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Original Article

Projecting the impact of a national strategy to accelerate stunting prevention in East Nusa Tenggara, Indonesia, using the Lives Saved Tool

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Abstract

Stunting remains a critical public health issue in East Nusa Tenggara (ENT), Indonesia, with prevalence rates among the highest in the country despite national efforts to reduce its occurrence. The aim of this study was to project the impact of the 2018–2024 National Strategy to Accelerate Stunting Prevention on children under five years old in ENT, using the Lives Saved Tool. A cross-sectional approach was employed, integrating data from various sources, including the 2020 Census of Indonesia, the Global Data Lab-Area Database, the Central Bureau of Statistics Republic Indonesia, the National Socioeconomic Survey, the 2017 Indonesia Demographic and Health Survey, the 2018 Basic Health Research, and the 2021 Indonesia Nutrition Status Survey. The analysis considered three scenarios: (1) a baseline scenario reflecting ENT's 2017 coverage, maintained through 2028; (2) a scenario assuming Indonesia achieves the Health Plan Action Stunting targets; and (3) a projection of stunting rates based on ENT-specific coverage. Under scenarios 1 and 2, the prevalence of stunting was projected to decrease from 40.04% in 2018 to 39.82% and 39.78%, respectively, by 2028, with scenario 3 reflecting a similar trend. The findings revealed a sharp increase in the number of stunting cases averted among children under five years old between 2017 and 2021, followed by a more gradual decline, culminating in the 2028 projections: 2,249 children (scenario 2), 2,130 children (scenario 3), and 1,966 children (scenario 1). Breastfeeding promotion emerged as the most impactful intervention, accounting for over half of the total stunting cases averted under both Indonesia-wide and ENT-specific coverage scenarios. This was followed by interventions such as multiple micronutrient supplementation and vitamin A supplementation. The study highlights that reducing the prevalence of stunting among children requires a comprehensive prioritization of intervention strategies. The implementation of breastfeeding promotion, combined with appropriate complementary feeding practices, is expected to contribute significantly to achieving the sustainable development goal targets.

Keywords: Stunting, Lives Saved Tool (LiST), Indonesia, *Strategi Nasional Percepatan Pencegahan Stunting* (stranas stunting), intervention

Introduction

Despite improvements in survival rates, a substantial number of young children worldwide continue to experience developmental challenges, as evidenced by persistent issues with stunting,

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wasting, and micronutrient deficiencies. Recent global data from 2019 reveal that 13 million children under five are stunted and 4.5 million are wasted, representing 9% of the global burden of these conditions [1]. The sustainable development goals (SDGs) include a specific target to reduce stunted children by 40% by 2025 and to eradicate all forms of malnutrition by 2030, as listed as the 2.2 target [2]. Alarmingly, in 2019, 46% of children in Southeast Asia were reported to suffer from micronutrient deficiencies [1]. Malnutrition critically affects children's growth, development, and survival and is a primary cause of child morbidity and mortality globally [3].

As one of the world's most populous developing countries, Indonesia is undergoing rapid economic and epidemiological shifts [4]. It has one of the world's highest rates of malnutrition and micronutrient deficiencies. Despite joining the global Scaling Up Nutrition campaign and government efforts, Indonesia's stunting rates remain among the highest globally. The 2018 Indonesia Basic Health Research indicated that 30.8% of children under five were stunted and 10.2% were wasted [5]. The 2021 Indonesia Nutrition Status Survey (*Survei Status Gizi Indonesia*/SSGI) data showed a stunting prevalence of 24.4% in this age group [6]. While stunting rates have decreased, concerns remain over inadequate nutritional practices, including low rates of exclusive breastfeeding, which is crucial for early child growth and immunity; insufficient vitamin A supplementation, essential for reducing the risk of severe infections and supporting overall growth; and limited multiple micronutrient supplementation, which addresses deficiencies critical to cognitive and physical development in young children [7,8].

In response, Indonesia launched a new policy in 2021 aimed at reducing childhood stunting (Presidential Regulation No. 72/2021), targeting a 14% stunting prevalence by 2024 and aligning with the 2030 SDG targets [9,10]. However, the efficacy of national policies in meeting these ambitious goals remains uncertain [11]. The National Strategy to Accelerate Stunting Prevention (Stranas Stunting) recommendations are built around nutrition-specific interventions; however, clinical trials show that these interventions have small effect sizes on stunting [12]. While nutrition-sensitive interventions are promising, evidence of their effectiveness on child growth is scant [13]. Moreover, Indonesia faces challenges in implementing large-scale, cohesive nutrition interventions [14]. To evaluate and improve these interventions, the Lives Saved Tool (LiST) offers a robust modeling approach that estimates the impact of scaling up community-based and facility-based interventions.

The LiST is increasingly employed by governments, international agencies, NGOs, and academics for program evaluation and strategic planning in nutritional health [15]. Developed by the Institute for International Programs at Johns Hopkins Bloomberg School of Public Health, LiST (http://livessavedtool.org) is a free nutrition modeling tool used in various studies worldwide [16-18]. The current research utilized LiST to project the impact of Indonesia's nutrition policies, offering insights for policy development in other low- and middle-income countries (LMICs). According to the SSGI 2021 data, a 1.6-fold increase in stunting cases was observed among children aged 6–23 months, which is the phase of complementary feeding. Unfortunately, data on complementary feeding interventions is not available within the LiST application, which limits the impact analysis in this study. The process involves selecting the region and intervention variables, after which results are generated directly. Exclusive breastfeeding promotion, vitamin A supplementation, and multiple micronutrient supplementation were prioritized as key interventions due to their established roles in early childhood development and their inclusion in national stunting reduction strategies.

