








## Social determinants and risks factors of nutrition and health during the first thousand days on human capital in low-middle-income countries

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**Abstract:** Social determinants and risks factors of nutrition and health during the first thousand days on human capital in low-middle-income countries. Low-middle-income countries (LMICs) are facing challenges for reaching outstanding performance on indicators related to wellbeing during the first 1000 days of life, therefore it is expected to observe difficulties for improving their Human Capital Index (HCI). These come from the impact of inadequate antenatal care, maternal short stature, inadequate breastfeeding, prematurity, low birthweight, small for gestational age newborns, and pregnancy in adolescent years on human capital from the first thousand days of life to long term on life. Therefore, the aim of this study was to implement a non-systematic review of the existing literature between February 2000 and October 2022 using MeSH terms related to each factor. **Results:** in LMICs antenatal care does not meet the required goals. High rate of adolescent pregnancies, and lower maternal stature are being reported; 6.5 million newborns in LMICs are small for gestational age, 50% LBW newborns are preterm. Exclusive breastfeeding is low in LMICs: 28-70%. Survival, schooling, and health are strongly associated with growth and adult height showing the impact of the disadvantages experienced in early life over HC. We can conclude: the determinants of good health in the first 1000 days of life do not meet the goals needed to improve growth and health during this critical period of life in LMICs, leading to important obstacles for achieving adequate health conditions and reaching an optimal HCI. **Arch Latinoam Nutr 2024; 74(2): 129-140.**

**Keywords:** first one thousand days of life; human capital; low- middle-income countries; antenatal care; adolescent pregnancies; breastfeeding.

**Resumen:** Determinantes sociales y factores de riesgo de la nutrición y salud durante los primeros mil días de vida sobre el Capital Humano en países de bajo y medio ingresos. Los países con bajo y medianos ingresos (PBMIs) enfrentan el reto de disminuir las brechas para alcanzar las metas en los indicadores de bienestar durante los primeros 1000 días de vida, de lo contrario presentarán dificultades para mejorar los Índices de Capital Humano (ICH). El objetivo fue realizar una revisión no sistemática de la literatura reciente para abordar los problemas, brechas y omisiones dentro de los primeros 1000 días en los países PBMIs. Se utilizaron los términos MeSH relacionados con los factores de riesgo de impacto más prevalentes a corto y largo plazo: capital humano, atención prenatal inadecuada, talla baja materna, lactancia materna inadecuada, prematuridad, bajo peso al nacer, talla pequeña para la edad gestacional, embarazo adolescente para realizar una revisión descriptiva sobre el impacto de estos factores, entre febrero 2000-octubre 2022. **Resultados:** en PBMIs la consulta prenatal no llega a la meta sugerida y hay tasas altas de adolescentes embarazadas y baja estatura materna. 6,5 millones de recién nacidos en PBMIs con peso para la edad gestacional; 50% recién nacidos bajos para la edad gestacional son pretérminos. La lactancia materna exclusiva es baja en PBMIs: 28-70%. La supervivencia, escolaridad y salud tienen una fuerte asociación con la estatura y desarrollo del adulto, demostrando el impacto de las desventajas sobre el Capital Humano. **Conclusión:** los determinantes de la buena salud durante los primeros 1000 días de vida en los países PBMIs no alcanzan las metas necesarias para mejorar el crecimiento y la salud, convirtiéndose en obstáculos para alcanzar óptimos ICH. **Arch Latinoam Nutr 2024; 74(2): 129-140.**

**Palabras clave:** primeros mil días de vida; capital humano, países con bajos y medianos ingresos; control prenatal; embarazo en adolescentes; lactancia materna.

### Introduction

The first 1000 days of life is the period from conception until 2 years of age, and it is critical for fetal and child growth. Fetal development and health are impacted by maternal prenatal nutrition status and nutrition during pregnancy, which has an influence on the appearance of

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neuro developmental defects and increases the future risk of cardiovascular and metabolic diseases (1). Calories and nutrients such as protein, long-chain polyunsaturated fatty acids, short chain fatty acids, oligosaccharides, and micronutrients such as vitamins (folate, vitamins A, D, B1, B6, and B12), and minerals iron, zinc, choline, and iodine are necessary for proper neurodevelopment (2). Mother's nutritional status affects embryonic development and organogenesis during fetal growth along the first 2–8 weeks of pregnancy. Thereafter, during the last two trimesters, nutrients are accumulated by the fetus to be used after birth (3). Nutritional deficiencies during these first 1000 days are related to changes in developmental trajectories of the individual that affect cardiovascular, metabolic, developmental, and even immunological health (1,4-8).

In Low- and Middle-Income countries (LMICs) at least 200 million children fail to achieve their developmental potential associated mostly to under nutrition (9). An adequate knowledge of the factors that affect growth, development, and nutrition in this period of life, allows interventions to prevent adverse effects and promote optimal growth and health, and to breakdown the intergenerational transmission of diseases, thus achieving healthier individuals and societies (10).

On the other hand, Human Development Index (HDI) is a statistical tool used to measure a country's achievements in its social and economic levels, based on standard of living, measured by Gross National Income (GNI) per capita; education, determined by mean and expected years of schooling and health, measured by Life Expectancy. The countries with a high index, above 0.9 are from Europe, North America, Oceania, Southeast Asia; lower indices are found in Latin America, and the lowest in Africa (11,12).

Countries by Income are classified by the Organization for Economic Cooperation and Development (OECD). In 2022, a High-Income Country (HIC), was a country showing more than \$12,696 GNI per capita in US dollars currency. According to these categorizations,

HICs are USA and Canada, Europe, Australia, and New Zealand, a few in America and Asia and most of the world's countries are LMICs. However, countries and particularly LMICs are not all at the same level of development and per capita incomes, with important variabilities that goes from Low-income countries less than 1,045 US dollars per capita, to Low-Middle income with a GNI within 1,045 to 4,095 USD, and among those countries, huge disparities in terms of food security, access to health services, and education and health promotion can be observed (13). The HDI does not always coincide with the income, because it has three variables: health, income, and education level. The ten countries with the highest HDI are: Norway, Switzerland, Hong Kong, Iceland, Germany, Sweden, Australia, Netherlands, Ireland, and Denmark. The ten countries with the lowest HDI are from sub-Saharan Africa. The HDI in Latin America ranks high in Chile and Argentina, low in Bolivia and some Central American countries (13).

