Long Run Impact of Childhood Nutritional Status: Evidence from LMICs

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Abstract

We study the impact of childhood nutrition circumstances on later-age nutritional and cognitive outcomes in Low-and-Middle-Income Countries (LMICs) using longitudinal data. We show that early childhood stunting is highly persistent as measured by the association between stunting status in early childhood and stunting status at age 15. Stunting in early childhood is associated with a lower height-for-age (HAZ) Z-score at age 15. Childhood stunting is also negatively associated with learning outcomes including PPVT, math and reading scores.

Keywords: Children; LMICs; Nutrition Outcomes; Human Capital

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1 Introduction

The world is currently home to 1.8 billion young people. This is the largest young generation in human history. Nearly 90 percent of young people live in low and middle-income countries, their number and share in total population continuously growing in some places. Every year, nearly 120 million youth become old enough to work (UNFPA EECA, 2014). This historically unprecedented young population offers a bounteous opportunity for Low and Middle-Income Countries(LMICs) to grasp their growth potential. These countries need to invest strategically in adolescent health and education because these are key investment areas to seize this demographic dividend (Dahl, Allen, Wilbrecht, & Suleiman, 2018). The young require intensive investment in health and education because healthy and educated people are constituent of human capital and ensure efficient utilisation of physical capital. They also contribute to growth through the supply of labour and savings. If this growing workforce is coupled with lower fertility and improved health, nutrition, and education, many countries may benefit from the explosive economic growth associated with the demographic dividend (Bloom, Canning, & Sevilla, 2003). Young people merit special attention not only because they have special health and nutrition needs, but because they are our future teachers, problem-solvers, and global leaders. The degree to which this generation responds to the challenges of tomorrow and promotes economic growth relies on optimal health and development throughout adolescence. Better nutrition in adolescence is essential because poor nutrition status is the leading risk factor and contributes to many of the predominant causes of adolescent death (Christian & Smith, 2018).

1.1 Childhood growth faltering and catch-up growth

Nutrition in the first 1000 days 'Window of Opportunity', from conception to 24 months of life, is crucial for physical, cognitive and socioemotional underpinning in later life (Demaio & Branca, 2018; Walker et al., 2011). Early nutrition failure has several implications from child survival, cognitive achievement, adult wage, loss of productivity, mental health to intergenerational effects (Caulfield, Richard, Rivera, Musgrove, & Black, 2006; Hoddinott, Maluccio, Behrman, Flores, & Martorell, 2008; Huang et al., 2013). Poor fetal growth or stunting in the first two years of life leads to irreversible damage, including shorter adult height, lower attained schooling, reduced adult income, and for women, decreased offspring birth weight (Victora et al., 2008; Vikram, 2018). In a cross-section analysis form 51 low- and middle-income countries it was found that from approximately 30 percent of deficit in height at 60 months was accumulated after 24 months (Leroy, Ruel, Habicht, & Frongillo, 2014). There is evidence that early age intervention is critical for nutrition and primary and pre-primary school-age children also consider merit for nutritional intervention and adolescent represent an additional window of opportunity (Benny, Boyden, & Penny, 2018; Crookston et al., 2013; Prentice et al., 2013). A non-intervention cohort study in the Philippines followed-up children from 2 to 12 year of age and concluded that there is a potential of growth catch up in later childhood and early adolescent years (Adair, 1999). Another longitudinal study from four developing countries found recovery in stunting from 1 to 8 year age (Lundeen et al., 2014). An intervention based longitudinal study in Guatemala found a significant intergenerational association of nutritional intervention in early childhood of mother with mothers' offspring's anthropometric indicators. A strong association was reported for sons in comparison to daughters (Behrman et al., 2009).

Recent multilateral (United Nation Decade of Action on Nutrition and SDG-2 and 3; food security and nutrition for all and all ages) policy initiatives have highlighted the need for multisectoral "double-duty actions" or interventions and policies (Hawkes, Demaio, & Branca, 2017; WHO, 2017). These interventions and policies aim to have the potential to reduce the risk of both undernutrition (including stunting and wasting) and overweight. In 2019, the World Health Organisation (WHO) called for an integrated 'Life Course' perspective on nutrition which focuses on addressing the nutritional needs at key life stages throughout the life (WHO, 2019). Examples of such interventions include protection and promotion of exclusive breastfeeding in the first six months, maternal nutrition programs, school policies and programs, and marketing regulations (Perez-Escamilla et al., 2018; WHO, 2017, 2019).