In East Nusa Tenggara (ENT), Indonesia, the stunting rate in children under five was 37.8% in 2021, the highest in the country [6]. As the third poorest province in Indonesia, ENT's nutritional indicators and infant mortality rates have historically been poor [19]. In ENT Province, the stunting prevention and treatment program, led by the Governor and Deputy Governor, was implemented between 2018 and 2023. As outlined in Governor Decree Number 324/KEP/HK/2018, this initiative transcended the health sector, mandating cooperation across various sectors. It aimed to enhance sectoral coordination for stunting management in the province [19]. A 30% decrease in stunting resulted from specific nutrition interventions, which targeted children in their first 1,000 days of life. Sensitive nutrition interventions, which comprise about 70% of stunting interventions, are ideally implemented through diverse development initiatives outside the health system. Despite existing research on stunting in Indonesia, no

comprehensive assessment of nutritional outcomes and health strategies has been conducted [20-22]. This study is the first detailed LiST-based analysis in East Nusa Tenggara, aiming to project the impact of the 2018–2024 Stranas Stunting program on stunting reduction and assess the province's ability to meet the 2030 SDG goal.

Methods

Data sources

This study used data from multiple sources, including the 2020 Census of Indonesia, the Global Data Lab-Area Database (GDL-AD) (2020), the Central Bureau of Statistics Republic Indonesia (*Badan Pusat Statistik* – BPS *Republik* Indonesia) (2019–2021), the National Socioeconomic Survey (*Survei Sosial Ekonomi Nasional* - SUSENAS) (2009–2021), and the 2017 Indonesia Demographic and Health Survey (IDHS). The distribution data on single-year age were obtained from the 2020 Census of Indonesia, while the total fertility rate and life expectancy at birth for the province of ENT were obtained from the GDL-AD, and these data were used for projection. Since 2016, the GDL has provided freely downloadable subnational development indicators for LMICs through its Area Database (https://www.globaldatalab.org/areadata). These indicators were constructed via aggregation from the representative survey and census datasets. The major data sources used by the GDL for this purpose were the Demographic and Health Surveys (https://www.dhsprogram.com), UNICEF Multiple Indicator Cluster Surveys (http://mics.unicef.org), and datasets from population censuses distributed by integrated public use microdata series (IPUMS) International (https://international.ipums.org).

Variables for input, outcome, and intervention

Stunting data inputs in the LiST were divided into four categories: demographics, baseline characteristics of child and maternal health, levels of intervention coverage, and intervention effectiveness. The changes in stunting prevalence, number of stunting cases prevented, and number of stunting cases prevented by intervention were used to define policy impact. In the LiST, stunting is defined as a child who is two standard deviations or more below the World Health Organization (WHO) child growth standards median height-for-age [23]. This study examined the interventions in the LiST that impacted stunting and compared them to those indicated in the 2018 Basic Health Survey (*Riset Kesehatan Dasar* - RISKESDAS 2018) and the 2021 Indonesia Nutrition Status Survey (*Survei Status Gizi Indonesia* - SSGI 2021).

Alternative scenarios

The study used the LiST to make the estimates. The stunting levels in ENT were projected using a three-scenario model from 2017 to 2028, as it includes both the National Action Plan for the Acceleration of Indonesia's Stunting Rate Reduction (RAN-PASTI) for 2024 and SDG targets for 2030. Each scenario was projected using data from 2017 as the baseline year and assumptions for the following years. The assumptions for each scenario were detailed as follows: (1) static trends (scenario 1): based on previous ENT coverage. The coverage was recorded as the same every year from 2017 to 2028; (2) Indonesia's coverage (scenario 2): designed from the Indonesia Health Profile and Nutritional Status Monitoring in 2017, with projected coverage from Indonesia's Action Plans of Health 2017–2023. After 2021, the coverage value is static until 2028; and (3) ENT's coverage (scenario 3): based on ENT coverage to project future stunting levels using the RISKESDAS 2018 and SSGI 2021. After 2021, the coverage value is static until 2028. Two types of data trends were presented, with differences in the years shown across the figures reflecting variations in scope and focus. First, the key milestone years (2018, 2023, and 2028) were used to facilitate comparison and trend analysis. Second, continuous year-by-year data from 2017 to 2028 was provided, offering a more detailed view of annual changes. This dual approach was employed to enable a comprehensive analysis of both significant milestone projections and granular trends.

Data analyses

In the first step, the population was projected from 2020 to 2028 because the most recent Indonesian census was conducted in 2020. This study updated input parameters for the year

2020 as the baseline and projected stunting from the 2017 IDHS to 2028 to project nutritional outcomes. In this study, the baseline levels were estimated by fitting a logistic regression curve to population-averaged survey data that passed through the last available data point. The trendline was shifted in this way in previously published LiST research [24], and it represents our increased confidence in more recent survey findings. The coverage indicators, such as maternal care, vitamin A supplementation, breastfeeding, measles and pneumonia prevention and treatment, and neonatal disease management, were used to determine the impact of maternal and child health interventions on stunting reduction. STATA version 16.1 was used to tabulate the IDHS unit data. SPECTRUM V.5.71 was used to project nutritional outcomes from 2017 to 2028.