According to UNICEF in 2021 almost 200 millions of children under five were stunted; however, chronic undernutrition is being usually left behind when programs of assistance are implemented because results might not be immediate, compared to the outcomes in treating acute undernutrition, thus the need for thinking in parallel to recover kids from acute moderate and severe malnutrition while improving access for antenatal care, maternal nutrition, access to quality services that can alleviate the chronic malnourished children and improve the future health of these kids (14).

Achieving wellbeing in practical ways, continues to be an important challenge across LMICs, and particularly in terms of hunger, undernourishment, food security, access to health care and bringing attention to those in need in real time but also thinking in the consequences for the future of LMICs. Is well established that economic benefits from better nutrition in children under five exist. As stated by Alderman (15) preventing child malnutrition and improving maternal nutrition and health will be beneficial in terms of reducing cost for healthcare of newborns, gaining in productivities from increased cognitive abilities and intergenerational benefits through improved health of mothers. It is important to highlight that while improvements in stunting and acute undernutrition are still being reported, there is a long road to be transited to achieve economic growth, holistic development, health and ultimately: wellbeing. Because of this, there is a need to understand key missing pieces for developing

practical and achievable goals that translate into public effective actions (15).

Based on the authors' experience and medical publications it was considered a review of eight key elements: inadequate antenatal care, maternal short stature, breastfeeding practice (adequate or not), prematurity, prevalence of low birth weight, small-for-age newborns, and adolescent pregnancies in LMICs as determinants of consequences in the first 1000 days in the short term and over the human capital in the long term (16). Therefore, the to conclude with an interpretation aim of this project was to perform a literature review to address the latest knowledge that can give light for addressing the urgent needs of LMICs. This revision covers each of the eight proposed topics on how these elements are intertwined with wellbeing and human capital in the hope that policies and programs will be revised with a perspective of mid and long term.

### Materials and methods

Using MeSH terms related to the most prevalent impact risk factors in the first thousand days of life in the short and long term (first one thousand days, human capital, inadequate antenatal care, maternal short stature, inadequate breastfeeding, prematurity, low birth weight, small for gestational age, adolescent pregnancy) a nonsystematic literature review was performed. The search was carried out on the MEDLINE, PubMed, Google

Scholar TM and Lilacs platforms, in addition to cross references, to obtain articles that would allow a descriptive review to be carried out on the impact of each of the most prevalent risk factors in the first thousand days of life on human capital. Of all the articles obtained between February 2020 and October 2022, those that met the following criteria were selected: a. English or Spanish language; b. Meta-analysis, controlled studies, qualified review articles and epidemiological studies; c. Articles indexed on recognized platforms; d. Recognized authors in research (3 or more research articles published in journals); e. Results that allowed the objectives of the review to be met.

### Results

After reviewing each article, the aspects of each risk factor in the first thousand days on short- and long-term health and, subsequently, on human capital were compiled, and were crossed to look for similarities and differences. Finally, we reviewed the impact of these risk factors (one by one and together) on human capital. The search allowed us to obtain 210 articles which, when applying the selection criteria, were reduced to 84 articles as evidenced in Figure 1.

Determinant	Publications screened n= 210	Publications included n= 84	Publication excluded n= 126
First thousand days: introduction	n= 24	n= 14	n= 10
Inadequate antenatal care	n= 18	n= 9	n= 9
Adolescent pregnancies	n= 29	n= 18	n= 11
Maternal short stature	n= 22	n= 5	n= 17
Prematurity	n= 7	n= 4	n= 3
Low birth weight	n= 13	n= 4	n= 9
Small for gestational age	n= 11	n= 2	n= 9
Inadequate breastfeeding	n= 24	n= 10	n= 14
Growth, nutrition and adult outcomes and its relation to human capital	n= 62	n= 18	n= 44

**Figure 1.** Articles selected for review

Those 84 articles were obtained after a careful check on the criteria for inclusion: relevance for each subtopic and relation to Human Capital and excluding the publications that were either duplicated or not related to health determinants of human capital. The messages are described below and are categorized by each determinant. The authors agreed to describe one topic at a time, discuss, and interpret the findings on each section respectively.

#### *Inadequate antenatal care*

Prenatal care for pregnant women is recognized as a critical intervention for the good development of the health of the future mother as well as the fetus and the future health of her child. Interventions carried out in this period can make a difference in the evolution of the mother-child dyad, especially those associated with the diagnosis and intervention of intrauterine growth retardation and maternal malnutrition as well as those related to congenital or perinatal infections, metabolic disturbances (as obesity or diabetes) and hypertension. Delays in diagnosis and intervention can cause major complications in maternal, fetal, or neonatal health, which could have been prevented with adequate control, considering this period as one of very high vulnerability in the pregnant woman in addition to extremely rapid fetal growth and development dependent on your intrauterine environment (17,18).

Traditionally, antenatal care's goal has been more than 4 visits with an early onset during the first trimester; however, the updated goal is 8 or more consultations (17). The lowest levels of coverage are observed in sub-Saharan Africa (24%); in Western and Central Africa (53%), Eastern and Southern Africa, and South Asia (55%) (18).

In Latin America, 91% of women had at least four controls during pregnancy (18). The coverages are high (>90%) in Chile, Costa Rica, Cuba, Puerto Rico, Paraguay, Dominican Republic (19). In LMICs, such as Bolivia, Brazil, Ethiopia, Ghana, Kenya, Nigeria, and Nepal it differed according to education level, and

control attendance is lower in rural zones and in the poorest quintile (20); in Bolivia 85% of women with secondary education upwards attended prenatal clinics versus 14% with a lower level (21). Studies in Venezuela also reveal that lack of knowledge of its importance is prevalent in the lowest educational level (22, 23). A good control during pregnancy guarantees the follow-up of its good development, while it allows awareness and proper interventions, in the presence of any complications and, as stated by UNICEF, "antenatal care could save millions of pregnancies and newborns" (24,25).

#### *Adolescent pregnancies*

Adolescent pregnancy profoundly affects girls' health trajectories, their psychosocial development and contributes to poor health outcomes and elevated risks of maternal mortality and morbidity. Almost 95% of the 16 million adolescent pregnancies per year are in LMICs, where stunting is concentrated (26,27). The prevalence differs according to psychobiologic factors: education level, family integrity, permissive/non-permissive societies, presence/absence of life projects, sex education, and early sexual activity (28, 29). The negative consequences are small for gestational age newborns, prematurity, school dropout, lack of professional formation, high maternal and perinatal mortality, and poverty (30,31).

