International Journal of Economics, Business and Management Research

Vol. 6, No.06; 2022

ISSN: 2456-7760

Relevance of Stunting and Economic Studies (Supported With Stunting Mapping Using K-means Clustering Method in Indonesia)

Reni Eka Septiani[1] and Mulyanto[2]

[1]Student of Master of Economics and Development Studies, Sebelas Maret University, Indonesia

[2]Lecturer at the Faculty of Economics and Business, Sebelas Maret University, Indonesia

doi: 10.51505/ijebmr.2022.6703 URL: http://dx.doi.org/10.51505/ijebmr.2022.6703

Abstract

This study aims to determine the relationship between stunting and economic studies and to map stunting-prone areas to find out which areas require priority for stunting management in Indonesia. This research is a quantitative descriptive study with literature review and clustering methods using k-means clustering which is visualized through a map using ArcGIS software. Secondary data collection was obtained from previous journals and stunting prevalence data for 34 provinces in Indonesia was obtained from the Nutrition Status Monitoring 2017 book, Basic Health Research 2018, Study on Nutritional Status of Indonesian Toddlers 2019. The results of the study show that children who experience stunting in the future will lose their potential income due to their low production performance and ultimately increase poverty rates, economic inequality, and state economic losses. The results of the stunting clustering were divided into 4 clusters. Cluster I shows that the provinces with the highest average stunting prevalence are Aceh, East Nusa Tenggara, West Nusa Tenggara, Central Kalimantan, and West Sulawesi. Cluster II consists of the provinces of North Sumatra, West Kalimantan, South Kalimantan, Central Sulawesi, South Sulawesi, Southeast Sulawesi, Gorontalo, Maluku, and Papua. Cluster III consists of the provinces of West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, West Java, Central Java, East Java, Banten, East Kalimantan, North Kalimantan, North Sulawesi, North Maluku, and West Papua. Cluster IV consist of the provinces of the Bangka Belitung Islands, Riau Islands, Jakarta, Yogyakarta, and Bali.

Keywords: Stunting, Child Health, Economics, K-means clustering

1. Introduction

Currently, the problem of child health, namely stunting, is a crucial problem in Indonesia. The Indonesian government is aggressively delivering stunting prevention programs in every region. This is because Indonesia is one of the countries that has a high prevalence of stunting.

Stunting is a condition of children under five who experience height less than -2 standard deviations from the international child growth standards set by WHO (Reinbold, 2011; de Onis & Branca, 2016). The direct cause of stunting in toddlers has started since the child was in the womb until the age of 2 years or called the first 1000 days of life. This period is an important period in building children's nutritional security, if during this period there is chronic malnutrition, children can experience stunting(Ministry of Health RI, 2018). These events are

Vol. 6, No.06; 2022

ISSN: 2456-7760

directly due to poor diet, inadequate nutrition for long-term growth, and repeated infections (WHO, 2010).

Stunting become an important problem, because the long-term impact of stunting greatly affects the formation of human capital and the country's economy. the long-term impact of current stunting can harm the country in the future, the country will lose a lot of economic potential because children who experience stunting have low productivity levels (Renyoet et al., 2016). Basic health research data shows that one in three Indonesian toddlers is stunted (Ministry of Health, 2013). The average prevalence of stunting in Indonesia in 2005-2017 was the third highest among countries in the Southeast Asian region (Ministry of Health RI, 2018). In this regard, an in-depth exploration of the relationship between stunting and economic studies and mapping of stunting-prone areas is carried out to find out which areas require priority in handling stunting prevalence reduction.

2. Research methods

This research is a quantitative descriptive study with literature study methods and k-means clustering. The literature study method is used to describe the relationship between stunting and economic studies. The literature study was carried out by collecting and analyzing various scientific journals relevant to the topics discussed in this study.

The k-means clustering method was used to map stunting prone areas. Stunting prevalence data for 34 provinces in Indonesia was obtained through official publications of the Indonesian government including the 2017 Nutrition Status Monitoring book, Basic Health Research 2018, Study on the Nutritional Status of Indonesian Toddlers 2019.