Results

ENT's demographic, socioeconomic, and health profiles are contrasted with Indonesia's national averages (**Table 1**). This region, comprising nearly 2% of Indonesia's population, experiences elevated health challenges, notably higher infant mortality rates. It also has lower life expectancies and significant socioeconomic disadvantages, including a poverty rate of 20.4% (double the national average) and a per capita income of merely a third of the national figure. Additionally, ENT suffers from substantially higher stunting and wasting rates, and maternal healthcare indicators, such as institutional births and antenatal care, are below national levels.

Table 1. Key demographic, social, economic, and health indicators of East Nusa Tenggara and Indonesia

Variable	Sources and year	East Nusa Tenggara	Indonesia
Demographic			
Total population	Census of Indonesia, 2020	5,325,566	270,203,917
Sex ratio	Census of Indonesia, 2020	100	102
Total fertility rate	GDL-Area Database, 2020+	3.4	2.3
Infant mortality rate (death per 1,000 lives birth)	GDL-Area Database, 2020+	29.7	22.5
Life expectancy (male)	BPS RI-statistics Indonesia, 2019–2021	65.3	69.7
Life expectancy (female)	BPS RI-statistics Indonesia, 2019–2021	69.1	73.6
Life expectancy (person)	BPS RI-statistics Indonesia, 2021–2022	67.2	71.8
Social			
Female literacy rate	BPS RI - SUSENAS, 2009–2021	92.9	94.7
Population below the poverty line (%)	BPS RI - SUSENAS, Sept 2021	20.4	9.7
Economic			
Per capita regional gross domestic product (IDR)	BPS RI-statistics Indonesia, 2019–2021	20,581.13	62,236.44
Health			
Stunting (%)	Nutritional Status Monitoring, 2017*	40.1	29.6
Wasting (%)	Nutritional Status Monitoring, 2017*	15.8	9.5
Institutional delivery (%)[a]	IDHS-7, 2017	65.9	79.4
Antenatal care (%)[b]	IDHS-7, 2017	66.8	77.4
Postnatal care (%)[c]	IDHS-7, 2017	72.2	78.5

[a]Delivery of babies is assisted by competent health workers in health service facilities (hospitals, *puskesmas* (health center), clinics, and health workers' practices) in accordance with Indonesian Government Regulation No. 47 of 2016
[b]Receiving antenatal care from a skilled provider and more than four visits
[c]Postnatal check within 2 days of birth
+GDL-AD: Global Data Lab-Area Database. The data can be accessed via: https://globaldatalab.org/areadata/table/2020/tfr+infmort/IDN/?level=1+4
*Nutritional status monitoring (Indonesian: *Pemantauan Status Gizi* [PSG]) conducted by the Directorate of Community Nutritional can be accessed via https://kesmas.kemkes.go.id/konten/105/0/012609-buku-saku-psg-2017

Stunting among children under five from 2018 to 2028 is presented in **Figure 1**. With static coverage, stunting was projected to decrease marginally from 40.04% in 2018 to 39.82% in 2028. With current ENT coverage, a similar decline is expected, while applying Indonesia-wide coverage could slightly enhance the reduction from 40,04% in 2018 to 39.78% by 2028. The absolute number of stunted children remaining under each scenario is presented in **Figure 2**. All coverage scenarios show an initial increase in stunting in 2018 and 2019, followed by a

gradual decline until 2022 and a sharper decrease through 2028. Static coverage was expected to result in the highest number of stunted children (269,000) compared to Indonesian coverage (268,000). ENT coverage predicted the lowest incidence, with 261,000 cases. The number of cases averted compared to the baseline and illustrates the potential reduction in stunting cases from 2017 to 2028 under various plans, as presented in **Figure 3**. Indonesia coverage was projected to avert the most cases (2,249), followed by ENT coverage (2,130) and static coverage (1,966).

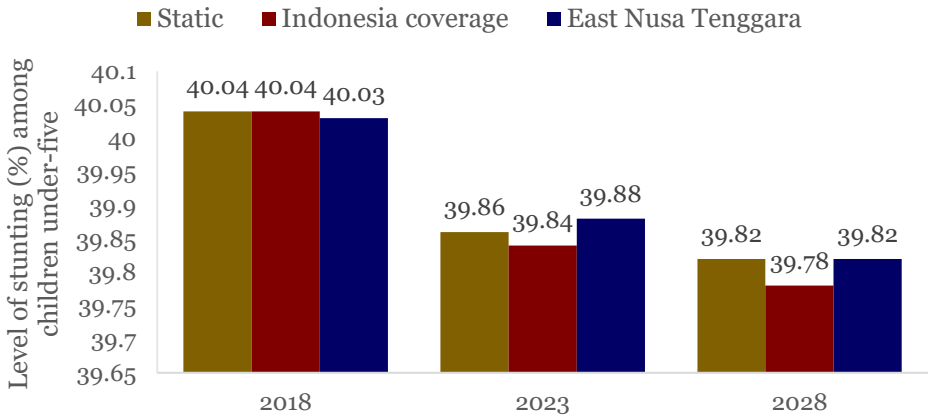

Figure 1. Percentage of stunting projected among children under five in East Nusa Tenggara from 2018 to 2028.