In LMICs, 252 million adolescent girls aged 15–19 are living, an estimated 38 million are sexually active and do not want a child in the next 2 years; unintentional pregnancies may end in abortions, which are often unsafe in this age group because of restrictive abortion laws or social factors (29). Africa is the highest in adolescent pregnancies, followed by Latin America and the Caribbean (LAC), with the second highest adolescent fertility rate in the world, estimated at 66.5 births per 1000 adolescents 15–19 years old for 2010–2015, with negative outcomes for newborns (preterm, LBW and SGA) compared to 46 births per 1000 adolescents in the same age group worldwide (29,32,33).

The nutritional risk in pregnant adolescents is significantly higher than non-adolescents, since growth has not been completed, energy, macro, and micronutrient requirements are increased; and prenatal check-ups occur later and are less frequent (34,35). Ganchimeg *et al.* analyzed a total of 124446 mothers and their infants were evaluated from 29 LMICs, and corroborated that adolescent mother had

higher risks of eclampsia, puerperal problems, low birthweight, and preterm delivery (34). In Colombia, undernutrition in pregnant adolescents duplicates adult women in terms of anemia, micronutrient deficiencies in early adolescence (10-14 years), toxemia, hypertension, maternal and perinatal mortality (36). In some LMICs, 31.2% of low birth weight (LBW) in pregnant adolescents, is twice as much as in adult women (34,37).

The importance of early sexual maturation in Latin American girls is also important to understand adolescent pregnancy, this fact is relevant for explaining the high prevalence within this group in the region (66.5/1000 adolescents), such as in Venezuela, where maturation is significantly earlier than that of Anglo-Saxon adolescents regarding the onset of puberty and menarche (38-42). In Venezuela in 2015, adolescent pregnancy rate was the highest in America (95/1000 adolescents), higher than that of the region and the world (30). Adolescent pregnancies constitute a multi sectorial social failure, which recycles poverty and increases underdevelopment, as pointed out by Sileo and Pérez Alonso in 2022 (43).

#### *Maternal short stature*

The median stature of women in South America is 158 cm and, in Central America it is 155 cm with several countries above the median while other countries, especially ones that have high autochthonous genetic frequencies, below the median; such is the case of Peru, Ecuador, Bolivia, Honduras, Guatemala and Nicaragua (44). Mothers with very short stature (less than 150.1 cm) are more likely to have a stunted child at two years of age, as well as prematurity, small for gestational age newborns, perinatal and maternal mortality. Approximately, 6.5 million small-for-dates (SFD) and or preterm birth in LMICs may be associated with short maternal stature (45-48).

#### *Prematurity*

The highest prematurity prevalence in LMICs is found in South Asia, Sub-Saharan Africa, and Southeast Asia. The global rate of prematurity is 10.4%, while in Latin America it is 9%. According to 47 studies from 27 LMICs, approximately half of LBW newborns is preterm. Small for gestational age newborns are very prevalent in LMICs and concentrated in South Asia (49-52).

#### *Low birthweight*

Low birthweight (LBW), as defined by the World Health Organization (WHO), as a weight at birth that is less than

2500 g. Newborns with LBW have a higher risk of neonatal mortality and are also at risk for stunting, poor neurodevelopment, and adult-onset diseases (53-55). Worldwide, an estimated 15-20% of all newborns weigh less than 2500 grams at birth, approximately 20.5 millions of babies. In Latin America and the Caribbean, the prevalence of LBW was 8.7% in 2015 (approximately 900 thousand babies in a year), it is high in Ecuador, Dominican Republic, and Central American countries and low in Chile, Cuba, and Costa Rica. This prevalence is quite higher than in more developed countries (7.3-7.6%), but lower than in low-income countries (14.3%). In numerical terms, implementing actions that reduce the prevalence of low birth weight by 10% would prevent low birth weight in 1.8 million children in low-income and middle-low-income countries. A major challenge in monitoring the incidence of LBW is that about 60% of newborn babies in LMICs are not weighed nor have birth weight recorded (56).

#### *Small for gestational age*

Small for gestational age and intrauterine growth restriction are important scenarios on maternal and fetal health, both associated with inadequate supply of nutrients, infections, or disturbances on mother's health. Implementation of effective interventions for babies born too small or too soon is urgent. Benefits associated with catch-up growth in infants who are born small should be considered for their possible short and long-term consequences, especially in neurodevelopment and growth (57). These authors, reported in Brazilian children small and adequate for gestational age, that a rapid weight gain, from birth to two years of life is associated with a lower risk of hospital admissions (diarrhea, pneumonia), and possibly with lower mortality (57).

Fetal as well as postnatal growth patterns are associated with body composition in early childhood. Studies on fat and lean mass strongly suggest that the risk of development of obesity and its main health consequences are at least partly established in fetal and early postnatal life (58).

### *Inadequate breastfeeding*

Exclusive breastfeeding (no other foods or water), early initiation (birth), and continued breastfeeding (12-23 months) is a specific action intended to have a direct impact on immediate determinants of nutrition. Exclusive breastfeeding (EBF) is one of six maternal, infant, and young child nutrition global targets adopted at the World Health Assembly in 2012, to be attained by 2025 (59). Late breastfeeding initiation and low exclusive breastfeeding rates characterize the patterns in most LMICs (60,61). In the great majority of countries, insufficient data is available to assess progress in achieving the WHO Global Nutrition Target for exclusive breastfeeding to at least 50% (59), and the recently updated WHO-UNICEF of at least 70% EBF prevalence by 2030 (62). Only 35 countries are on the right track for EBF target (63).

In low-income and middle-income countries, only 52% of children younger than 6 months of age are exclusively breastfed. However, rates of exclusive breastfeeding vary widely between and within LMICs; South Asia 61% and Bolivia 55.7%, while in Honduras 30.2%, Nicaragua 31.7%, and Nigeria 28.7% (61). Worldwide and Latin America and the Caribbean EBF 2015-2021, an estimated in 44% and 43% respectively (61, 64). Based on current trajectories, six LMICs (Perú, Burundi, Cambodia, Lesotho, Rwanda, and Sierra Leone) are projected to meet the WHO-UNICEF Global Nutrition Target of 70% EBF prevalence by the year 2030 at a national scale (65).