1.2 Nutrition and Cognitive Outcomes

A significant body of research demonstrates a profound influence of childhood health and economic circumstances on adult health, educational attainment, employment, and socioeconomic status (Case, Fertig, & Paxson, 2005; Caulfield et al., 2006; Heckman, 2000; Hoddinott et al., 2008; Huang et al., 2013). In 2017, the Lancet series on childhood development emphasised the importance of investment in early childhood through a life course approach. The study recognised that early life ill-health experiences have long-term consequences on the brain and physiological development as well as on psychosocial outcomes, earning, marriage, and fertility (Black et al., 2017).

Early childhood has come to be recognised as a critical period for brain development, and adverse influences at this stage limit the potential for human capital development in the later life. In developing countries, children living under 2 years of age experiences health and nutrition risk (chronic and acute malnutrition) simultaneously and these risks create an obstacle to the proper development of language and cognitive abilities (Aboud & Yousafzai, 2015; Prado & Dewey, 2014). Malnutrition at early ages leads to marked disadvantage over the life course as it is associated with deficits in attention, cognitive and educational achievement, productivity and income (Alderman, Hoddinott, & Kinsey, 2006; Galasso, Weber, & Fernald, 2019; Victora et al., 2008).In developing countries, this can have severe consequences given the magnitude of poverty and deprivation. Evidence shows that more than 200 million children under the age of five years fail to reach their full developmental potential due to poverty, malnutrition, poor health, and unstimulating home environments in developing countries (Grantham-McGregor et al., 2007). A testament to this statement is the statistics on malnutrition in India, although extreme poverty has been on the decline in India, a large absolute number of people continue to live in poverty especially in rural India (Kharas, Hamel, & Hofer, 2018).

If a country is to promote the demographic transition and take advantage of the demographic dividend children need to have adequate support for their health needs in order to ensure they recognised their opportunities in the education system, where poor health often contributes to educational underachievement (Bloom et al., 2003).). Malnutrition in children ages 5–19 years has profound consequences on education and health outcomes, although more studies and analyses could determine the extent of this impact on national development (Galloway, 2017).

A recent study in china found gender-specific detrimental effects of childhood hunger on women's late-life cognitive abilities (Cui, Smith, & Zhao, 2020). Using Young Lives data for India, Peru, Vietnam, and Ethiopia Singh and Krutikova (2017) did not found much evidence of significant gender gaps in learning at school entry age (5 years old) or in early primary school (8 years old) in any of four countries. Gender gaps do, however, develop at later ages in most countries and are particularly evident after the age of 12, a period coinciding with adolescence and post-primary schooling. Substantial heterogeneity in the direction of gender gaps was observed, where significant gender gaps mostly favour boys in Ethiopia, India and Peru, but typically favour girls in Vietnam (Singh & Krutikova, 2017). Gender norms, roles, aspirations, opportunity cost, time use, perceived differential returns and preferences may lead to a negative bias toward females in educational attainments (Alderman & King, 1998; Saewyc, 2017). Dercon and Singh (2013) using 3 waves of Young Lives Study data from Ethiopia, India, Peru, and Vietnam found a pronounced gender bias against girls in education that is reflected at different ages and in an "institutionalised" form in India. The bias systematically emerged from parent's educational aspiration and ultimately resulted in the gender gaps in cognitive achievement in early adolescence in India and Ethiopia, a reverse pattern was observed in Vietnam that favoured the girls. Some longitudinal evidences on nutritional status and cognitive outcomes.

The present study is an attempt to understand the persistence of stunting. In other words, how and to what extent does childhood stunting affect later-age stunting? What are the impacts of stunting on cognitive outcomes? Addressing these questions is particularly important from human capital implications perspective.