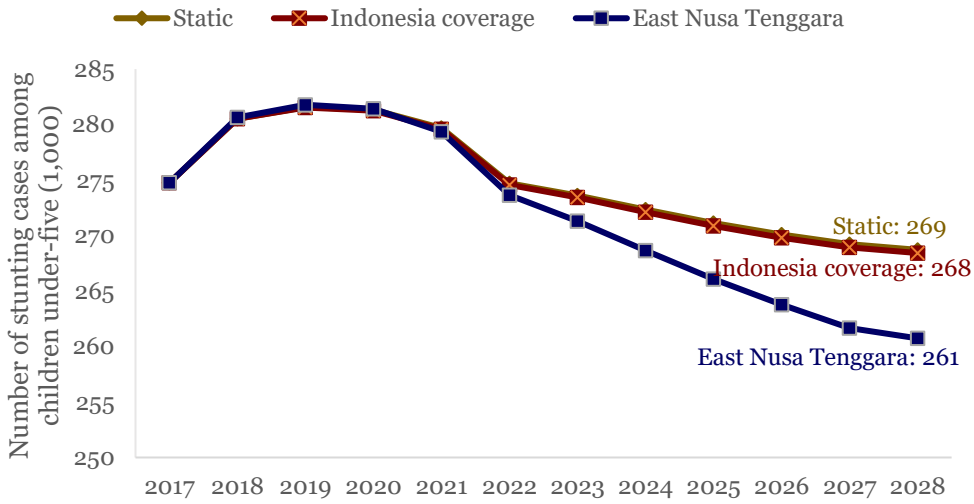

Figure 2. Number of children under five with stunting (per 1,000) projected in East Nusa Tenggara from 2017 to 2028.

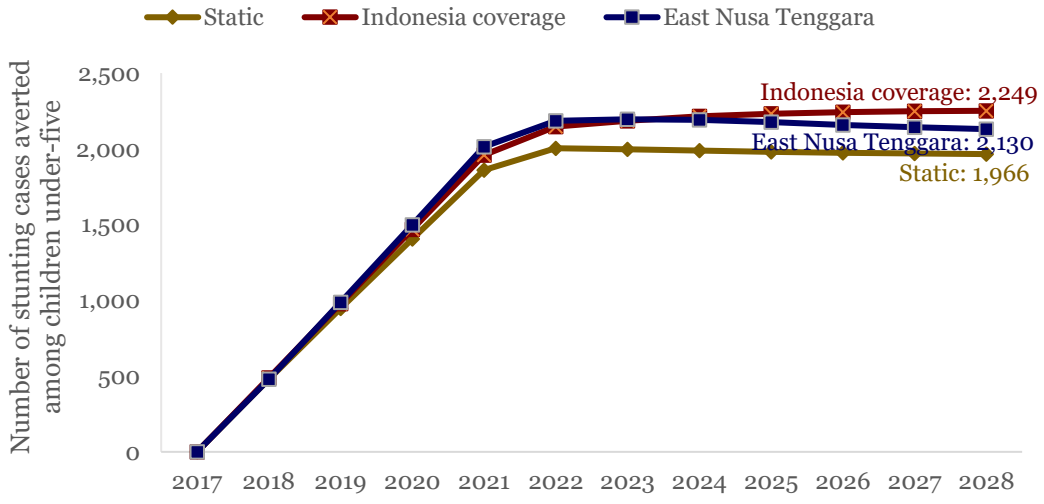

Figure 3. Projection of the number of stunting cases among children under five years of age averted with alternative coverage in East Nusa Tenggara from 2017 to 2028.

The number of stunting cases averted in ENT from 2018 to 2028 through various interventions is presented in **Table 2**. All scenarios consistently impact stunting reduction, with each intervention contributing similarly each year. In 2018, scenario 1 showed 480 cases averted, with breastfeeding promotion contributing to 45.3% of these cases, vitamin A supplementation to 38.8%, and multiple micronutrient supplementation (MMS) to 15.9%. By 2023, this scenario is expected to avert 1,997 cases: 905 through breastfeeding, 775 via vitamin A, and 317 through MMS. By 2028, the predicted averted cases total 1,960, with similar proportional contributions from each intervention.

Table 2. Projected number and percentage of stunting cases among children under five years of age averted by each intervention in East Nusa Tenggara from 2018 to 2028

Intervention	Stunting cases averted (n)			Cases averted by 2028 due to intervention (%)
	2018	2023	2028	
Static coverage (scenario 1)				
Breastfeeding promotion	218	905	888	45.3
Vitamin A supplementation	186	775	760	38.8
Multiple micronutrient supplementation	76	317	311	15.9
Total	480	1,997	1,960	100.0
Indonesia coverage (scenario 2)				
Breastfeeding promotion	292	1,305	1,344	59.7
Vitamin A supplementation	95	422	435	19.3
Multiple micronutrient supplementation	102	457	471	20.9
Total	489	2,184	2,250	100.0
East Nusa Tenggara coverage (scenario 3)				
Breastfeeding promotion	297	1.357	1.324	61.8
Vitamin A supplementation	83	379	369	17.3
Multiple micronutrient supplementation	100	459	448	20.9
Total	480	2,195	2,141	100.0

In scenario 2, the following variables would avert stunting: breastfeeding promotion (59.7%), vitamin A supplementation (19.3%), and MMS (20.9%). In 2018, the number of stunting cases averted was 292 by breastfeeding promotion, 95 by vitamin A supplementation, and 102 by MMS. In 2023, the projected number of children averted from stunting would be 1,305 with breastfeeding promotion, 422 with vitamin A supplementation, and 457 with MMS. In 2028, the projected number of children averted from stunting would be 1,344 with breastfeeding promotion, 435 with vitamin A supplementation, and 471 with MMS.