The steps taken for the application of the k-means clustering method are as follows:

a. Determine the number of clusters, then determine the center value or the initial centroid of each cluster randomly.
b. Calculate the distance of each data to each centroid using the Euclidean distance formula:

$$d(Xi,Cj)=\sqrt{\sum_{i=1}^{N}(Xi - Cj)^2}$$

d(Xi,Cj) = Distance data i to centroid j
Xi = Data to i
Cj = Centroid

c. Grouping data into each cluster based on the minimum distance.
d. Next, repeat the distribution of data to each cluster by creating a new centroid formed from the calculation of the average data value of each cluster that has been formed in stage 3.
e. Calculate the distance of each data to each centroid using the Euclidean distance formula.
f. Grouping data into each cluster based on the minimum distance.
g. If there is data that moves clusters, then repeats to stage 2. However, if there is no data that moves clusters, then clustering is complete (Wahyuni & Saepudin, 2021).]

Vol. 6, No.06; 2022

ISSN: 2456-7760

3. Results and Discussion

3.1 Child Health and Economic Studies

Health is an important topic that is relevant to be studied in depth for researchers in the field of economics because the topic is closely related to economics. In this regard, the science of health economics emerged and developed. Health economics became known in 1963 through Kenneth Arrow's work entitled Uncertainty and the Welfare Economics of Medical Care which was published in The American Economic Review (Ahsan et al., 2022). Health economics studies the application of economics to the health sector, namely how to meet the need for health with limited resources.

According to Murti in Ahsan et al. (2022) economy and health have a close reciprocal relationship, because the health status of a country's population is able to affect the level of welfare and economic growth of that country, and vice versa the economy of a country affects the determination of health budget allocations, research and development of health technology, and service quality. Long-term health improvement is closely related to economic growth which can be explained through 3 mechanisms: better nutrition, improved health infrastructure, and improved health technology (Frakt, 2018).

Health in the focus of this research is the health of children. Children's health has an important role in promoting human and economic development. A real example, in a company requires capital to support the operation of the company in the form of money, assets, or other valuable resources. Valuable resources include human capital which is wealth in human form (Currie, 2019). Human capital plays an important role in the economy because humans have the ability to continue to develop and innovate, thus sustaining the pace of the economy. Quality human capital results from guaranteed childhood health. Based on Currie's research (2019) that good health in childhood reduces forms of disability and death, children can live longer, and get more education which in turn has an impact on increasing wages and the amount of income tax paid in adulthood.

The importance of children's health for the future of economic development makes child health care activities part of a country's long-term investment. Investment in children's health can be done through the establishment of appropriate policies on the indicators that make up the economy. Guaranteed children's health cannot be separated from the right economic policy stimulus. Health economics plays a role in analyzing problems and determining appropriate policies by using resources efficiently.

3.2 Child Health Benchmarks

Stunting is the best indicator for determining the level of child well-being and an accurate marker of inequality in human development (de Onis & Branca, 2016). The prevalence of stunting is a very important indicator for determining the overall health and nutritional status of children (Bloem et al., 2013; De Onis et al., 2011; Dewey & Begum, 2011). Childhood stunting is the most common form of malnutrition globally (Prendergast & Humphrey, 2014).

Vol. 6, No.06; 2022

ISSN: 2456-7760

The incidence of stunting in children reflects long-term chronic malnutrition or the cumulative effect of continuous malnutrition during pregnancy up to the first 2 years of life (Dewey & Begum, 2011). Furthermore, Dewey & Begum (2011) explain that in developing countries, stunting is more common than wasting and underweight because stunting is more sensitive to food quality than wasting and underweight. Stunting is less relevant if it is associated with temporary food shortages because stunting indicates insufficient diet which can be due to long-term chronic infection, so stunting is a representative indicator of long-term malnutrition in children (Yaya et al., 2020).

Failure to thrive is a common marker of child health problems, namely markers of pathological disorders that are closely related to increased morbidity and mortality, decreased cognitive and neurological function, and increased risk of chronic disease in adulthood (de Onis & Branca, 2016). Furthermore, stunting limits physical and cognitive abilities because stunted children experience irreversible physical and neurocognitive damage (de Onis & Branca, 2016).

3.3 The Process of Stunting

Stunting is a condition of children under five who experience height less than -2 standard deviations from the international child growth standards set by WHO (Reinbold, 2011; de Onis & Branca, 2016). Stunting is a condition of chronic malnutrition that lasts for a long time (Karyati, 2021).