On average between 2015-2021, early initiation of breastfeeding in LMICs was 44% and continued breastfeeding 70% (61). Continued breastfeeding is more common in poor mothers than in wealthy mothers (60). When breastfeeding support is offered to mothers, the duration and exclusivity of breastfeeding is increased (66). In LMICs, delivery of any intervention to support breastfeeding, except telephone alone, will improve exclusive breastfeeding by approximately two-fold. Superior effects were obtained from interventions delivered by a combination of

professional and lay persons, in antenatal and post-natal intervention, and when intensity was between four to eight sessions (67). The cost of not breastfeeding is estimated to be \$302 billion in economic losses annually, or 0.49% of world gross domestic product, by contrast to amount of \$4.70 per live newborn needed to meet the WHO-UNICEF for EBF by 2025 (68).

### *Growth, nutrition and adult outcomes and its relation to human capital*

According to the Human Capital Project from the World Bank, Human Capital is “the knowledge, skills, and health that people invest in and accumulate throughout their lives, enabling them to realize their potential investing in nutrition, health care, quality education, jobs and skills will help to increase Human Capital, which is fundamental to guarantee inclusion within societies and ending poverty” (13).

In addition, the World Bank HC Project 2018 and the World Economic Forum, Davos 2017, describe 3 key components: Survival, Schooling, and Health that integrate the Human Capital Index (HCI) which is a “summary measure of the amount of Human Capital that a child born today can expect to acquire by age 18, given the risks of poor health and poor education that prevail in the country where she lives” (13).

The HCI focuses on the interpretation and analysis of the future worker productivity. Higher scores such as those found in Singapore, Hong Kong, Japan, South Korea also in America, and Europe; Canada, Finland, Sweden, Iceland, and Chile (the only country in Latin America in the first top 50) reflect, that children born in those countries have higher chances for being productive, than those where the index is 0.5, such as Morocco, indicating that a child born today will only have half of his/her potential to be fulfilled (69-71).

For the purposes of this article, nutrition and all the derivatives in terms of the benefits provided when a good nutritional status is achieved for pregnancies, newborns, adolescents, growth, and biological development, is taken as an umbrella which is central to some of the obtained results in education, and health. The argument that nutrition is an investment rather than a social grant is not new, and our team agrees with this, as recent evidence shows the collaboration between economists and biomedical researchers to provide information on the savings (economic, social, and biological) accounted from early nutrition interventions (15,72).

Pooled data from COHORTS (Consortium for Health Orientated Research in Transitioning Societies) from LMICs, in which mothers were recruited before or during pregnancy, and children followed up to adulthood, gave important information on the associations recorded. The associations were found between maternal age and offspring birth weight, gestational age at birth, height-for-age, and weight-for-height z-scores in childhood, attained schooling, adult height, body composition, body mass index, waist circumference, fat, and lean mass, also risk factors (blood pressure and fasting plasma glucose concentration) (73,74).

Young maternal age at childbearing ( $\leq 19$  years) is associated with an increased risk of preterm birth and intrauterine growth restriction, infant mortality, and undernutrition. Younger mothers breastfeed for a shorter duration, tend to have lower socioeconomic status, less schooling, and less stable partnerships. Promotion of weight gain in children with growth failure is an important goal, even though some studies suggest that rapid weight gain in the first two years is related to an increased risk of obesity, and cardio metabolic risk (75).

Catch-up-growth has been studied in developed countries (75), and not in underdeveloped countries, where final height is very important for Human Capital and the proper development of the society (57). This "catch-up dilemma" was addressed in high-income countries (HICs) (75), without a consideration of how growth affects adult outcomes (57). Considering that growth in height as a key indicator for the prediction of Human Capital in different environments, there is enough evidence that stature is the result of previous influences -advantageous or not- over an individual. It is thus important to consider the "catch-up dilemma" when considering nutrition interventions in different age groups (57,58).

The key question and challenge for pediatricians and policymakers ¿what is the age for promotion of growth for enhanced survival and improved Human Capital and if this will lead to an increase in cardio metabolic disease? It is an important one to be answered (76).

According to the World Bank, a 1% loss in adult height due to stunting in childhood is associated with a 1.4% loss of economic productivity (70). Children stunted 20% in growth, have less income than those without stunting (77, 78). Between 2017-2019, a prospective

follow-up of 1499 Guatemalan adults who participated in an early childhood trial (1969-1977) with the aim of identifying linear growth trajectories in early childhood; reported three growth trajectories: low, intermediate, and high. Those of high and intermediate growth were positively associated with the cognitive and socio-emotional functioning of the adult (79). Also, available evidence reports that breastfeeding enhances HC by having a positive effect on intelligence which is relevant to the first sustainable development goal (poverty), the fourth (education), and the eighth (inclusive economic growth) (60). In addition, an estimated between US\$ 257 billion and US\$ 341 billion are being lost of the total gross national income by not engaging in breastfeed practices (80).

Adair *et al.* in 2009, determined that there was an association between conditioned weight with increased blood pressure, when adjusted for height and Body Mass Index, conditioned weight in children was not associated with adult blood pressure. On the other hand, undernutrition was strongly associated with shorter adult height, less schooling, reduced economic productivity, and for women lower offspring birth weight (81).

Maternal stature was associated with birth weight and height, and the strongest associations were for stature in adulthood and at two years of age (46,82). Lean body mass is an important determinant of physical work capacity, with implications for productivity in physically demanding jobs; this study is an extension of the prior Guatemalan report and analyzes the follow-up data collected when the subjects were 21-27 years old and assess the relative importance of prenatal and postnatal growth for adult body size and composition (83).

Now, a new approach is being considered: the survival component until 20 years of age as an important measure to be included in addressing Human Capital (84), even though healthy growth and development during the first thousand days are key in consolidating the solid basis of health, skills, knowledge,

nutritional status, and learning that prevails until the end of the growth and maturation period. This statement is fundamental to consider the life course approach when addressing Human Capital and its influence (1).

### **Conclusions**

The intention of this review article was to investigate the impact of early life alterations that impact the future health of human beings, affecting the Human Capital of societies. In terms of equity, the large differences between more developed and less developed regions mean that Human Capital is uneven between them with the consequent differential in their development.