In scenario 3, the following variables would avert stunting: breastfeeding promotion (61.8%), vitamin A supplementation (17.3%), and MMS (20.9%). In 2018, the number of stunting cases averted was 297 through breastfeeding promotion, 83 through vitamin A supplementation, and 100 through MMS. In 2023, the number of stunting cases averted would be 1,357 through breastfeeding promotion, 379 through vitamin A supplementation, and 459 through MMS. In 2028, the number of stunting cases averted would be 1,324 through breastfeeding promotion, 369 through vitamin A supplementation, and 448 through MMS.

The age-sex pyramid of ENT across four intervals: 2020, 2025, 2030, and 2035, highlighting demographic changes, is presented in **Figure 4**. The population is projected to grow from 5.08 million in 2020 to 6.08 million in 2035. Notably, the pyramid is expected to narrow by 2035 due to declining fertility and increasing longevity. In 2020, 29.2% of the population was under 15 and 10.2% was over 60. The population of children under five years of age is estimated to remain stable at around 0.56 million in the next decade. Projections for stunting in ENT's under five years of age population by 2028 are depicted in **Table 3** and **Table 4**. Scenario 1 estimates a reduction in stunting from 40.13% in 2017 to 39.82% in 2028, mirroring the decline predicted in scenario 3. Scenario 2 forecasts the highest stunting rate, decreasing from 40.13% in 2017 to 39.78% in 2028. In terms of absolute numbers, scenario 1 predicts a reduction from 274,766 children in 2017 to 268,713 in 2028. Scenario 2 projects a decrease to 268,425 children, while scenario 3 anticipates the most significant drop to 260,038 children, the lowest among the scenarios. The averted stunting cases, with scenario 2 leading to 2,251 averted cases by 2028, followed by scenario 3 with 2,130, and scenario 1 averting 1,966 cases, is presented in **Table 5**.

Table 3. Projected level of stunting (%) among children under five years of age-by-age group and alternative scenarios in East Nusa Tenggara from 2017 to 2028

Coverage scenarios	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Static coverage (scenario 1)												
0–59 months	40.13	40.04	40.05	40.00	39.94	39.86	39.86	39.86	39.86	39.84	39.84	39.82
<1 month	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29
1–5 months	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29
6–11 months	25.90	25.71	25.71	25.71	25.71	25.71	25.71	25.71	25.71	25.71	25.71	25.71
12–23 months	41.27	41.04	40.89	40.89	40.89	40.89	40.89	40.89	40.89	40.89	40.89	40.89
24–59 months	44.94	44.94	44.87	44.76	44.65	44.61	44.61	44.61	44.61	44.61	44.61	44.61
Indonesia coverage (scenario 2)												
0–59 months	40.13	40.04	40.04	39.99	39.92	39.84	39.84	39.83	39.82	39.80	39.80	39.78
<1 month	23.29	23.29	23.28	23.27	23.27	23.27	23.26	23.26	23.26	23.26	23.26	23.26
1–5 months	23.29	23.28	23.27	23.26	23.25	23.24	23.24	23.23	23.23	23.23	23.23	23.23
6–11 months	25.90	25.70	25.69	25.68	25.68	25.67	25.66	25.66	25.66	25.66	25.66	25.65
12–23 months	41.27	41.04	40.88	40.87	40.87	40.86	40.85	40.85	40.84	40.84	40.84	40.84
24–59 months	44.94	44.94	44.87	44.76	44.65	44.60	44.59	44.58	44.58	44.58	44.57	44.57
East Nusa Tenggara coverage (scenario 3)												
0–59 months	40.13	40.03	40.04	40.00	39.95	39.87	39.88	39.87	39.87	39.85	39.85	39.82
<1 month	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.28	23.28	23.28	23.28
1–5 months	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.29	23.28
6–11 months	25.90	25.71	25.70	25.70	25.70	25.70	25.70	25.69	25.69	25.69	25.69	25.69
12–23 months	41.27	41.04	40.88	40.87	40.86	40.86	40.86	40.86	40.86	40.86	40.86	40.86
24–59 months	44.94	44.94	44.86	44.75	44.63	44.58	44.57	44.57	44.57	44.57	44.56	44.56

Table 4. Projected number of stunting cases among children under five years of age in alternative scenarios in East Nusa Tenggara from 2017 to 2028

Coverage scenarios	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Static coverage (scenario 1)												
0–59 months	274,766	280,535	281,572	281,336	279,697	274,701	273,617	272,340	271,118	270,077	269,212	268,713
<1 month	2,649	2,706	2,704	2,691	2,678	2,665	2,652	2,643	2,632	2,631	2,624	2,634
1–5 months	13,246	13,531	13,520	13,455	13,390	13,326	13,260	13,216	13,159	13,155	13,120	13,170
6–11 months	17,680	17,925	17,911	17,824	17,737	17,653	17,566	17,508	17,432	17,427	17,380	17,447
12–23 months	57,998	60,759	56,825	56,781	56,511	56,234	55,964	55,689	55,505	55,264	55,249	55,101
24–59 months	183,192	185,613	190,613	190,584	189,382	184,822	184,174	183,284	182,391	181,600	180,839	180,362
Indonesia coverage (scenario 2)												
0–59 months	274,766	280,525	281,537	281,267	279,590	274,551	273,426	272,112	270,866	269,806	268,929	268,425
<1 month	2,649	2,706	2,703	2,689	2,676	2,663	2,649	2,640	2,629	2,628	2,621	2,631
1–5 months	13,246	13,527	13,509	13,438	13,369	13,301	13,232	13,184	13,127	13,123	13,088	13,138
6–11 months	17,680	17,920	17,898	17,806	17,715	17,626	17,535	17,473	17,397	17,392	17,345	17,411
12–23 months	57,998	60,758	56,815	56,758	56,476	56,192	55,914	55,632	55,441	55,200	55,185	55,037
24–59 months	183,192	185,613	190,612	190,576	189,354	184,769	184,095	183,183	182,273	181,463	180,690	180,207
East Nusa Tenggara coverage (scenario 3)												
0–59 months	274,766	280,660	281,786	281,422	279,348	273,632	271,293	268,641	266,069	263,760	261,675	260,038
<1 month	2,649	2,716	2,708	2,681	2,654	2,628	2,601	2,581	2,555	2,547	2,526	2,528
1–5 months	13,246	13,581	13,538	13,406	13,272	13,139	13,003	12,906	12,778	12,737	12,630	12,639