2 Data and Methodology

The study will use from data from Young Lives study, a multicounty and first of its type of study of childhood poverty with longitudinal data on children in Ethiopia, India (Andhra Pradesh and Telangana), Peru and Vietnam (`www.younglives.org.uk`). The principal objectives of the study were to produce long-term high quality panel data on children's growing in poverty, the impact of policy changes on child welfare and to inform policymakers and other stakeholders to respond on these issues (Wilson, Huttly, & Fenn, 2006). The study followed over 15 years two cohorts of children; the younger cohort (n 2000 per country) was born in 2001-02 and surveyed at roughly (including about 6 months before and 6 months after ages) 1, 5, 8, 12 and 15 years and the older cohort (n 1000 per country) was born in 1994-95 and surveyed at ages roughly 8, 12, 15, 19, and 22 years. In each country, children and their families were randomly selected from 20 semi-purposefully selected sentinel sites. The Young Lives study was designed to help study issues of poverty in childhood so children from low-income families were over-sampled. While the samples selected are not nationally representative, they do represent the geographic, ethnic, social, and economic variation of each of the four countries. Comparison of socioeconomic (i.e. access to public services, caregivers' education, household assets) and key child outcomes or variables to the nationally representative surveys shows similar patterns and variations (Barnett et al., 2013). This study will utilise data from all 5 waves on younger cohorts of children in all four countries. All four countries vary in their level of development, income inequality, and nutrition transition Figure A.1, Figure A.2a, and Figure A.2b.

Dependent variables: Our primary aim is to understand the impact of childhood nutritional circumstances on later-age nutritional and cognitive outcomes. For nutritional status, stunning (low-height-for-age) is taken as our primary outcome variable. The dependent variable takes a dummy form where 1 indicates the presence of stunting and 0 otherwise. Stunting is defined using the (WHO) child growth reference. For cognitive outcomes, we use child math and reading scores and PPVT test scores.

Independent variables: Our key independent variable of interest is childhood nutrition status. As a determinant, stunting status is defined as not-stunted, moderately stunted, and severely stunted. We control for socioeconomic factors, including child, mother, and household-level controls.

Econometric Specification:

$$Y_{ic}^{k} = \beta_0 + \sum_{j=1,5/8} \beta_{2j} \mathbf{STage}_i^j + \theta \mathbf{X}_{ic} + \delta_c + \epsilon_{ic} \quad (1)$$

where Y_{ic}^{k} is the outcome of interest (stunting and cognition) for the children i living in sentinel site or cluster c. As we are interested in assessing the impact of childhood nutritional status on nutritional and cognitive outcomes in adolescence, Y_{ic}^{k} in Equation Equation 1 takes the value of stunting status at ages 5, 8, 11, and 15 years. Stunting status is defined as 1 if the value of HAZ is below -2 SD from (WHO 2006) child growth standard and 0 otherwise.

For cognitive outcomes, our outcome variable of interest are standardised scores on math, early grade reading achievement (EGRA), Peabody Picture Vocabulary Test (PPVT), language, and reading for different age-groups.

3 Results

Table 1 shows the sample description, attrition rate, and socioeconomic characteristics of the study population over time and across countries. The total attrition rate varies between 3 percent in Vietnam to 9 percent in Ethiopia over 5 waves. In Ethiopia, 61.27% children are from the lowest wealth tercile compared to 28.32% in India and 18.24% in Vietnam. The last row of the Table 1 shows the prevalence of stunting over five rounds of the data. Ethiopia has the largest percent (41.99%) of children with stunting in round one, and in the fifth round, 25.48% are stunted. In India, 30.71% of children were stunted in the first round and 27.77% in the latest fifth round. Overall, Vietnam has the lowest prevalence of stunting over the five rounds.

Figure 1 shows the persistence of any form of stunting (HAZ< -2 SD) and severe stunting (HAZ< -3 SD) in Ethiopia, India, Peru, and Vietnam. It is observable from this figure that although the prevalence of severe stunting is lower compared to any form of stunting, it is more persistent.

Table 2 Panels A and B show the results of the impact of stunting status at age 1 and 5 on later-age (age 15 years) nutrition status. This is estimated using Equation 1 where stunting status is used as a categorical variable with not-stunted is taken as the reference category. In the case of both ages, the magnitude of severe stunting in predicting adolescent stunting is significantly higher compared to the moderate stunting status. The probability of being stunted at age 15 years is 58 percentage points higher for the children who were severely stunted at age 5 compared to not stunted at age 5. Detailed country-specific results for these outcomes are shown in Table 3. Here, we also find a similar and higher impact of severe stunting at age 5 on the likelihood of stunting at age 15. The effects are more pronounced in case of Vietnam and India.