The authors working in one of the LMICs, which is Venezuela, have experience in the factors of the first thousand days of life that are detrimental to the normal growth and development of an individual. We have chosen this finding as a background to discuss how it affects Human Capital in the future.

These deficiencies and problems affecting nutrition during pregnancy and early life, have a high impact on individual health and development during the life course around the world, especially in LMICs. Inadequate antenatal care, adolescent pregnancies, maternal malnutrition and short stature, prematurity, low birth weight, small-for-date and inadequate breastfeeding are the most prevalent risk factors during the first 1000 days of life.

On the other hand, nutrition is an investment, not a grant; investments in children's physical, mental, and emotional development through nutrition, health care, and quality education are essential for the future productivity of individuals and countries. These situations have a clear impact on humans and on the development of countries: stunted adults are less productive, therefore, investment in health and social policies and programs are thus a priority for LMICs and Human Capital.

Rapid growth in early childhood is associated with short-term benefits for children from developing countries, which will have to be weighed against its possible long-term disadvantages. Follow-up studies are needed to assess in more detail whether and to what extent maternal anthropometrics, fetal and postnatal growth patterns, and nutrition influence body composition in later life. Therefore, a need to rethink on priorities that combine bringing assistance to the immediate needs while planning actions with outcomes to be revealed in middle and long terms are key to ensure the braking of vicious cycles of poverty-malnutrition-health-education, so LMICs can see an improvement in their Human Capital in the future.

### **Conflict of interest**

All authors declare that we have no conflict of interest in this article.

### **References**

1. Vasan RS, Zachariah JP, Xanthakis V. Life course developmental approach to ideal cardiovascular health and cardiovascular disease prevention: opportunities and unanswered questions. *J Am Coll Cardiol.* 2020; 23:2708–2711. doi: 10.1016/j.jacc.2020.10.011.
2. Schwarzenberg SJ, Georgieff MK and Committee on Nutrition. Advocacy for improving nutrition in the first 1000 days to support childhood development and adult health. *Pediatrics.* 2018;141(2): e20173716. doi: 10.1542/peds.2017-3716.
3. Beluska-Turkan K, Korczak R, Hartell B, Moskal K, Maukonen J, Alexander DE, et al. Nutritional gaps, and supplementation in the first 1000 days. *Nutrients.* 2019;11(12):2891. doi.org/10.3390/nu11122891.
4. Hanley B, Dijane J, Fewtrell M, Grynberg A, Hummel S, Junien C, et al. Metabolic imprinting, programming, and epigenetics: a review of present priorities and future opportunities. *Br J Nutr.* 2010;104(Suppl 1): S1-25. doi.org/10.1017/s0007114510003338.
5. Esquivel-Lauzurique M, Álvarez-Valdés G, Castro-Pacheco BL, Santana-Espinosa MC, Machado-Lubián MC, Herrera-Alcázar V. Comprehensive care for Cuban children in the first 1000 days of life. *MEDICC Rev.* 2019;21(1):30-35.
6. Gómez G, Nogueira Predivelli A, Fisberg RM, Kovalskys I, Fisberg M, Herrera-Cuenca M, on behalf of the ELANS Study Group. Dietary diversity and micronutrients adequacy in women of childbearing age: Results from ELANS Study. *Nutrients.* 2020;12(7):1995. doi.org/10.3390/nu12071995.
7. Macías-Tomei C, Rached Sosa I, Apitz-Castro R, Taboada MC, Salmen T, Sileo E. Consumo de nutrientes



