectors and representing approximately 4% of the population. Further, approximately 3-8% of the population represent vulnerable or priority groups (e.g., elderly, childhood vaccinations, free care for children under-five, maternity care, and priority diseases) and are able to access subsidized health services. Despite these efforts to provide basic health services to select populations, the majority of the population lack financial protection and pay for health expenses out-of-pocket. Substantial inequity in health financing continues to challenge the health and wellbeing of poor and rural populations.

The national ***Essential Package of Health Services (EPHS)*** is largely delivered through community health workers, and public sector primary and referral health care facilities (181). The EPHS in Senegal targets specific activities to address the health needs and access for vulnerable populations including women, children, adolescents, people living with HIV and rural populations (181). Nutrition-specific efforts through ***the PNC (1995-2002) and the PRN (2002-2006)*** may also have improved the uptake of health services through local health and nutrition promotion, growth monitoring of children under-3, provision of basic health services (e.g., micronutrients, deworming tablets, insecticide-treated mosquito nets and oral rehydration salts), as well as referrals for health services and home visits of participating children (60). Efforts to improve accessibility of RMNH services have included the introduction of the ***National Free Delivery and Caesarean Policy*** (2005 to present) initially introduced in the five poorest regions and subsequently scaled up nationally (except in Dakar) to address financial barriers and increase skilled attendance at birth in order to

reduce maternal/infant mortality rates. In the qualitative analysis, mothers in communities indicated that attendance at antenatal care provided opportunities for advice related to infant and child nutrition and dietary diversity. Although these policies and programs may have helped to address the burden of RMNCH and offer opportunities for promotion of health and nutrition among women and children in Senegal, they are largely recent initiatives that may not have substantially contributed to the greatest declines in stunting. ***Access to and use of RMNCH services has demonstrated substantial improvements*** between 1992 and 2017, as the proportion of women attending at least four antenatal care increased fourfold from 14% to 57% and the proportion of births attended by skilled health providers also increased over the same period from 47.2% to 68.4% (Table 2). Our decomposition analysis also highlighted that ***improvements in maternal and newborn healthcare accounted for the greatest proportion of changes in HAZ*** for both under-5 and 2-5 years, representing 27% and 18.6% respectively. In addition, the high coverage of vaccines represented 9.3% of predicted changes in HAZ for children aged 2-5 years.

The availability of human resources for health continues to represent a challenge to ensuring equitable access to quality health services in Senegal. The availability of health providers in Senegal has improved modestly with the number of physicians increasing from 594 to 1,066, and the number of nursing and midwifery personnel increasing from 3,287 to 4,822 between 2004 and 2016 respectively. Despite this progress, as of 2016 the density for both physicians and nursing/midwifery personnel remains 0.068 and 0.309 per 1,000 population respectively (68), substantially below the WHO recommendation for member states to meet a minimum threshold of 1 physician per 1,000 population.

Despite these limitations relating to human resources, strengthening of the local health system has increased accessibility of preventive and basic primary health care to rural communities in Senegal. The introduction of five cadres of ***community health providers has supported the local provision of curative and preventative health services*** by matrones, community health agents (agents de sante communautaires, ASC) and home-based care providers (dispensateurs de sante a domicile, DSDOM). ASC and matrones are based in community health huts, and the DSDOM operate in specific areas to provide care for communicable diseases including malaria, diarrhea, and acute respiratory illness in children. Community volunteers (relais communautaires) and female community leaders or 'godmothers' (Bajenu Gox) represent cadres of local health providers that engage largely in health promotion, behaviour change communication and community mobilization (69). Although the estimated number of community health providers remains below the recommended numbers, national key informants indicated that these ***lower cadre health providers have facilitated the health promotion and referrals for health services***. The ***Bajenu Gox Program (2009 to Present)*** is implemented largely by NGOs and development partners in order to promote maternal and child health and increase the use of RMNCH services. Mothers in communities indicated that local Bajenu Gox are a key source of information and support relating to child nutrition, particularly breastfeeding. Further, the increased training, capacity and availability of national nutrition experts through the establishment of both undergraduate and graduate university programs focused on nutrition was reported by several national key informants as addressing a key gap in human resources for health nationally. Recent policies, such as the ***National Community Health Policy (Politique Nationale de Sante Communautaire 2014-2018)*** provide guidance for Senegal's diverse community health efforts, including community health workers. Community health committees oversee and manage health huts (e.g., manage finances, collect user fees and manage commodities/supplies), as well as select local community health workers (181).