4 Conclusion and Way Forward

In this study, we investigate the impact of childhood stunting status on adolescent nutritional outcomes in four YLS countries. We adopt a longitudinal view that shows the persistence and transition in nutrition status. Our preliminary findings show a significant association between persistent stunting in childhood and poor nutritional outcomes in adolescence. In the next steps, we will deepen our understanding of these dynamics by considering how the height-for-age (HAZ) Z-score is impacted over time by childhood circumstances as a continuous variable. Moreover, we will also estimate the impact of early-age nutritional outcomes on schooling, cognitive achievements, and labour markets in developing countries.

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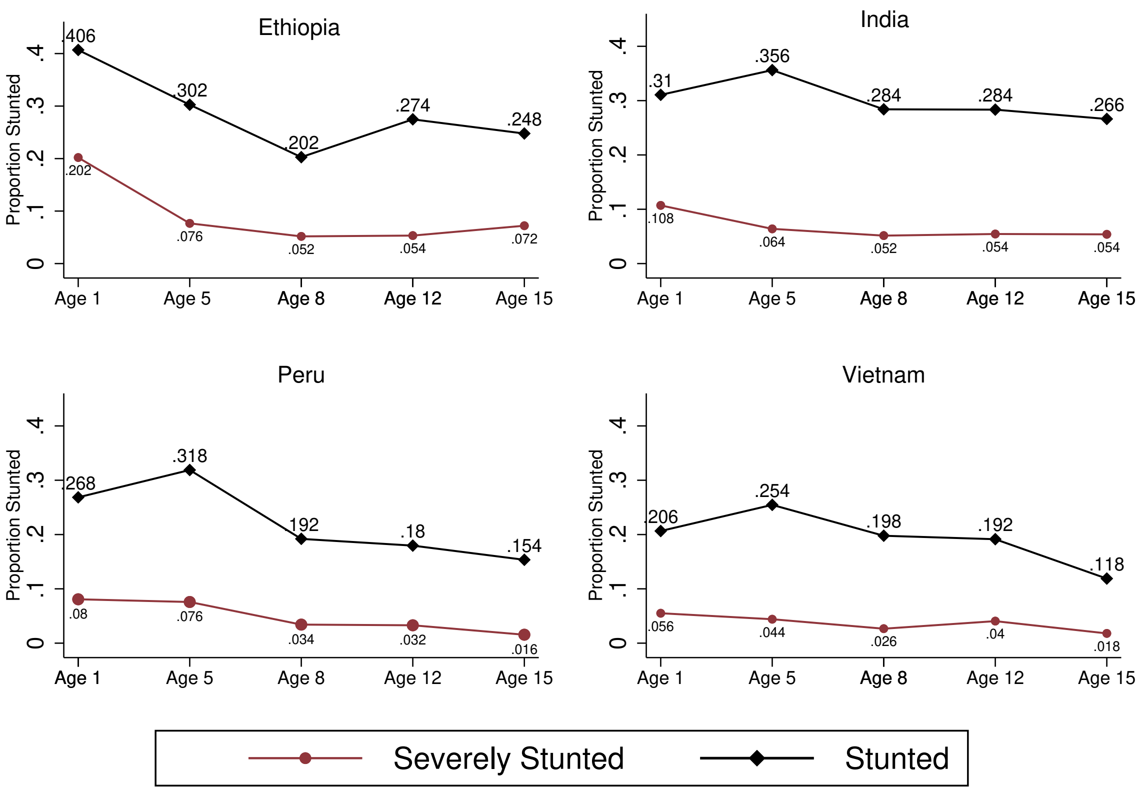
Figures and Tables:

Figure 1: Persistent of Stunting in Young Lives Ciuntries



Notes:This figure shows the trend of per capita Gross National Income among Young Lives Study countries since 2000. rences in rates of inflation between the countries. Data used in the figure comes from the World Bank, World Development Indicators (WDI) (World Bank, 2023)