Studies show that malnutrition in pregnant women, anemia, smoking, and air pollution can limit the growth of the fetus so that it is vulnerable for babies to be born with low weight, in addition to infections that often occur in the early 2 years of the child's age are at risk of inhibiting the growth and development of children so that children experience stunting (Dewey & Begum, 2011). Pregnant women generally experience a lack of energy and protein, so that during pregnancy they need more nutritional intake than when they are not pregnant. These conditions are also accompanied by the condition of a short pregnant woman with a height of <150 cm which has an impact on the birth weight of a child <2500 grams and a height of <48 cm, then after birth it is exacerbated by the low initiation of early breastfeeding and exclusive breastfeeding. 6 months, as well as inadequate nutrition from complementary foods for breastfeeding given to children (Ministry of Health RI, 2018).

3.4 Stunting Impact

The incidence of stunting in children under five has a negative impact both in the short and long term. The short-term impact of stunting can cause death. Global data shows that 3.1 million under-five deaths each year or 45% of under-five deaths in 2011 were caused by malnutrition and stunting contributed the most to these cases (Black et al., 2013). This is because children who experience stunting are vulnerable to the risk of infections that result in death such as diarrhea, pneumonia, and measles, even when entering adulthood they are vulnerable to the risk of chronic diseases such as cardiovascular (Oot et al., 2016).

The long-term risks experienced by children who experience stunting are generally associated with lower cognitive abilities than normal children and lower incomes in adulthood when

Vol. 6, No.06; 2022

ISSN: 2456-7760

children find work. Children who experience stunting cannot maximize their intellectual potential and are more susceptible to disease, besides that in the future they will lose their potential income due to low production performance and ultimately increase poverty and economic inequality (Adji et al., 2019). Renyoet et al., (2016) research shows that every individual born has their own economic potential, and stunted children cause state economic losses due to decreased productivity and the losses suffered by the state reached to Rp. 3,057 billion-Rp. 13,758 billion. Mary (2018) research conducted in 74 developing countries between 1984 and 2014 found that an increase in the percentage of stunting led to a decrease in Gross Domestic Product (GDP) per capita by 0,4%.

3.5 Clustering of Stunting Vulnerable Areas in Indonesia

Based on the calculation of the average stunting prevalence in each province in 2017-2019, there is only one province that has a stunting prevalence below the World Health Organization (WHO) standard of 20%, namely the province of Bali. The average rate of stunting prevalence in the province of Bali in 2017-2019 is 18,43%. The following is the data on the average value of stunting prevalence for each province in Indonesia in 2017-2019:

Table 1. Average Stunting Prevalence by Province in 2017-2019

Province	Average Stunting Prevalence (%)
Aceh	35,70
North Sumatra	30,33
West Sumatra	29,33
Riau	27,03
Jambi	25,43
South Sumatra	27,83
Bengkulu	28,10
Lampung	28,40
Bangka Belitung Islands	23,53
Riau Islands	20,47
Jakarta	20,10
West Java	28,83
Central Java	29,13
Yogyakarta	20,73
East Java	28,80
Banten	26,77
Bali	18,43
West Nusa Tenggara	36,20
East Nusa Tenggara	42,23
West Kalimantan	33,77
Central Kalimantan	35,10
South Kalimantan	33,03
East Kalimantan	29,30
North Kalimantan	28,87
North Sulawesi	26,03
Central Sulawesi	33,23
South Sulawesi	33,70
Southeast Sulawesi	32,17
Gorontalo	33,03
West Sulawesi	40,67
Maluku	31,47
North Maluku	28,50
West Papua	28,57
Papua	31,77

Source: Processed Secondary Data (2022)

Vol. 6, No.06; 2022

ISSN: 2456-7760

Table 1 shows the average prevalence that varies between provinces. The lowest average value of stunting prevalence was achieved by the province of Bali at 18.43%, while the highest average value of stunting prevalence was occupied by the province of East Nusa Tenggara of 42.23%. The province of Bali had a stunting rate of 19.10% in 2017, 21.80% in 2018 and 14.40% in 2019 (Ministry of Health RI, 2018; Indonesian Ministry of Health, 2019). Bali stunting prevalence achievement in 2019 is the lowest stunting percentage achievement during 2017-2019 among 33 other provinces. This situation is different from the province of East Nusa Tenggara (NTT) which during 2017-2019 had a stunting percentage above 40%. Based on the data collected, the percentage of stunting in NTT in 2017 was 40.30%, in 2018 it was 42.60%, and in 2019 it was 43.80%. The achievement figure in 2019 in the province of NTT was the highest percentage of stunting during 2017-2019 compared to 33 other provinces. Based on the results of the clustering, the researchers divided the provinces into 4 clusters. Cluster division is presented in the following table:

Table 2. Stunting Cluster

Cluster I	Cluster II	Cluster III	Cluster IV
Aceh West Nusa Tenggara East Nusa Tenggara Central Kalimantan West Sulawesi	North Sumatra West Kalimantan South Kalimantan Central Sulawesi South Sulawesi Southeast Sulawesi Gorontalo Maluku Papua	West Sumatra Riau Jambi South Sumatra Bengkulu Lampung West Java Central Java East Java Banten East Kalimantan North Kalimantan North Sulawesi North Maluku West Papua	Bangka Belitung Islands Riau Islands Jakarta Yogyakarta Bali

Source: Clustering Results (2022)

Cluster 1 is the regional cluster with the highest average stunting rate in Indonesia in 2017-2019. The number of provinces in this cluster is 5 provinces. The average stunting rate in cluster I was 37.98%. The highest percentage of stunting in cluster 1 was occupied by the province of East Nusa Tenggara with an average stunting of 42.23%, followed by West Sulawesi which had an average stunting of 40.6%. Central Kalimantan is the province with the lowest average stunting percentage in cluster 1, which is 35.1%. Cluster 1 spatial visualization is shown through a map in red with a percentage range of 35.10%-42.23%.

Cluster II is the regional cluster with the second highest average stunting rate in Indonesia in 2017-2019. The number of provinces in this cluster is 9 provinces. The percentage of stunting rates in cluster II for each province is not too big. The average stunting rate in cluster II was 32.49%. The highest stunting rate was found in West Kalimantan province with a percentage of

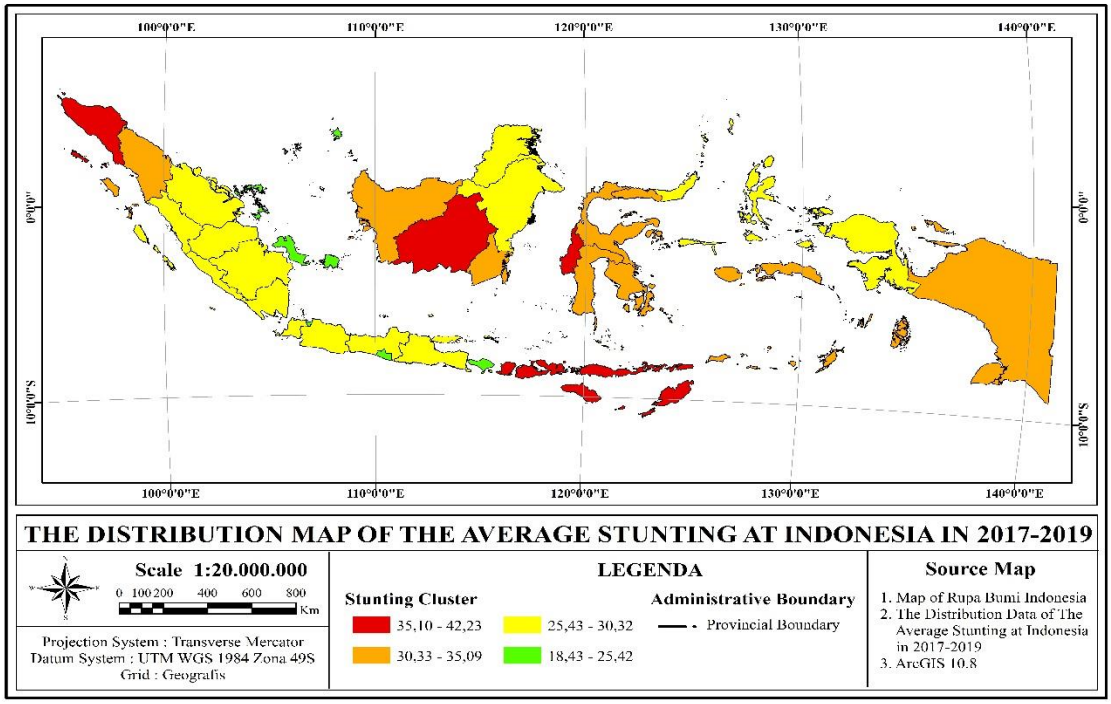
Vol. 6, No.06; 2022

ISSN: 2456-7760

33.77% and the lowest was in North Sumatra province at 30.3%. Cluster II spatial visualization is shown through a map in orange with a percentage range of 30.33%-35.09%.