Health & Nutrition Programs

Achievements in health and nutrition outcomes may also be attributed to the implementation of several nutrition-specific and –sensitive programs in Senegal over the last two decades.

The ***Community Nutrition Program (PNC)*** (1995-2001) represented a ***catalytic national initiative to address nutritional challenges in Senega***l due to environmental conditions, as well as poor socioeconomic climate and poverty due to the structural adjustments and devaluation of the CFA franc (60). Funded by the World Bank and implemented by the Agency for Public Works and Employment (AGETIP), this program targeted poor urban areas (49) and was piloted for six months in three cities and subsequently implemented in almost all urban areas nationally over a period of five years (61). This program involved the dissemination of health education messages, food supplementation and distribution, growth monitoring and increased promotion of nutrition through community-based efforts and campaigns. The PNC was established to overcome poverty and economic challenges after the structural adjustment programs and currency devaluation, by also addressing unemployment (particularly among youth) and child malnutrition (182). Despite substantial challenges to implementation including high costs, inadequate targeting of efforts in rural areas and capacity building of stakeholders, as well as a lack of coordination and ownership of nutrition by the Ministry of Health, the PNC helped to recognize nutrition as a priority and improve coordination across multiple levels, sectors and diverse stakeholders in Senegal (49).

In 1994, the ***National Committee for the Fight Against Malnutrition (Commission Nationale de Lutte contre la Malnutrition, CNLM)*** was initiated by a Presidential decree, to provide safety nets for the poor and ensure oversight for the implementation of the PNC (49). However, a lack of incentive structure, resources and clear roles and responsibilities of partners represented substantial challenges and limited the effectiveness of the CNLM (49). In 2001, the ***Cellule de Lutte contre la Malnutrition*** **(CLM**) was established (and replaced the CNLM) with the support of development partners, including the World Bank, USAID, UNICEF and WHO. The CLM represents a coordinating body for nutrition, and has been instrumental in catalyzing increased political will and prioritization of nutrition by decision-makers over time, including increased financial allocation of resources (49). Key programs led by the CLM include the PRN, Universal Salt Iodization Project, Fortification Enhancement Program (PRF), Food Security Support Project for Vulnerable Households (PASAV), demand-based financing component of the health and nutrition financing project (PFSN), results-based financing project for maternal care, and projects focused on nutritional/food crises in Podor, Ranerou, Matam and Kanel regions (62). The ***CLM has substantially contributed to the institutionalization and coordination of nutrition by establishing a framework and coordination of nutrition-related efforts across all regions of the country***. In our qualitative analysis, several national respondents felt that the establishment of the CLM represented a substantial contribution towards ensuring nutrition represented a priority across sectors and levels.

The ***Nutrition Enhancement Program (PRN)*** was implemented between 2002 to 2006, with a subsequent reform introduced in 2007-2014. This program expanded on lessons from the PNC and utilized a multisectoral approach to improve the nutritional status of vulnerable populations, particularly children under five years of age living in poor urban and rural areas, as well as pregnant and lactating women (63). The PRN represents a key initiative of the CLM and also focused on strengthening institutional and organizational capacity to implement and evaluate nutrition interventions. In addition it provided growth monitoring and counselling to mothers and children, promotion of antenatal and postnatal care, as well as vaccination, deworming and micronutrient supplementation, including vitamin A (183). Several evaluations of the impact on child malnutrition of the PNC and PRN indicated minimal reduction of stunting prevalence as a result of the PNC. Improved uptake of vitamin A, deworming, use of bed nets, iron supplementation, malaria

prophylaxis and oral rehydration solution for diarrhea were observed after implementation of the PRN. Further, children that received the intervention were less likely to be underweight (183). National key informants felt that this represented a paradigmatic shift in nutritional approaches and the institutionalization of nutrition across sectors and multiple levels of governance represented a key driver of improvement in nutrition and stunting.