Coverage scenarios	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
6–11 months	17,680	17,991	17,932	17,754	17,573	17,397	17,218	17,089	16,920	16,865	16,723	16,736
12–23 months	57,998	60,759	57,023	56,831	56,266	55,697	55,136	54,568	54,159	53,624	53,450	53,003
24–59 months	183,192	185,613	190,586	190,750	189,583	184,772	183,336	181,498	179,657	177,988	176,346	175,133

Table 5. Projected number of stunting cases averted among children under five years of age by age group and alternative scenarios in East Nusa Tenggara from 2017 to 2028

Coverage scenarios	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Static coverage (scenario 1)												
0–59 months	0	480	946	1,406	1,859	2,004	1,997	1,989	1,981	1,974	1,969	1,966
<1 month	0	0	0	0	0	0	0	0	0	0	0	0
1–5 months	0	0	0	0	0	0	1	1	1	1	1	1
6–11 months	0	136	136	135	135	134	134	133	133	133	133	134
12–23 months	0	344	529	529	526	524	522	520	518	516	516	515
24–59 months	0	0	281	742	1,198	1,345	1,340	1,335	1,329	1,324	1,319	1,316
Indonesia coverage (scenario 2)												
0–59 months	0	489	978	1,469	1,960	2,147	2,184	2,215	2,232	2,242	2,249	2,251
<1 month	0	0	1	2	2	2	3	3	3	3	3	3
1–5 months	0	4	12	17	21	25	29	33	33	33	33	33
6–11 months	0	140	148	154	158	161	165	169	168	168	168	169
12–23 months	0	344	536	548	556	561	566	571	576	573	573	572
24–59 months	0	0	281	748	1,224	1,398	1,421	1,439	1,452	1,465	1,471	1,473
East Nusa Tenggara coverage (scenario 3)												
0–59 months	0	480	987	1,499	2,013	2,185	2,195	2,191	2,176	2,158	2,143	2,130
<1 month	0	0	0	0	0	0	0	0	0	0	1	1
1–5 months	0	0	0	0	0	1	1	1	1	2	2	2
6–11 months	0	136	139	140	142	141	140	139	138	138	137	137
12–23 months	0	344	540	553	561	560	555	550	546	541	539	535
24–59 months	0	0	308	806	1,309	1,483	1,499	1,501	1,490	1,477	1,465	1,456