- en embarazo y lactancia. Evaluación en mujeres embarazadas. ArchVenez Puer Ped. 2020; 83(Supl.4):12-24.
8. Herrera-Cuenca M, Nogueira Previdelli A, Koletzko B, Hernández P, Landaeta-Jiménez M, Sifontes Y, and on behalf of the ELANS Study Group. Childbearing age women characteristics in Latin America. Building evidence bases for early prevention. Results from the ELANS Study. *Nutrients*. 2021; 13:45. doi.org/10.3390/nut13010045.
  9. Mayneris-Perxachs J, Swann JR. Metabolic phenotyping of malnutrition during the first 1000 days of life. *Eur J Nutr*. 2019;58(3):909-930. doi: 10.1007/s00394-018-1679-0.
  10. Macías-Tomei C, López-Blanco M, Castro MJ, Mariño Elizondo M Izaguirre-Espinoza I. A life course approach in the Venezuelan consensus on nutrition in the first 1000 days of life. Presented at the Joint International Meeting: 22nd EAA Congress- 15th ISGA Congress-5th International Conference of Evolutionary Medicine; 2022 Aug 24-27; Vilnius, Lithuania. Abstract Book. Vilnius University Press; 2022. p. 117.
  11. United Nations. Human development country rankings; 2021 [cited 2022 Mar 22]. Available in: [https://www.theglobaleconomy.com/rankings/human\\_development/SouthAmerica/2021](https://www.theglobaleconomy.com/rankings/human_development/SouthAmerica/2021).
  12. World Population Review. Human Development Index (HDI) by country; 2022 [cited 2022 Mar 22]. Available in: <https://worldpopulationreview.com/country-rankings/hdi-by-country>.
  13. World Bank. The world by income and region; 2021 [cited 2022 Mar 22]. Available in: <https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html>.
  14. UNICEF-WHO-World Bank. Joint child malnutrition estimates/level and trends; 2021 [cited 2022 Sept 20]. Available in: <https://data.unicef.org/topic/nutrition/malnutrition/>.
  15. Alderman H. The economic cost of a poor start to life. *J Develop Origins Health Dis*. 2010;1(1):19-25. doi.org/10.1017/S2040174409990158.
  16. López-Blanco M, Macías Tomei C, Dini Golding E, Castro MJ. 2022. Problems, omissions, and gaps in the first 1,000 days of life in low and middle-income countries. Conference presented at the Joint International Meeting: 22nd EAA Congress- 15th ISGA Congress-5th International Conference of Evolutionary Medicine; 2022 Aug 24-27; Vilnius, Lithuania. Abstract Book. Vilnius University Press; 2022. p. 49.
  17. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. Summary: Highlights and Key Messages from the World Health Organization's 2016. Global Recommendations for Routine Antenatal Care. Geneva, 2016.
  18. UNICEF. Global databases: Antenatal care based on MICS, DHS, and other nationally representative household survey data. 2022. [cited 2022 Apr 10]. Available in: <https://data.unicef.org/topic/maternal-health/antenatal-care/>.
  19. Dini Golding E, López-Blanco M, Macías-Tomei C, Pérez Alonso MM. Problems, omissions, and gaps in the first 1000 days of life in Latin America. Presented at the Joint International Meeting: 22nd EAA Congress- 15th ISGA Congress-5th International Conference of Evolutionary Medicine; 2022 Aug 24-27; Vilnius, Lithuania. Abstract Book. Vilnius University Press; 2022. p. 82.
  20. Woldeamanuel BT. Factors associated with inadequate prenatal care service utilization in Ethiopia according to the WHO recommended standard guidelines. *Front Public Health*. 2022; 10:998055. doi: 10.3389/fpubh.2022.998055.
  21. Bueckens P, Hernández P, Infante C. La atención prenatal en América Latina. *Rev Salud Pub México*. 1990; 32:673-689.
  22. Faneite P, Rivera C, González M, Linares M, Faneite J. ¿Por qué no se controla la embarazada? *Rev Obstet Ginecol Venez*. 2002;62(2):77-81.
  23. Faneite P, Rivera C, Rodríguez F, Rosanna A, Moreno S, Cangemi L. Consulta prenatal: ¿motivos de inasistencia, se justifica? *Rev Obstet Ginecol Venez*. 2009;69(3):147-151.
  24. United Nations Children's Fund (UNICEF). The Progress 2000 of Nations. Antenatal care could save millions. New York (NY), 2000.
  25. United Nations Children's Fund. UNICEF Global databases. New York (NY), 2016.
  26. United Nations. Department of Economic and Social Affairs, Population Division 2015. World Fertility Patterns. New York (NY), 2015. [cited: 2022 Feb 24]; Available in: <https://www.un.org/en/development/desa/population/publications/pdf/fertility/worldfertility-patterns-2015.pdf>.
  27. Johnson W, Moore SE. Adolescent pregnancy, nutrition, and health outcomes in low-and middle-income countries: what we know and what we don't know. *BJOG*. 2016;123(10):1589-1592. doi: 10.1111/1471-0528.13782.
  28. Gómez PI, Molina R, Zamberlin N, Távara L. Factores relacionados con el embarazo y la mortalidad en menores de 15 años en América Latina y el Caribe. Orozco LT, editor. Lima: FLASOG; 2011.
  29. Pan American Health Organization-World Health Organization-UNFPA-UNICEF. Accelerating progress toward the reduction of adolescent pregnancy in Latin American and the Caribbean. Report on a Technical Consultation. 2016. Washington, D.C., August 29-30.
  30. Moreno Olmedo A. La familia popular venezolana: Temas de formación sociopolítica. Fundación Centro Gumilla, editor. Caracas: Publicaciones UCAB. Imprenta Minipres; 2012.

31. Quintero Rondón AP, Rojas Betancur HM. El embarazo a temprana edad, un análisis desde la perspectiva de madres adolescentes. *Rev Virtual Universidad Católica del Norte*[internet]. 2015 Jun; [cited 2022, Febr 10];44:222-237. Available in:<http://revistavirtual.ucn.edu.co/index.php/RevistaUCN/article/view/626/1161>.
32. Observatorio de Políticas Sociales y Desarrollo. Embarazo y Adolescencia en República Dominicana. Santo Domingo 2017. Vicepresidencia de la República Dominicana.
33. Hudda MM, O'Flaherty M, Finlay JE, Al Mamun A. Time trends and sociodemographic inequalities in the prevalence of adolescent motherhood in 74 low-income and middle-income countries: a population-based study. *Lancet Child Adolesc Health.*2021;5: 26-36.doi: 10.1016/S2352-4642(20)30311-4.
34. Ganchimeg T, Ota E, Morisaki N, Laopaiboon M, Lumbiganon P, Zhang J, et al. Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multi-country study. *BJOG.* 2014;121(Supp 1):40-48. doi: 10.1111/1471-0528.12630
35. Francisco J. Embarazo en Adolescentes en Venezuela. Reconsideración del problema. En: Díaz Bruzual A, López Loyo ES, editores. Academia Nacional de Medicina de Venezuela. Caracas: Editorial Ateproca; 2018.Vol. XXII. p. 1-35.
36. Sarmiento OL, Ramirez A, Kutschbach BS, Pinzon PL, Garcia S, Olarte AC, et al. Nutrition in Colombian pregnant women. *Public Health Nutr.*2012;15(6):955-963. doi:10.1017/S1368980011003399.
37. Atalah Samur E. Enfoque epidemiológico y nutricional de la embarazada adolescente. *Nutrición en el embarazo. Arch Latinoam Nutr.* 2015;65(Supl 1):188.
38. López Blanco M. Growth as a mirror of conditions in a developing society: The case of Venezuela. In: Hauspie R, Lindgren G, Falkner F, editors. *Essays on Auxology.* Presented to James Mourilyan Tanner. Welwyn Garden City, UK: Castlemead Publ; 1995a. p. 312-331.
39. López-Blanco M, Landaeta Jiménez M, Izaguirre-Espinoza I, Macías-Tomei C. Crecimiento y Desarrollo Físico. En: Méndez Castellano H, editor. *Estudio Nacional de Crecimiento y Desarrollo Humanos de la República de Venezuela.* Caracas: Escuela Técnica Popular Don Bosco, Ed. Salesiana; 1995b. p. 755-773.
40. Sileo E. Pubertad: variantes normales, patológicas y características principales. En: Terán Dávila J, Febres Balestrini F, editores. *Endocrinología Ginecológica y Reproducción Humana.* Caracas: Editorial Ateproca; 1995. p. 17-25.
41. Macías-Tomei C, López-Blanco M, Espinoza I, Vásquez-Ramírez M. Pubertal development in Caracas upper middle-class boys and girls in a longitudinal context. *Am J Hum Biol.*2000;12(1):88-96. doi: 10.1002/(SICI)1520-6300(200001/02)12:1<88::AID-AJHB10>3.0.CO;2-H
42. Macías-Tomei C. Maduración Sexual: Comparación con valores de referencia nacionales e internacionales. En: López M, Izaguirre I, Macías C, editores. *Crecimiento y Desarrollo: Bases para el Diagnóstico y Seguimiento Clínico.* Caracas: Editorial Médica Panamericana; 2013. p. 179-187.
43. Sileo E, Pérez Alonso MM. Embarazo en adolescentes menores de 15 años: ¿un problema social? [disertación]. Caracas: Academia Nacional de Medicina de Venezuela; 2022.
44. Rodríguez-Martínez A, Zhou B, Sophiea MK, Bentham J, Paciorek CJ, Lurilli ML, et al. NCD Risk Factor Collaboration (NCD-RisC). Height and body-mass index trajectories of school-aged children and adolescents from 1985 to 2019 in 200 countries and territories: apooled analysis of 2181 population-based studies with 65 million participants. *Lancet.*2020;396(10261):1511-1524. doi: 10.1016/S0140-6736(20)31859-6.
45. Barros FC, Barros AJD, Villar J, Matijasevich A, Domingues MR, Victora CG. How many low birthweight babies in low- and middle-income countries are preterm? *Rev Saúde Pública.* 2011;45(3):607-616. doi: 10.1590/s0034-89102011005000019.
46. Addo OY, Stein AD, Fall CH, Gigante DP, Guntupalli AM, Horta BL, et al and Consortium on Health Orientated Research in Transitional Societies (COHORTS) Group et al. Maternal height and child growth patterns. *J Pediatr.* 2013;163(2):549-554. <https://doi.org/10.1016/j.jpeds.2013.02.002>.
47. Lee AC, Katz J, Blencowe H, Cousens S, Kozuki N, Vogel JP, et al. National and regional estimates of term and preterm babies born small for gestational age in 138 low-income and middle-income countries in 2010. *Lancet Glob Health.* 2013;1(1):e26-36. doi:10.1016/S2214-109X(13)70006-8.
48. Kozuki, N, Katz J, Lee ACC, Vogel JP, Silveira MF, Sania A, et al. Short maternal stature increases risk of small-for-gestational-age and preterm births in low- and middle-income countries: individual participant data meta-analysis and population attributable fraction. *J Nutr.* 2015;145(11):2542-2550. doi: 10.3945/jn.115.216374
49. Vogel PL, Lee ACC, Souza JP. Maternal morbidity and preterm birth in 22 low- and middle-income countries: a secondary analysis of the WHO Global Survey dataset. *BMC Pregnancy Childbirth.* 2014; 14:56. doi:10.1186/1471-2393-14-56
50. Laelago T, Yohannes T, Tsige G. Determinants of preterm birth among mothers who gave birth in East Africa: systematic review and meta-analysis. *Ital J Pediatr.* 2020; 46:10.doi.org/10.1186/s13052-020-0772-1
51. Walani SR. Global burden of preterm birth. *Obgyn.* 2020;150: 31-33.doi.10.1002/ijgo.13195.
52. Martinelli KG, Soares Dias BA, Lemos Leal M, Belotti L, Garcia EM, Dos Santos Neto ET. Prematuridade no Brasil entre 2012 e 2019: dados do Sistema de Informacoes