Implementation of the *PNC, CLM and PRN* represent over two decades of national political will and investment, community-based delivery of nutrition-specific and –sensitive activities, as well as capacity building and coordination of stakeholders. ***Results from our study back the positive impacts of these initiatives, and although we could not quantitatively examine the PNC, CLM or PRN, these were suggested as very important by several experts in our policy and program review***. Therefore, we posit that these represented ***important contributions towards the period of greatest declines in child stunting, which occurred between 1995 and 2005*** in Senegal.

Water, Sanitation and Hygiene (WASH) Initiatives

Improved water access and sanitation facilities are important factors in relation to child health and survival. Only 68% of Senegal's population currently has access to piped water, though this improved about 26% since 1992. Similarly, access to improved sanitation facilities doubled between 1992 and 2017. Rates of open defecation reduced notably from 39% in 1992 to 15% in 2017 (184,185). Existing literature suggests that improvements in piped water access for a household and reduced open defection rates may be linked to child stunting in Senegal (151,186). Our decomposition analysis found that improvements in access to piped water was the third most important factor in explaining HAZ change in children under-5 (explaining 8% of HAZ change among under-5 children, and 7% among children 2-5 years old). In addition, among the younger cohort, reduction in open defecation explained 7% of the HAZ change. National stakeholders felt that improvements in sanitation and water access had contributed to increased nutritional status among children. While mothers may have concurred, they also felt shared ongoing concerns regarding lack of access to improved toilet facilities, local waste disposal and access to safe drinking water. ***Our work thus posits that improvements in WASH, particularly reduced open defecation and overall in household sanitation, may be strongly linked to the observed child stunting declines in Senegal***. Key WASH initiatives in the country include the ***Water Sector Project (1996-2004), Long-Term Water Supply Project (2002-2005)*** and ***Water and Sanitation Millennium Project (2005-2015)***. Despite these efforts, WASH initiatives are not equitably delivered in Senegal and there remains much scope for targeting of poor and rural regions.

Delivery Platforms

In terms of delivery platforms for above successful nutrition-specific and –sensitive initiatives (e.g., fortification-based, financial incentive-based, community-based, school-based and technology-based platforms), Senegal's stunting is largely attributable to success in programs delivered through ***community-based platforms*** (detailed in Section 5.4). Key nutrition-specific (e.g., Community Nutrition Project (1995-2001), Nutrition Development Policy Letter (2001-2014), the Coordination Unit for the Fight Against Malnutrition/CLM (2001-present), the Nutrition Enhancement Program I & II (2002-2014), and the National Health Development Plan (2009-2018)) have utilized a community-based approach. Key poverty reduction strategies and programs (e.g., the *Poverty Reduction Strategy Paper I, II and National Strategy for Social and Economic Development)* and other nutrition-sensitive efforts (e.g., the *National Action Plan for Education for All (2000-2015)*; and the consecutive *Water Sector Project (1996-2004), Long-Term Water Supply Project (2002-2005) and Water and Sanitation Millennium Project (2005-2015)* have targeted vulnerable and marginalized

populations including women, children, elderly and people living with HIV through establishing infrastructure, systems and behaviours at community-level.