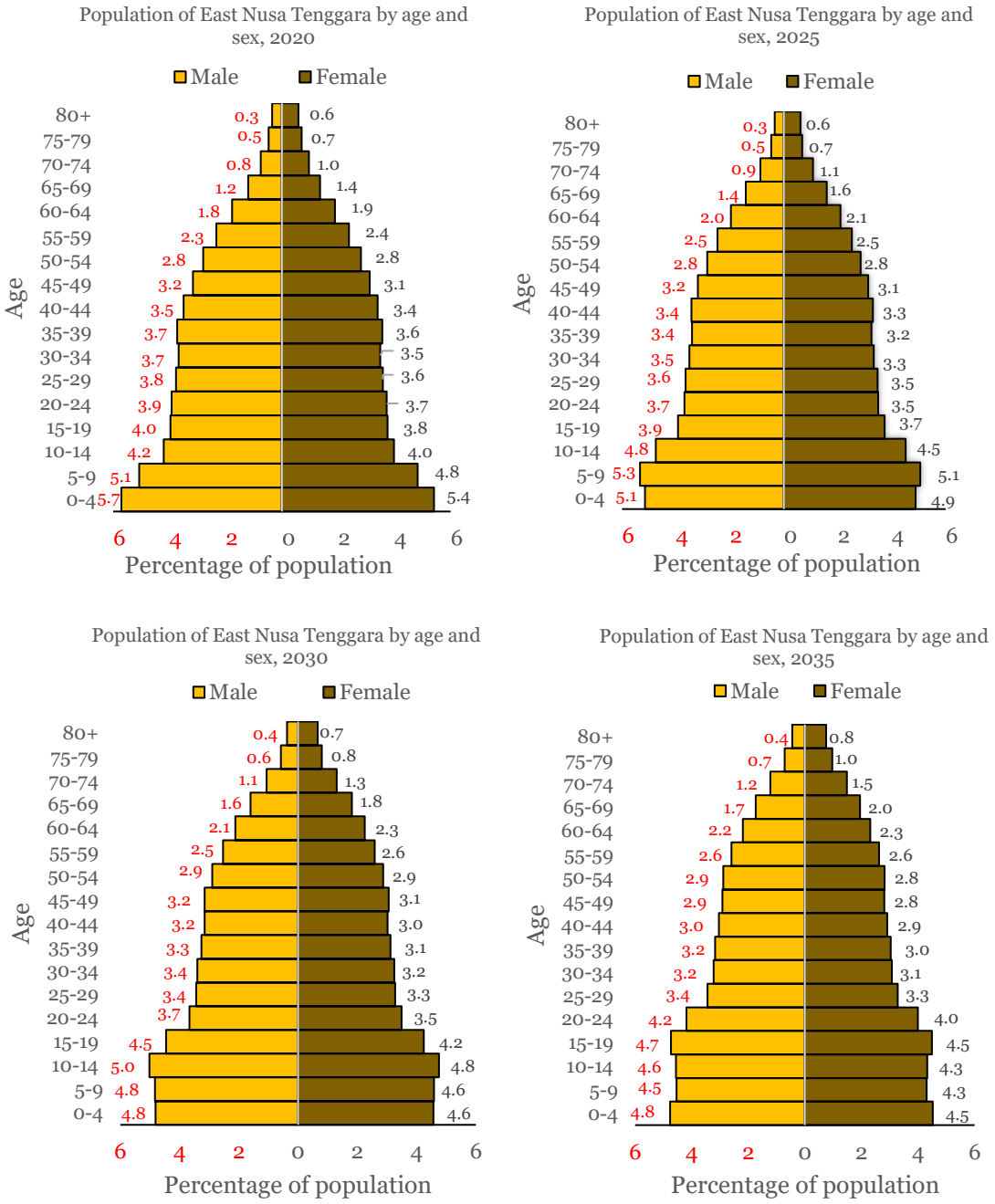

Figure 4. Percentage distribution of the population by age-sex pyramid in East Nusa Tenggara in 2020, 2025, 2030, and 2035.

Discussion

To address stunting, a focus on maternal and child nutrition is essential. Indonesia's stunting rates, although declining, remain above WHO's <20% recommendation [25]. Although ENT's coverage results in the lowest absolute number of stunted children, Indonesia's coverage averts more cases because it starts with a higher coverage level. This means that more cases can be prevented by bringing more children into an improved nutritional status, leading to a higher number of averted cases. Without intervention, 127 million children under five years of age could be stunted by 2025, a figure the WHO aims to reduce to 100 million [26]. Indonesia has made progress in vitamin A supplementation and breastfeeding but lacks targeted pregnant women interventions. Interventions targeting pregnant women should not be underestimated, as they include iron and folic acid (IFA) supplementation, supplementary feeding for undernourished

pregnant women, and currently, MMS, along with antenatal care (ANC), balanced nutrition promotion, pregnant women peer groups (*Kelas Ibu Hamil*), and the 10- Point checklist for ANC.

The "10 T" refers to the ten-item checklist completed by healthcare workers during ANC visits, covering critical assessments and interventions such as weight and height measurement, blood pressure checks, nutritional status evaluation, fetal monitoring, vaccinations, laboratory tests, case management, and counseling [27]. This study evaluated critical nutrition-specific interventions for reducing stunting in ENT, Indonesia's highest stunting region, and suggested tailored interventions like breastfeeding promotion, vitamin A supplementation, and multiple micronutrient supplementation (MMS).

Indonesia, with a high stunting prevalence, aims for a 28% stunting rate by 2021 [11]. This research projects stunting figures and assesses the impact of priority interventions, focusing on breastfeeding promotion, vitamin A supplementation, and MMS, identified as key variables by Stranas Stunting program [28]. These interventions could reduce stunting cases among children under five years of age, similar to findings that suboptimal breastfeeding practices contribute to 11.6% of mortality in this age group [29].

Government efforts to improve the nutrition and health of children and pregnant women include clean water, sanitation, early childhood education, nutritious food, and a clean and healthy lifestyle [9]. Presidential Regulation Number 72 of 2021 concerning Accelerating the Reduction of Stunting is the legal umbrella for activities that began in 2018 [10]. Stranas Stunting has a series of five pillars that include activities to accelerate the reduction of stunting to achieve SDGs by reaching the national target of stunting prevalence, as measured in children under 5 years of age. The five pillars are political commitment and national and regional leadership, national campaign and behavior change communication, convergence of central, regional, and community programs, food security and nutrition, and monitoring and evaluation [10]. The National Population and Family Planning Agency, as the chief executive for accelerating stunting reduction in Indonesia, issued the 2021–2024 RAN-PASTI as a reference when implementing the acceleration of stunting reduction for ministries and agencies, provincial governments, regency/city governments, village governments, and other stakeholders. The framework used in the RAN-PASTI focuses on three approaches: the nutrition intervention approach, the multi-sectoral and multi-stakeholder approach, and the family-based approach [30].

Despite progress, uneven coverage of maternal and child health interventions persists in ENT, Indonesia, where stunting and child mortality are critical public health issues. To enhance maternal health services, the region's Health Office launched the "Maternal and Child Health Revolution" in 2009, formalized in Kupang District through Regulation No. 16 of 2010. This initiative, a collaborative effort involving local health offices, NGOs, and professional organizations, aimed to accelerate maternal and child health services. Evaluations indicate improvements in infrastructure and healthcare provision, including increased health centers and emergency neonatal services, and greater engagement in pregnancy registration, ANC, and exclusive breastfeeding initiatives [31]. Furthermore, studies indicated that the maternal and child health revolution program contributed to reduced maternal and infant mortality rates in Kupang and other districts in ENT between 2008 and 2018 [32]. However, the program's focus has not been extensive, particularly in child nutrition services like complementary feeding. Cultural barriers also remain unaddressed, signifying the need for a more holistic approach to maternal and child health in the region [33]. To facilitate support for families at risk of stunting, assistance for prospective brides and couples of childbearing age, and monitoring of at-risk families, the National Family Planning Coordinating Board (*Badan Kependudukan dan Keluarga Berencana Nasional* - BKKBN) established a family assistance team comprising midwives, family empowerment and welfare team cadres, and family planning cadres. In addition, the family assistance team also comes from local residents so that they understand the existing culture [34]. The specific nutrition programs target the broader community, not just expectant mothers and children in their first 1,000 days of life. Activities that are normally macro and implemented across ministries and agencies can be applied as a part of sensitive nutrition interventions [10,35]. Our findings on prioritizing nutrition-specific interventions are consistent with the literature, which has reported the positive effects of breastfeeding promotion, vitamin A supplementation, and MMS on the reduction of malnutrition in LMICs, including Indonesia. It