Cluster III is a regional cluster with the third highest average stunting rate. The number of provinces in this cluster is 15 provinces. The average stunting rate in cluster III is 28.06%. The average percentage of the highest stunting rate is in the province of West Sumatra, which is 29.33%, followed by East Kalimantan, which is only a very small difference, which is 29.3%. The lowest average percentage rate of stunting in cluster III is in Jambi province at 25.43%. Cluster III spatial visualization is shown through a map in yellow with a percentage range of 25.43%-30.32%.

Cluster IV is the regional cluster with the lowest average stunting rate. There are 5 provinces that occupy the cluster with the lowest average stunting rate. The average stunting rate in cluster IV is 20.65%. The highest average stunting percentage in this cluster is occupied by the province of Bangka Belitung islands at 23.53%, followed by Yogyakarta at 20.73%, Riau islands was 20.47%, Jakarta was 20.1%, and the lowest was Bali at 18.43%. Cluster IV spatial visualization is shown through a map in green with a percentage range of 18.43%-25.42%. The complete map visualization can be seen in the following image:



Source: Author's calculations using ArcGIS 10.8 (2022)

Figure 1. Stunting Average Distribution Map in 2017-2019

Vol. 6, No.06; 2022

ISSN: 2456-7760

4. Conclusion

The importance of children's health for the future of economic development makes child health care activities part of a country's long-term investment. Guaranteed children's health cannot be separated from the right economic policy stimulus. Children who experience stunting in the future will lose their potential income because of their low production performance and ultimately increase poverty rates, economic inequality, and state economic losses.

The results of the stunting clustering were divided into 4 clusters. Cluster I shows that the provinces with the highest average stunting prevalence are Aceh, East Nusa Tenggara, West Nusa Tenggara, Central Kalimantan, and West Sulawesi. Cluster II consists of the provinces of North Sumatra, West Kalimantan, South Kalimantan, Central Sulawesi, South Sulawesi, Southeast Sulawesi, Gorontalo, Maluku, and Papua. Cluster III consists of the provinces of West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, West Java, Central Java, East Java, Banten, East Kalimantan, North Kalimantan, North Sulawesi, North Maluku, West Papua. Cluster IV consists of the provinces of Bangka Belitung Islands, Riau Islands, Jakarta, Yogyakarta, and Bali.

5. Suggestion

Investment in child health through a balanced nutrition program, especially for pregnant women to prevent stunting, needs to be done massively. Data collection on pregnant women by health workers needs to be carried out intensively so that programs related to education about nutrition and nutrition for pregnant women can target all pregnant women to remote areas.

References

Adji, A., Asmanto, P., & Tuhiman, H. (2019). Priority Regions for Prevention of Stunting. TNP2K Working Paper 47/2019. Jakarta, Indonesia, November, 1–28.

Ahsan, A., Bella, A., Kusuma, D., Thabrany, H., Ariany, R., Fattah, R., Relaksana, R., & Nugrahani, Y. (2022). Pengantar Ekonomi Kesehatan (Seri Ekono). PPJK Kementrian Kesehatan Republik Indonesia.

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., Onis, M. De, & Ezzati, M. (2013). Maternal and Child Nutrition 1 Maternal and child undernutrition and overweight in low-income and middle-income countries. 6736(13). https://doi.org/10.1016/S0140-6736(13)60937-X

Bloem, M. W., de Pee, S., Hop, L. T., Khan, N. C., Laillou, A., Minarto, Moench-Pfanner, R., Soekarjo, D., Soekirman, Solon, J. A., Theary, C., & Wasantwisut, E. (2013). Key strategies to further reduce stunting in Southeast Asia: lessons from the ASEAN countries workshop. Food and Nutrition Bulletin, 34(2 Suppl), 8–16. https://doi.org/10.1177/15648265130342s103