Reduced Fertility & Early Pregnancies

Total fertility and adolescent fertility both decreased between 1992 to 2017 from 6.0 to 4.6 (births per woman 15-49 years) and 127 to 78 (births per 1,000 girls aged 15-19 years), respectively (Table 2). The age at first marriage increased from 16.6 years to 19.7 years between 1992 and 2015 and the spacing between births showed some improvement from 32.4 months to 34.6 months over the same period (Appendix 19). In our decomposition analysis, ***decreases in early age at pregnancy represented a driving factor for change in HAZ*** for both age groups explaining 3% each for children under-5 and 2-5 years, respectively. In addition, both decreased fertility and increased inter-pregnancy spacing were highlighted in the qualitative findings by national respondents and mothers in communities as factors leading to improvements in nutrition, by allowing women to focus and invest in their children's health and wellbeing. A detailed review of the linkages between reduced fertility, inter-pregnancy intervals, and adolescent births and the impact on child nutrition in Senegal is provided in Appendix 19. ***Our research posits that reduced overall fertility and early pregnancy may have been important drivers of child stunting decline in Senegal and could be linked to improved education and several of the MNCH efforts previously described.***

Maternal Nutrition

Women's nutritional status in Senegal may have also improved substantially over time. Pathways to improved maternal nutrition could have been through several links previously discussed (e.g. improvements in education, empowerment, greater use of RMNCH services and decreased fertility). In short, higher education is associated with delayed marriage and pregnancy, decreased adolescent pregnancy, and increased capacity for decision-making related to health and nutrition (Appendix 17). Increased utilization of primary health services among women, including RMNCH services, has known positive attribution to maternal healthcare and maternal nutrition. For example, antenatal care attendance encourages community-based counselling to improve maternal diet and fetal growth, supplementation of iron and folic acid to address maternal anemia, fetal growth monitoring, education on infant feeding practices and awareness of family planning methods to increase spacing between pregnancies; the latter contributes to increased maternal nutrient stores and supports provision fetal growth (Appendix 17).

Our review of maternal growth trajectories in Senegal suggests that while average height has not improved maternal weight and BMI (largely driven by weight) has been increasing for several decades (Appendix 18). Because the DHS 2017 survey did not collect maternal anthropometry, we were not table to assess the impact of maternal height and BMI on child HAZ gains, however we can infer from earlier studies and other analyses. Our Victora curve analysis suggests some early improvement in maternal nutrition (inferred from the reduction in birth disadvantage among children) from 1992/93 to 2000; however these gains reverse in more recent (2017) DHS rounds.
An earlier decomposition study found that maternal height explained 8% of the gains in child HAZ between 1992/93 and 2011 (151), however, other studies in Senegal have shown that maternal height and BMI do not predict HAZ or linear growth (163,166,187). Our qualitative inquiry shed more light on the continued challenges around dietary diversity and micronutrient deficiencies experienced by mothers, and thus did not provide strong supportive evidence of improvements in maternal nutrition. In light of ***mixed evidence pertaining to maternal nutrition changes***, it is unclear how large a role maternal nutrition played to the changes in HAZ in Senegal. It appears that it was not as large a factor as others have previously suggested and that inadequate maternal nutrition may continue to limit progress to addressing chronic malnutrition among children.

Dietary Intake

Adequate dietary intake and a well-balanced diet are necessary for the prevention of stunting in children. Research by Bork et al, indicates that ***dietary diversity and food variety were positively associated with HAZ*** in 6 to 24 month olds in Senegal (188). The infant and young child feeding index score is comprised of dietary diversity, meal frequency, breastfeeding, bottle-feeding, and frequency of food consumption. This index was positively associated with HAZ for both 6-12 month olds, and 18-24 month olds in Senegal. Linear growth among infants between the ages of 18 and 24 months was positively associated with the infant and young child-feeding index, and with meal frequency. The infant and young child feeding index was not associated with dietary diversity, food variety or breastfeeding for infants of all ages in this study (188). In a rural region of Senegal, the young child feeding index was not found to be associated with either height-for-age or with linear growth, among 12 to 42 month old infants (187). This research also indicated that frequent consumption of fruit, milk, fish/meat and cereal were not associated with HAZ or linear growth, however vegetable consumption was positively associated with HAZ (187). A study in the village of Potou examined whether animal source consumption and owning livestock reduced the risk of chronic malnutrition in children, and found that consumption of beef and eggs was found to be correlated with better HAZ scores (189). Consumption of other animal source products including milk/milk products, sheep/goat meat, poultry meat and owning livestock were not found to be positively associated with HAZ (189).