was reported that children under two years of age who were exclusively breastfed had a 20% decreased risk of becoming stunted in low-income populations [36]. In Bangladesh, a similar approach was taken to develop a new tool adopting the LiST based on these priority interventions. Based on its national-level analysis, the shift of allocated funding for vitamin A supplementation from 17% to 31%, along with the promotion of infant and young child feeding (IYCF), including the promotion of breastfeeding and vitamin A supplementation for children aged 6–23 months from 64% to 69%, could cumulatively increase the number of children over five years of age in Bangladesh living without stunting by 1.37 million by 2030. In addition, by excluding external determinants, this reallocation of limited resources could reduce the national prevalence of stunting from 36% to 32% by 2030 [37].

The LiST modeling method mentioned in this study lacks specific and sensitive interventions, such as IYCF and water, sanitation, and hygiene (WASH), respectively, due to data availability. This limitation may introduce bias in the results, as a previous study suggests that optimal IYCF or complementary feeding could have averted 500,000 cases of stunting [38]. This is the biggest number, followed by preventive zinc supplementation and WASH with universal coverage (if scaled up to 90%). Breastfeeding promotion and vitamin A supplementation were reported to avert around 50,000 cases of stunting [38]. The data obtained in this study were aggregated and not individual, which could affect the prediction model and increase the inaccuracy of the model for predicting future stunting rates [39]. Additionally, The role of mothers in providing nutrition to their children, which is highly dependent on the role of fathers, can hinder the implementation of future interventions, resulting in inaccuracies in the prediction model due to these biases [40].

Our study represents a valuable contribution to the literature utilizing LiST and other modeling tools to accelerate stunting prevention in ENT. To our knowledge, this is the first LiST-based study to present stunting trends and provide information on various interventions to reduce stunting in ENT, offering evidence for investment decisions. ENT has a high level of malnutrition and poverty, making this research finding essential. The findings suggest that ENT has the potential to achieve SDG objective 2.2 by 2030, supported by reports of stunting prevention estimates in number by intervention. This study's strengths include the use of a well-established modeling tool (LiST) and a robust assessment of uncertainty, which is crucial to avoid “incredible certitude” in policy analysis [41]. Unlike typical analyses that report exact predictions, our study transparently communicates uncertainty by incorporating comprehensive data sources and additional inputs specifically for stunting interventions [18]. Through alternative scenarios, we provided a clear range of potential outcomes, ensuring that the model supports informed and cautious decision-making for maternal and child health policy.

The LiST projections are the product of impact factors based on expected changes in coverage of interventions or services [42]. While this study is comprehensive and useful for program design in ENT, it has limitations. It did not encompass all estimates for nutrition-specific and nutrition-sensitive interventions known to reduce stunting, such as those related to agriculture, education, child development, and nutrition (including early or exclusive breastfeeding and complementary feeding) or in enhancing low-coverage interventions like pediatric iron folic acid and zinc supplementation [17]. Our evaluation indicates that several nutrition-specific indicators will be needed to effectively avert stunting. In addition, the majority of the analysis is based on ex-ante projections, so assumptions were made. Furthermore, the LiST requires enhanced data quality and tools for epidemiological analysis to better reflect the epidemiological context and to construct realistic; detailed scenarios focused on coverage improvements as a key strategy [43]. Limited field data restricted the ability to provide detailed descriptions of key interventions in this study, and the influence of more impactful interventions on stunting prevention estimates remains unverified. Predicting intervention scenarios based on community priorities and available resources could benefit from further cost-effectiveness studies. Finally, given the study's focus on specific nutritional interventions, broader research encompassing nutritional sensitivity is recommended in other Indonesian provinces to effectively address stunting as part of the SDGs.

Conclusion

Achieving the SDGs of reducing the prevalence of stunting among children requires a comprehensive analysis of priority intervention projections. Despite the limited data available, breastfeeding promotion consistently provides the most significant contribution to averting cases of stunting in all scenarios. Increasing breastfeeding promotion, along with implementing extensive and appropriate complementary feeding practices, is expected to facilitate SDG targets in ENT and Indonesia overall.

Ethics approval

This study is a projection exercise. The input is based on publicly available data and has no access to personal identifiers. Additionally, the Institutional Review Board (IRB) of Universitas Indonesia provided ethical review approval (557/UN2.F10.D11/PPM.00.02/2022).

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Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request. Additionally, the appendix is accessible at https://bit.ly/4fw3MLI.

Declaration of artificial intelligence use

This study used artificial intelligence (AI) tools and methodologies in manuscript writing support, including AI-based language models, such as ChatGPT, which was employed to: (a) language refinement (improving grammar, sentence structure, and manuscript readability); and (b) technical writing assistance (providing suggestions for structuring complex technical descriptions more effectively). We confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were solely made by the authors.

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