Currie, J. (2019). Child health as human capital. Health Economics, 1–12. https://doi.org/10.1002/hec.3995

Vol. 6, No.06; 2022

ISSN: 2456-7760

De Onis, M., Blössner, M., & Borghi, E. (2011). Prevalence and trends of stunting among pre-school children, 1990-2020. Public Health Nutrition, 15(1), 142–148. https://doi.org/10.1017/S1368980011001315

de Onis, M., & Branca, F. (2016). Childhood stunting: A global perspective. Maternal and Child Nutrition, 12, 12–26. https://doi.org/10.1111/mcn.12231

Dewey, K. G., & Begum, K. (2011). Long-term consequences of stunting in early life. Maternal and Child Nutrition, 7(SUPPL. 3), 5–18. https://doi.org/10.1111/j.1740-8709.2011.00349.x

Frakt, A. B. (2018). How the Economy Affects Health. Journal of the American Medical Association, 319(12), 1187–1188. https://newsatjama.jama.com/category /the-jama-forum/

Karyati, Y. (2021). Pengaruh Jumlah Penduduk Miskin , Laju Pertumbuhan Ekonomi , dan Tingkat Pendidikan terhadap Jumlah Stunting di 10 Wilayah Tertinggi Indonesia Tahun 2010-2019 Stunting merupakan salah satu target Sustainable Development Goals (SDGs) yang termasuk pada t. Journal Riset Ilmu Ekonomi Dan Bisnis, 1(2), 101–108. https://doi.org/https://doi.org/10.29313/jrieb.v1i2.401

Kemenkes RI. (2018). Buletin Stunting. Kementerian Kesehatan RI, 301(5), 1163–1178.

Kemenkes RI. (2019). Studi Status Gizi Balita. In Kementrian Kesehatan Republik Indonesia.

Kementerian Kesehatan RI. (2018). Buku Saku Pemantauan Status Gizi Tahun 2017. In Buku saku pemantauan status gizi tahun 2017 (pp. 7–11).

Mary, S. (2018). How much does economic growth contribute to child stunting reductions? Economies, 6(4). https://doi.org/10.3390/economies6040055

Oot, L., Sethuraman, K., Ross, J., & Diets, A. E. S. (2016). Food and Nutrition Technical Assistance III Project The Effect of Chronic Malnutrition (Stunting) on Learning Ability, a Measure of Human Capital : A Model in PROFILES for Country-Level Advocacy. February.

Prendergast, A. J., & Humphrey, J. H. (2014). The stunting syndrome in developing countries. Paediatrics and International Child Health, 34(4), 250–265. https://doi.org/10.1179/2046905514Y.0000000158

Reinbold, G. W. (2011). Economic inequality and child stunting in Bangladesh and Kenya: An investigation of six hypotheses. Population and Development Review, 37(4), 691–719. https://doi.org/10.1111/j.1728-4457.2011.00453.x

Vol. 6, No.06; 2022

ISSN: 2456-7760

Renyoet, B. S., Martianto, D., & Sukandar, D. (2016). Potensi Kerugian Ekonomi Karena Stunting Pada Balita Di Indonesia Tahun 2013. Jurnal Gizi Dan Pangan, 11(3), 247–254. https://doi.org/10.25182/jgp.2016.11.3.

Wahyuni, W. A., & Saepudin, S. (2021). Penerapan Data Mining Clustering Untuk Mengelompokkan Berbagai Jenis Merk Mesin Cuci. SISMATIK, 306–313. https://sismatik.nusaputra.ac.id/index.php/sismatik/article/view/35%0Ahttps://sismatik.nusaputra.ac.id/index.php/sismatik/article/download/35/31

WHO. (2010). Nutrition landscape information system (NLIS) Country Profile : Interpretation Guide. In World Health Organization. www.who.int/nutrition

Yaya, S., Uthman, O. A., Kunnuji, M., Navaneetham, K., Akinyemi, J. O., Kananura, R. M., Adjiwanou, V., Adetokunboh, O., & Bishwajit, G. (2020). Does Economic Growth Reduce Childhood Stunting ? a Multicountry Analysis of 89 Demographic and Health Surveys in Sub- - Saharan Africa. 1–7. https://doi.org/10.1136/bmjgh-2019-002042