The inconsistencies in findings among these studies may be attributed to differences in the measurement tools used to access dietary intake patterns and differences in the samples, i.e. different villages, age groups, and sample sizes. Our quantitative *Victora curve* analysis suggests that ***children's nutrition has improved over the studied years***, as the curve that represents growth faltering has flattened out over time. The 1992/93 curve shows a steep decline between 6 and 24 months, however, by 2017, the curve is much flatter and children do not reach as low of a HAZ score during the growth faltering process. This suggests that nutrition among children in this age group has improved and dietary intake may have contributed to this improvement.

Breastfeeding Promotion

In Senegal, the prevalence of exclusive breastfeeding drastically improved since the early 1990s, however, it remains alarmingly low. In 1992/93, only 5% of mothers exclusively breastfed for up to six months; by 2017, this rose to 42% (70). Early initiation of breastfeeding also increased modestly from 22% in 2005 to 33% in 2017 (70). Literature on breastfeeding in Senegal revealed that the average duration of breastfeeding was approximately two years, with early weaning occurring due to maternal pregnancy or perceived good eating on the part of the child. Children who were perceived as small or weak were weaned for longer, and had lower mean HAZ scores (190). Complementary feeding beginning at earlier than six months of age was found to be strongly associated with lower LAZ and HAZ (191,192). Supplementing with other foods was found to cause diarrhea due to bacterial contamination, which impedes growth (192), while exclusive breastfeeding promotes increased energy intake from breast milk (193). Overall, studies show that the longer children were breastfed, the faster they grew up to three years of age.

Improvements in breastfeeding practices can be observed in our Victora curve analysis, and our equity intervention analysis. In examining the Victora curves from 2000 onward, a clear flattening pattern can be observed among children between 0 and 6 months. The 2000 curve shows a steep decline in predicted HAZ score from birth onwards, while the 2005 curve shows a plateauing in the first 6 months of life, indicating that breastfeeding practices may have improved. The 2017 curve is flatter still in the initial 6-month window, suggesting breastfeeding has been further improved. Our

equity analysis by breastfeeding interventions also supported these findings (Appendix 11). We were not able to locate any standalone policies and programs that prioritized breastfeeding initiatives, though they are included in many of the previously discussed policies/programs (such as PRN etc). Some improvements in breastfeeding practices were also reported by national stakeholders and mothers, though harmful newborn early-feeding cultural practices are still commonplace. ***Our work thus supports that improvements in breastfeeding practices may have played a significant role in child stunting gains in Senegal.***

Political Will & Multisectoral Action

Government efforts to improve nutrition in Senegal have been ongoing for nearly three decades, including early food supplementation programs and introduction of surveillance monitoring systems from the late 1970s. According to the World Bank, the evolution of nutrition policy have occurred across several phases including: i) establishing a foundation (1950-1970s); ii) implementation of a curative approach (1970-1990s); iii) institutionalization of nutrition (1990-2000s); iv) intensification and decentralization (2000-2010s); and v) adoption of a multisectoral approach (2010-Present) (49). The election of President Wade in 2000 also represented a turning point for nutrition, as he was a significant champion for improving health and nutrition in Senegal. This high-level commitment supported its institutionalization and prioritization at all levels of governance (49), including introduction of nutrition as a line in the national budget, as well as the establishment of the high-level ***Cellule de Lutte Contre la Malnutrition*** (2001 to Present) and a national nutrition policy (*Nutrition Policy Letter*, 2001).