Table 1: Cohort profile and descriptive statistics

Variable \ Country		Ethiopia	India	Peru	Vietnam
Survey Round	1	1999	2011	2052	2000
	2	1912	1950	1963	1970
	3	1885	1931	1943	1964
	4	1875	1915	1902	1932
	5	1812	1890	1860	1941
Total Attrition Rate		9.4	6.0	9.4	3.0
Age	in months	98.34	98.25	96.44	99.34
Sex of Child	Male	52.75	53.77	50.36	51.24
	Female	47.25	46.23	49.64	48.76
Residence	Rural	64.27	72.97	28.51	79.12
	Urban	35.73	26.84	71.49	20.88
Wealth Tercile	Lowest	61.27	28.32	29.69	18.24
	Middle	29.76	38.32	30.65	33.16
	Highest	8.97	33.36	39.66	48.6
Mother's Age	Years	34.43	30.7	33.92	34.31
Sex of Head	Male	79.43	91.41	85.63	85.59
	Female	20.66	8.59	14.37	14.41
Stunting	1	41.99	30.71	28.35	20.83
	2	31.34	35.67	33.18	25.31
	3	21.47	28.9	20.65	20.01
	4	28.97	29.21	18.98	19.58
	5	25.48	27.77	16.06	12.24

Notes: Data for this table come from five-waves of Young Lives Study

Table 2: Effect of stunting at age 1 and 5 on stunting status at age 15

Country	**Stunting at age 15**	**p-value**	**95% CI**
Panel A, *Stunting at age 1*			
Moderately stunted	.21 (0.015)	< 0.001	0.18 - 0.24
Severely Stunted	.37 (0.020)	< 0.001	0.33 - 0.41
Panel B, *Stunting at age 5*			
Moderately stunted	.27 (0.014)	< 0.001	0.25 - 0.30
Severely Stunted	.58 (0.024)	< 0.001	0.53 - 0.63

Notes: This table is based on data from the younger cohort of YLS.