- sobre Nascidos Vivos. *Rev Bras Est Pop.* 2021;38(1-15): e0173. doi.org/10.20947/S0102-3098a0173.
53. Christian P, Lee SE, Donahue AM, Adair LS, Arifeen SE, Ashorn P, et al. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. *Int J Epidemiol.* 2013;42(5):1340-1355. doi: 10.1093/ije/dyt109.
  54. Jornayvaz FR, Vollenweider P, Bochud M, Mooser V, Waeber G, Marques Vidal P. Low birth weight leads to obesity, diabetes, and increased leptin levels in adults: the CoLaus study. *Cardiovasc Diabetol.* 2016; 15:73. doi: 10.1186/s12933-016-0389-2.
  55. Gu H, Wang L, Liu L, Luo X, Wang J, Hou F, et al. A gradient relationship between low birth weight and IQ: a meta-analysis. *Sci Rep.* 2017;7(1):18035. doi: 10.1038/s41598-017-18234-9.
  56. United Nations Children's Fund-World Health Organization. *Low birthweight estimates: Levels and trends 2000-2015.* Geneva, 2019. World Health Organization (License: CC BY-NC-SA 3.0 IGO).
  57. Victora CG, Barros FC, Horta BL, Martorell R. Short-term benefits of catch-up growth for small for gestational age infants. *Internat Epidemiol Assoc.* 2001; 30:1325-1330.
  58. Ay L, van Houten VA, Steegers EAP, Hofman A, Witteman JCM, Jaddoe VWV, et al. Fetal and postnatal growth and body composition at 6 months of age. *J Clin Endocrinol Metab.* 2009;94(6):2023-2030. doi: 10.1210/jc.2008-2045
  59. World Health Organization. *Global Nutrition Targets 2025.* Policy Brief Series. 2014 [cited 2022 Aug 10]. Available in: <https://apps.who.int/nutrition/global-target-2025/en>.
  60. Victora CG, Bahl R, Barros A, Franca G, Horton S, Krasovec J. Lancet Breastfeeding Series Group. Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelength effect. *Lancet.* 2016; 387:475-490. doi.org/10.1016/S0140-6736(15)01024-7
  61. United Nations Children's Fund. *Breastfeeding.* UNICEF 2022. [cited 2022 Oct 01]; Available in: <https://data.unicef.org/topic/nutrition/breastfeeding>.
  62. WHO / UNICEF. *The Extension of the 2025 maternal, infant, and young child nutrition targets to 2030.* World Health Organization. 2018; [cited 2022 Oct 1]. Available in: <https://www.who.int/nutrition/global-target-2025/discussion-paper-extension-targets2030.pdf?ua=1>.
  63. *2021 Global Nutrition Report: The state of global nutrition.* Bristol, UK: Development initiatives. 2021. [cited 2022 Oct 22]. Available in: [https://globalnutritionreport.org/documents/851/2021\\_Global\\_Nutrition\\_Report\\_aUfTRv0.pdf](https://globalnutritionreport.org/documents/851/2021_Global_Nutrition_Report_aUfTRv0.pdf); 106 p.
  64. Mazariegos M, Ramírez Zea M. Lactancia materna y enfermedades crónicas no transmisibles en la vida adulta. *Arch Latinoam Nutr.* 2015;65(3):143-151.
  65. Bhattacharjee NV, Schaeffer Exclusive. *Breastfeeding faces continued challenges in Low-and Middle-Income countries.* 2021. [cited 2022 Sept 19]. Available in: <https://www.thinkglobalhealth.org/article/exclusive-breastfeeding-faces-continued-challenges-low-and-middle-income-countries>.
  66. McFadden A, Gavine A, Renfrew MJ, Wade A, Buchanan P, Taylor JL, et al. Support for healthy breastfeeding mothers with healthy term babies (Review). *Cochrane Database of Systematic Reviews.* 2017;2: CD001141. doi.org: 10.1002/14651858.CD001141.pub5.
  67. Olufunlayo TF, Roberts AA, MacArthur C, Thomas N, Odeyemi KA, Price M, et al. Improving exclusive breastfeeding in low and middle-income countries: A systematic review. *Matern Child Nutr.* 2019;15(3): e12788. doi:10.1111/mcn.12788.
  68. Bhattacharjee NV, Schaeffer LE, Hay SI, Kusuma D and Local Burden of Disease Exclusive Breastfeeding Collaborators. Mapping inequalities in exclusive breastfeeding in low- and middle-income countries, 2000-2018. *Nat Hum Behav.* 2021; 5: 1027-1045. doi: 10.1038/s41562-021-01108-6.
  69. World Economic Forum. *The Global Human Capital Report 2017. Preparing people for the future of work.* New York (NY) 2017.
  70. World Bank. *The Human Capital Project: Frequently Asked Questions: What is Human Capital and why does it matter? (Last edition 2022)* [cited 2022 Oct 12]. Available in: <https://www.worldbank.org/en/publication/human-capital/brief/the-human-capital-project-frequently-asked-questions#HCP2>.
  71. Herrera Cuenca M, Mariño Elizondo M, López-Blanco M. *Human capital and malnutrition in Latin America: the challenge of the XXI century.* Presented at the Joint International Meeting: 22nd EAA Congress- 15th ISGA Congress- 5th International Conference of Evolutionary Medicine; 2022 Aug 24-27; Vilnius, Lithuania. Abstract Book. Vilnius University Press; 2022. p. 92.
  72. Alderman H, Behrman JR. Reducing the incidence of low birth weight in low-income countries have substantial economic benefits. *The World Bank Research Observer.* 2006;21(1):25-48. doi.org/10.1093/wbro/lkj001
  73. Victora CG, Adair A, Fall C, Hallal PC, Martorell R, Richter L, et al and Maternal and Child Undernutrition Study Group. Maternal and child undernutrition: consequences for adult health and human capital. *Lancet.* 2008; 26:371(9609):340-357. doi: 10.1016/S0140-6736(07)61692-4.
  74. Fall C, Singh SH, Osmond C, Restrepo-Mendez MC, Victora C, Martorell R, et al and the COHORTS Group. Association between maternal age at childbirth and child and adult outcomes in the offspring: a prospective study in five low-income and middle-income countries (COHORTS collaboration). *Lancet Glob Health.* 2015;3(7): e366-377. doi:10.1016/S2214-109X(15)00038-8.