Coordination efforts across nutrition-specific and –sensitive sectors and stakeholders have been ongoing for over two decades. Although it was never implemented/funded the ***National Plan of Action for Nutrition (PNAN)*** (1997-2002), it represented a catalytic contribution in the field. The ***1994 Presidential Decree*** and creation of the ***CNLM*** also highlighted the importance and institutionalization of nutrition across multiple sectors (49). Recent concerted efforts have involved the introduction of the ***Multisectoral Strategic Plan for Nutrition in Senegal (PSMN)*** (2017-2021) that aims to operationalize the recent ***National Nutrition Development Policy (PNDN)*** (2015-2025), to prevent malnutrition and non-communicable diseases, address micronutrient deficiencies, strengthen availability/accessibility of diverse foods, improve research, innovation and governance in nutrition. The introduction of the ***2001-2014 Nutrition Policy Letter*** represented the first effort to define nutrition policy and outlined the important multisectoral contributions including food insecurity, sanitation, and health. Recently, many multi-sector and sector-specific efforts have been initiated, recognizing the continued prioritization and collaboration of diverse stakeholders to improve nutrition nationally (Box 1).

Box 1: Recent nutrition-related policy and program efforts in Senegal

Recent Multi-Sectoral Efforts to Improve Nutrition

- 2009-2012: Child Nutrition and Food Security Project (Projet Nutrition Enfant et Sécurité Alimentaire, NESA)
- 2011-Present: Scaling Up Nutrition (SUN) Movement
- 2012-2016: Integrated Education and Nutrition Program (Programme Integré Santé Education Nutrition, PISEN)
- 2014-2035: Emerging Senegal Plan (Plan Senegal Emergent, PSE)
- 2015-2025: National Nutrition Development Policy (Document de Politique Nationale de Développement de la Nutrition, PNDP)

- 2015-2017: Yaajende Agriculture and Nutrition Development Program for Food Security in Senegal (Programme de Développement Agricole Sécurité Alimentaire Yaajeende)
- 2017-2021: Multisectoral Strategic Plan for Nutrition in Senegal (Plan Stratégique Multisectoriel de la Nutrition du Senegal, PSMN) to define key

Recent Sector-Specific Efforts to Improve Nutrition

Poverty Reduction

- 2009-2011: Rapid Response Child-Focused Nutrition and Social Transfers Project (Project de Nutrition Ciblé3 et Transfers Sociaux, NETS)
- 2013-2017: National Strategy for Social and Economic Development (Stratégie Nationale de Développement Economique et Sociale, SNDES)
- 2013-2019: National Family Safety Scholarship Program (Programme National de Bourses de Sécurité Familiale, PNBSF) 2013-2019

Health System Strengthening & MNCH

- 2009-2018: National Health Development Plan (PNDS)
- 2009-Present: Bajenu Gox Project
- 2013-2017: Strategic Plan for Developing Universal Health Coverage in Senegal
- 2014-2018: National Community Health Policy (Politique Nationale de Sante Communautaire, PNSC) and National Community Health Strategic Plan (Plan Strategique National de Sante Communautaire)
- 2016-2021: Community Health Program (PSSC)

Food Security & Agriculture

- 2010-2015: Food Fortification Enhancement Program (Programme de Renforcement de la Fortification des Aliments)
- 2011-2015: National Agricultural Investment Program (Programme Nationale d'Investissement Agricole, PNIA)

6.2: Remaining Nutritional Challenges

Though stunting prevalence at a national level has declined, some provinces still have upwards of >30% prevalence (Kolda). Stunting reduction occurred in all wealth quintiles and among the least two maternal education groups (no education, primary), but wide wealth and maternal education inequalities still exist. Across wealth quintiles – top inequality pattern is noted (richest are better off than all others) – thus there is a need for mass population strategies to target the remaining four quintiles (Appendix 11). Stunting by maternal education in 2017 shows that those with no education are notably worse off than those with at least primary-level education, thus suggesting that mass population strategies should target those who remain uneducated. Urban-rural disparities in stunting prevalence have decreased slightly over time but the prevalence is still twice as high in rural areas compared to urban. Children in rural areas must be targeted with appropriate nutritional interventions.