The dependent variable in column (2) is stunting at age 15 in dummy form. All regression estimations involve fixed effects at the sentinel site level, and Standard errors in parentheses are clustered at the sentinel site level. Results are obtained by estimating (1) Controls include age, sex, residence, household size, wealth status, and mothers' education

Table 3: Effect of stunting at age 1 and 5 on stunting status at age 15, country-specific results

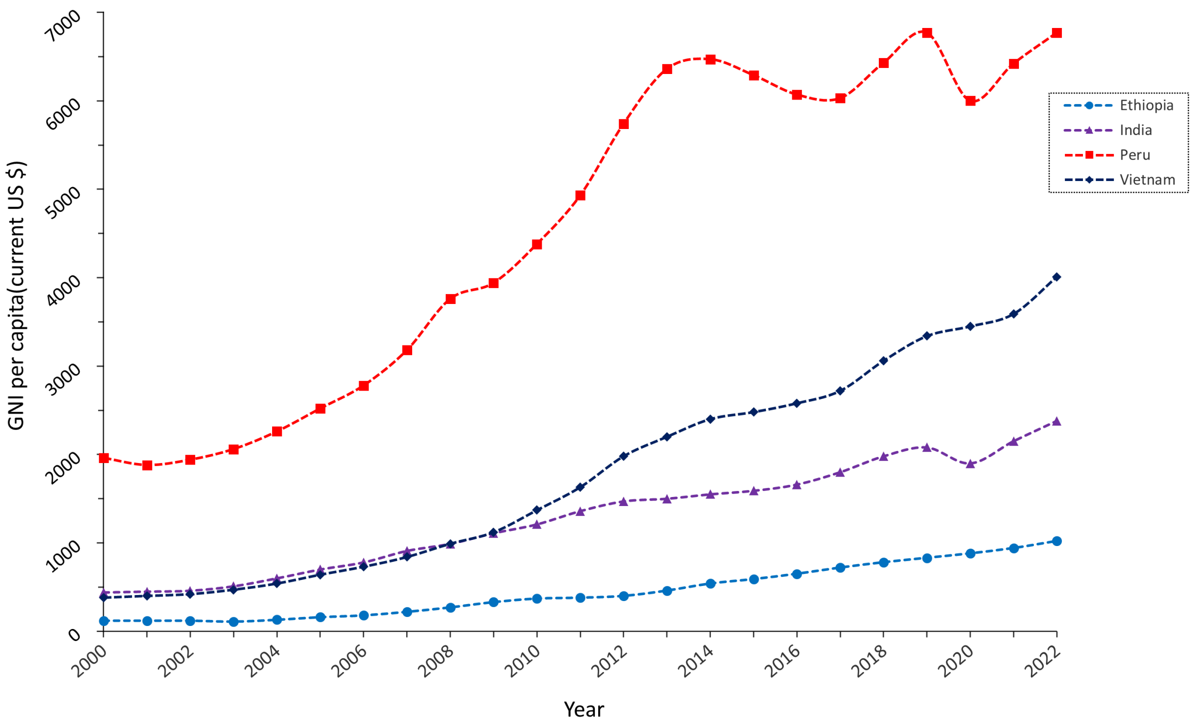
Country	Stunting at age 15	p-value	95% CI
Ethiopia, *Stunting at age 1*			
Moderately stunted	.19 (0.030)	< 0.001	0.12 - 0.25
Severely Stunted	.29 (0.030)	< 0.001	0.22 - 0.35
Stunting at age 5			
Moderately stunted	.26 (0.034)	< 0.001	0.19 - 0.33
Severely Stunted	.49(0.038)	< 0.001	0.41 - 0.57
India, *Stunting at age 1*			
Moderately stunted	.19 (0.030)	< 0.001	0.13 - 0.25
Severely Stunted	.41 (0.031)	< 0.001	0.35 - 0.48
Stunting at age 5			
Moderately stunted	.32 (0.027)	< 0.001	0.27 - 0.38
Severely Stunted	.60 (0.047)	< 0.001	0.51 - 0.71
Peru, *Stunting at age 1*			
Moderately stunted	.24 (0.236)	< 0.001	0.20 - 0.29
Severely Stunted	.36 (0.047)	< 0.001	0.26 - 0.46
Stunting at age 5			
Moderately stunted	.25 (0.022)	< 0.001	0.21 - 0.30
Severely Stunted	.51 (0.045)	< 0.001	0.42 - 0.61
Vietnam, *Stunting at age 1*			
Moderately stunted	.22 (0.031)	< 0.001	0.16 - 0.29
Severely Stunted	.46 (0.052)	< 0.001	0.36 - 0.57
Stunting at age 5			
Moderately stunted	.24 (0.026)	< 0.001	0.17 - 0.30
Severely Stunted	.74 (0.056)	< 0.001	0.62 - 0.86