75. Eriksson JG, Forsen T, Tuomilehto J, Osmond C, Barker DJP. Early growth and coronary heart disease in later life: a longitudinal study. *Br Med J.* 2001;322(7292):949-953. doi:10.1136/bmj.322.7292.949.
76. Adair LS, Fall C, Osmond C, Stein AD, Martorell R, Ramirez-Zea M, et al and the COHORTS group. Associations of linear growth and relative weight gain during early life with adult health and human capital in countries of low and middle income: findings from five birth cohort studies. *Lancet.* 2013;382(9891):525-534. doi:10.1016/S01406736(13)60103-8
77. Martorell R, Horta BL, Adair LS, Stein AD, Richter L, Fall CHD, et al and Consortium on Health Orientated Research in Transitional Societies Group. Weight gain in the first two years of life is an important predictor of schooling outcomes in pooled analyses from five birth cohorts from low- and middle-income countries. *J Nutr.* 2010;140(2):348-354. doi:10.3945/jn.109.112300
78. Mangialavori G, Abeyá Gilardon E, Biglieri Guidet A, Durán P, Kogan L. La alimentación de los niños menores de 2 años. Resultados de la Encuesta Nacional de Nutrición y Salud-ENNyS 2000-2009. Ministerio de Salud, Presidencia de la Nación. Los primeros 1000 días de vida. Una ventana de oportunidad para el desarrollo del país. *Rev Exp.* 2017:16-19.
79. Ramírez-Luzuriaga MJ, Hoddinott J, Martorell R, Patel SA, Ramírez-Zea M, Waford R, et al. Linear growth trajectories in early childhood and adult cognitive and socioemotional functioning in a Guatemalan cohort. *J Nutr.* 2021; 151:206-213. doi:10.1093/jn/nxaa337.
80. Walters DD, Phan LTH, Mathisen R. The cost of not breastfeeding globally results from a new tool. *Health Policy Plan.* 2019;34(6):407-417. doi:10.1093/heapol/czz050.
81. Adair LS, Martorell R, Stein AD, Hallal PC, Sachdev HS, Prabhakaran D, et al for the COHORTS group. Size at birth, weight gain in infancy and childhood, and adult blood pressure in 5 low- and middle-income-country cohorts: when does weight gain matter? *Am J Clin Nutr.* 2009;89(5):1383-1392. doi: 10.3945/ajcn.2008.27139.
82. Stein AD, Barros FC, Bhargava SK, Hao W, Horta BL, Lee N, et al and Consortium of Health-Orientated Research in Transitioning Societies (COHORTS) investigators. Birth status, child growth, and adult outcomes in low- and middle-income countries. *J Pediatr.* 2013;163(6):1740-1746. doi: 10.1016/j.jpeds.2013.08.012.
83. Li H, Stein AD, Barnhart HX, Ramakrishnan U, Martorell R. Associations between prenatal and postnatal growth and adult body size and composition. *Am J Clin Nutr.* 2003;77(6):1498-1505. doi: 10.1093/ajcn/77.6.1498.
84. Black RE, Liu L, Hartwig FB, Villavicencio F, Rodriguez-Martinez A, VIDALETTI LP, et al. For Optimizing child and adolescent health and development Series 1. *Lancet.* 2022; 399:1730-1740. doi.org/10.1016/S0140-6736 (21)02533-2.

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