Similar to stunting trajectories, the prevalence of underweight children in Senegal also experienced a steady decline between 1993 and 2016. Overweight and wasting prevalence also decreased but both were already below 10% at the beginning of this period so only slight declines were seen. As of 2016, 17% of under-5 children were stunted, 14% were underweight, 7% were wasting, and about 1% of children were overweight (Appendix 21). Significant variation exists in these indicators across the country. Child underweight varies the most notably with the highest rates reported in Sedhiou and Matam (22%) and lowest in Katar (7%) in 2017; the degree of disparity between the

highest and lowest estimates has persisted over time. Wasting also varies across provinces, and the worst off provinces seem to shift over time. In 1993, the northeastern part of the country (Matam and Saint-louis) was more wasted, but by 2000 the level of wasting in these provinces was matched, or in some cases exceeded, by the central (Koalack and Kaffrine) and southeastern provinces (Tambacounda and Kedougou). In 2005, the highest wasting prevalence had shifted to Thiès and Louga. Most recently, the Matam has returned to being the province with the highest wasting prevalence in 2017, the least wasted region being Ziguinchor (5%). Overweight prevalence in 2017 is generally quite low across the country and variation across provinces is minimal. Maternal short stature (<145 cm) maternal short stature was low (<1%) across the provinces in Senegal, however maternal anemia remained persistently high in 2017, and currently more than half of Senegalese mothers are anemic (Appendix 21). Maternal underweight, however, had wide variation with Province 2 (28%) being highest and Province 4 (8%) lowest in 2016. Maternal underweight prevalence was highest for Kaolack at 18% and lowest for Matam at 4.2% according to the most recent estimates available from 2005. Maternal anemia prevalence was over 50% for 11 out of 14 provinces in 2017 (Appendix 21).

6.3: Study Strengths

Several strengths of this work should be noted. This is the first mixed-method systematic and comprehensive overview of the major determinants of stunting reduction in Senegal. We undertook a range of exercises, including a systematic literature review, qualitative inquiry with diverse national and community stakeholders, robust quantitative analyses, policy/program mapping and an exploration of financial allocations, to paint a holistic picture of the stunting situation in Senegal. This contrast between qualitative and quantitative approaches expanded the horizon for unraveling key drivers of under-5 stunting reduction. Second, we expanded the range of determinants previously considered, on the basis of a comprehensive set of variables according to an evidence-based and context-specific conceptual framework on stunting chain of causality, providing further detail and granularity to our analyses. We managed to harmonize all standardized individual-level DHS and MICS surveys conducted at foud different time points. This allowed us to explore different time periods throughout 1992/93-2017; such as those spanning several peaceful democratic transitions, political commitment towards achieving the MDGs, and substantial prioritization of cross- and multi-sectoral nutrition focused efforts. Third, the hierarchical modeling approaches undertaken in all quantitative analyses permitted more appropriate modeling of pathways (adjusting for confounders and examining mediators) between potential stunting determinants. Fourth, the qualitative component aimed to captured diverse, multi-level perspectives, particularly the addition of six focus group discussions with mothers across three regions and six communities helped to elicit diverse tangible changes in socioeconomic status, local infrastructure, as well as changes in behaviour, health and nutrition. Finally, this was the first systematic effort to compile all nutrition-relevant published and un-published literature and accompanying in-depth policy/program analysis on Senegal – to date, no other such effort has been conducted for the country.

6.4: Study Limitations

Several limitations of our work should be noted. Qualitative data collection, transcription and analysis was conducted primarily in French. This approach may have limited the selection and diversity of quotes for inclusion in the report, as only select quotes were translated and presented. However, efforts to capture and integrate diverse perspectives that were representative of findings were made.

Our decomposition analyses was statistically powerful and included a wide range of potential explanatory factors. Nonetheless, limitations of the Oaxaca-Blinder decomposition apply as cited in previous literature (44,151,194). Another limitation pertains to confounding. Although we adjusted for confounding variables in the quantitative analyses, some residual confounding may remain from unmeasured confounders or poorly estimated variables. Interactions between different factors within and between the different hierarchical levels may also affect the results, although they were not assessed due to measurement challenges.