Notes: This table shows country-specific estimates of the effects of stunting at age 1 and 5 on nutritional outcome at age 15. The dependent variable in column (2) is stunting at age 15 in dummy form. All regression estimations involve fixed effects at the sentinel site level, and standard errors in parentheses are clustered at the sentinel site level. Controls include age, sex, residence, household size, wealth status, and mothers' education

A Appendix A. Figures

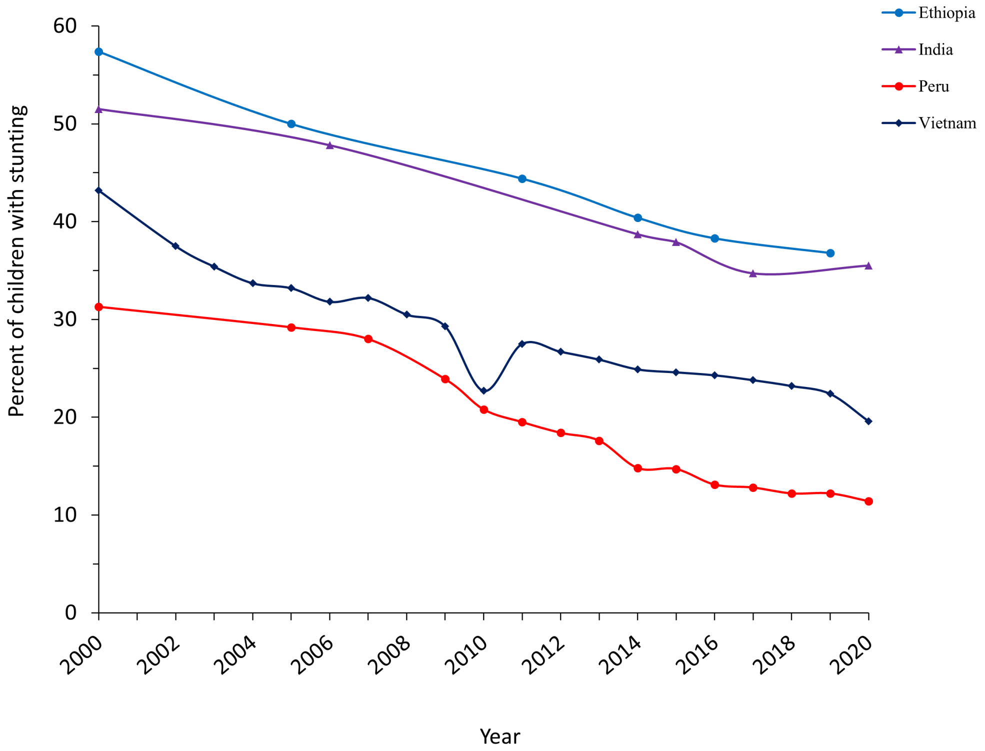
Explain what this part contains

Figure A.1: GNI per capita trajectories of Young Lives Study (YLS) countries

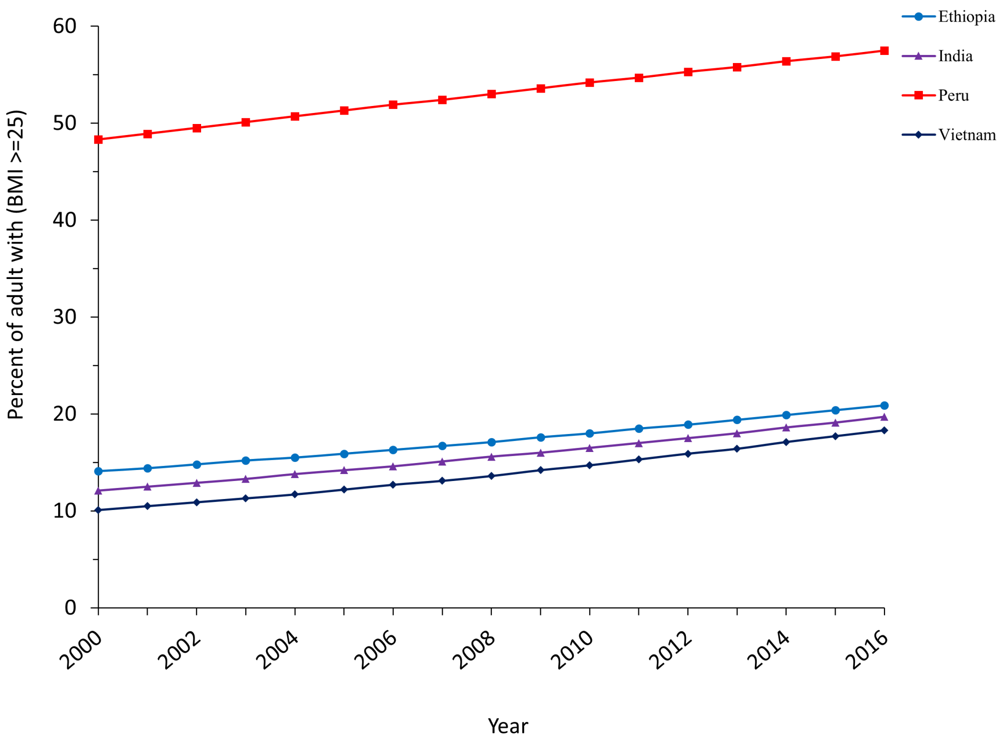


Notes:This figure shows the trend of per capita Gross National Income among Young Lives Study countries since 2000. GNI per capita (formerly GNP per capita) is converted to U.S. dollars using the World Bank Atlas method. GNI, calculated in national currency, is usually converted to U.S. dollars at official exchange rates for comparisons across economies, although an alternative rate is used when the official exchange rate is judged to diverge by an exceptionally large margin from the rate actually applied in international transactions. To smooth fluctuations in prices and exchange rates, a special Atlas method of conversion is used by the World Bank. This applies a conversion factor that averages the exchange rate for a given year and the two preceding years, adjusted for differences in rates of inflation between the countries. Data used in the figure comes from the World Bank, World Development Indicators (WDI) (World Bank, 2023)

Figure A.2: Trends in stunting among children and overweight/obesity among adults in YLS countries



(a) stunting among children under five age



(b) Overweight or obesity among adults (BMI $\geq$ 25)

Notes:This figure shows the trend of under-five age children with stunting (too short for their age) and adults with overweight or obesity (BMI $\geq$ 25) in YLS countries since 2000. Data used in this figure comes from Our World in Data.