Our mapping of financial data pertaining to nutrition-specific and -sensitive initiatives in Senegal may be incomplete considering we reported only data we could obtain from stakeholders and published literature. Significant gaps in national health expenditure data, and the financial allocations for specific programs highlights a gap in our understanding of the investment, implementation and scale of these efforts.

Several data limitations should also be noted. As discussed above, data pertaining to direct measures of food insecurity and dietary intake of all under-5 children (e.g. exclusive breastfeeding, appropriate introduction of complementary feeding, actual food consumption frequency and diversity) were generally lacking. As a result, we relied on proxies and available survey indicators (e.g. 24 hour recall) – though these imprecise indicators are not without their shortcomings. Information on migration patterns within the country was also limited. There was generally a limited scope of ecological variables available for our assessment, and several important domains were not quantifiable even through such area-level predictors– food security, agriculture production, etc. The DHS lacked data to measure intrauterine growth, such as low birthweight (which was only collected in select surveys and is poorly reported), small for gestation age babies, preterm birth, etc. Maternal height and BMI data was not able for all of our surveys of interest (particularly the endpoint DHS 2017 survey) and thus we could not quantitatively examine the association between these indicators and child HAZ gains; from earlier Exemplar studies and existing literature on Senegal, these may have had an important impact. We were not able to quantitatively examine several programs due to the challenges posed in measuring such phenomena (e.g., political will, political instability and changes in governance structures, conflict etc.) and limitations of data availability on several programs (e.g. vitamin A supplementation, community health workers/volunteers, Essential Package of Health Services, etc.), though we did attempt to use several proxy intervention coverage variables to this end. We were not able to conduct age-stratified analyses for <6 month and 6-23 month children due to limited statistical power and/or meaningful HAZ change over time in these populations; and thus could have missed important age-specific HAZ determinants (e.g. such as breastfeeding and dietary intake from food frequency questions). The quality of anthropometry data was of particular concern in Senegal; at least one DHS survey (2010/11) had child anthropometry data with >20% flagged/implausible values. Our group is currently undertaking a systematic and robust quantitative analyses to understand survey quality in Senegal and other Stunting Exemplar countries.

Further work is needed to examine and test our narrative on subnational drivers of stunting decline in Senegal. Additionally, future work should consider examining determinants of other child and maternal nutritional outcomes in tandem with stunting. For example, such as stunting and wasting combined – a population of children that has been reported to be the most nutritionally disadvantaged and at risk for premature mortality. Cost-effectiveness analysis of various programs to understand the return on investment would assist in prioritizing future investments and for cross-country learnings. In general, further strengthening of information systems is needed at central and local levels, to collect quality of care indicators systematically. This will provide further insight on interventions beyond the information provided by quantitative coverage data.

6.5: Conclusions

In closing, this systematic and comprehensive overview of stunting decline in Senegal describes a multifactorial story of stunting change, highlighting the importance of political will, leadership and prioritization of commitments to improved nutrition. The implementation of nutrition-specific and –sensitive interventions, using largely community-based approaches, have led to significant gains in child growth. Implementation of mandatory and voluntary insurance schemes, introduction of cadres of community health workers and volunteers, as well as efforts to subsidize targeted interventions for children and pregnant women have increased utilization and accessibility of health services at community level. Efforts to improve access to water and sanitation, namely reduction of open defecation, have also contributed to important gains in childhood stunting. Taken together, child stunting reduction success in Senegal can be attributed to long-standing prioritization of nutrition in national development plans, implementation of national nutrition-specific and –sensitive interventions, and targeting the most disadvantaged populations. The adoption of a multisectoral approach has been critical to facilitate the prioritization, coordination and implementation of nutrition efforts and priorities across diverse sectors and stakeholders.

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