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A Comprehensive Roadmap for Reversing Under-Five Malnutrition on the Arab States Based on the Sustainable Development Goals

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Abstract

Introduction: Eradicating malnutrition, which is a global problem, is one of the 17 Sustainable Development Goals (SDGs) established by the United Nations. Identifying indicators that can predict and prevent malnutrition is important for ensuring physical and mental health of children. **Aim:** To analyze and identify the SDG indicators of Arab States influencing stunting, as an indicator of malnutrition, among children under-five of age. **Methods:** Indices representing nutrition-related SDG indicators were compiled from global SDG data for 22 countries of the Arab region. Of all SDG indicators, 76 relevant indicators covering the 17 SDGs were identified and compiled from the global database of UNDP. Descriptive analysis was used to correlate the indicators of stunting (using height-for-age below 2 standard deviation score) with 77 SDG indicators. The associations were presented as graphic illustrations. **Findings:** Almost two-thirds of the SDG indicators showed some association with stunting [47 (61%)]. The associations varied by level of income. High income countries (HIC) performed better than the low income countries (LIC). Middle income countries (MIC) were staggering to move towards the HIC. All the SDGs had at least 2 or more indicators that correlated with stunting. The most significant indicator that was associated with nutrition was the corruption index for SDG16: "Peace, Justice and Strong Institutions", which was reversely correlated with stunting. **Conclusions:** All the 17 SDGs are integral for reversing malnutrition and can be integrated into a comprehensive roadmap for reversing malnutrition. The high correlation with SDG17 indicates that the situation of conflict in the Arab countries is one of the major holdbacks for development. Peace and justice are a mandate for preventing malnutrition in children and its consequences in this region.

1. Introduction

The Sustainable Development Goals (SDGs) include 17 goals which were developed by the UN General Assembly in 2015 (U.N., 2015). They have 169 targets and are monitored by 230 indicators as a means for driving progress towards achieving the goals presented by the UN Statistical Commission through the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs, 2016) to be achieved by 2030 (Bayoumi et al., 2022). Nutrition by ending hunger (SDG2) is a core dimension of the SDGs. Target 2.2: states that by 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age (de Onis et al., 2013). The reduction of child stunting is also the first of six goals in the Global Nutrition Targets for 2025 (WHO Resolution WHA65.6, 2012) and a key indicator in the second SDG of Zero Hunger (WHO, 2012).

Global estimates of stunting indicate that a considerable percent of children under five are stunted (1 in five), particularly in low income countries (LIC) and middle income countries (MIC) (UNICEF, 2019). Estimates of 149 billion stunted children indicate that these figures may have drastic effects on the economy of nations. In the Eastern Mediterranean region (EMR) the average weighted rate of stunting is 28% (Nasreddine et al., 2018) being the highest in LIC (Al-Jawaldeh et al., 2020). Stunting has devastating consequences on child development (Dewey & Begum, 2011). These children as adults may earn 20 per cent less than their non-stunted peers, (UNICEF, 2019) and stunting can reduce a country's gross domestic product by up to 3 per cent (Victora et al., 2010). Stunting and child growth deficits are difficult to reverse, while cognitive deficits may be permanent after two years (Fink et al., 2016).

Arab nations living in conflict are struggling to maintain development. Their progress in SDGs as indicated by the indicators, is slow and many challenges face these countries as shown in the report for the Arab SDG index and dashboard in 2022 (Bayoumi et al., 2022). Improving children's nutritional status is the foundation of sustainable and prosperous societies and paramount to achieving the 2030 "Sustainable Development Goals" (SDGs), including Goal 2 to improve nutrition and end all forms of malnutrition. Eliminating stunting supports the achievement of SDG targets on ending preventable childhood deaths and eliminating poverty, among others. In addition, improving children's nutritional status is central to addressing three of the six World Health Assembly (WHA) targets for reducing stunting in children under five years of age by 40% by 2025 (de Onis et al., 2013).

Several factors underlie the problem of stunting. Consistent evidence suggests nonexclusive breastfeeding for the first 6 months, low household socio-economic status, premature birth, short birth length, and low maternal height and education are particularly important child stunting determinants in middle and low income countries (Danaei et al., 2016). Children from households with both unimproved latrines and untreated drinking water are also at increased risk (Torlesse et al., 2016). However other factors than nutrition play a role in stunting. Community and societal factors—particularly, poor access to health care and living in areas of ongoing conflict and famines—have been repeatedly associated with child stunting (Argaw et al., 2019; Beal et al., 2018). Hence it is important to develop a more comprehensive and holistic overview of how to tackle the problem of malnutrition from a multidisciplinary, multidimensional approach.

The 17 SDGs approach the problems of human development from a more holistic overview. Hence the aim of this study is to identify SDG indicators inputs that crosscut with stunting in order to guide countries in the Arab region on how to manage and prevent stunting in children under five years of age.

2. Methods

Data about the SDGs in 22 countries of the Arab were compiled from the SDG global database. The countries were categorized by level income as per the World Bank classification. The 7 low income countries (LIC) included Djibouti, Comoros, Mauritania, Sudan, Somalia, Syrian Arab Republic and Yemen. The 9 middle income countries (MIC) included Algeria, Egypt, Iraq, Jordan, Lebanon, Libya, Morocco, State of Palestine and Tunisia. The six high income countries (HIC) of the gulf region included Bahrain, Kuwait, Qatar, Saudi Arabia, Sultanate of Oman and United Arab Emirates (UAE). Data for the State of Palestine source (https://www.pcbs.gov.ps/pcbs_2012/Publications.aspx). Other data source was obtained from the UNDP global database (Bayoumi et al., 2022). Stunting is measured by the percent prevalence of stunting in children under five years of age, whereby stunting is defined as below −2 SDs from the median height-for-age of the reference population using the WHO growth standards (WHO, 2006). Indices representing nutrition-related SDG indicators were compiled from global SDG data for the 22 Arab states of the Arab League. The relevant indicators for each of the 17 SDGs were compiled from the global database of UNDP included SDG1 (4), SDG2 (8), SDG3 (11), SDG4 (3), SDG5 (7), SDG6 (4), SDG7 (2), SDG8 (4), SDG9 (6), SDG10 (2), SDG11 (4), SDG12 (4), SDG13 (1), SDG14 (5), SDG15 (3), SDG16 (7), SDG17 (2) with a total of 77 indicators representing the targets of the 17 SDGs. They were correlated with stunting and income group through descriptive analysis. The source of data from 2022 Arab Region SDG Index and Dashboard Report and Cambridge University SDG report in 2022 (Bayoumi et al., 2022).

The SDGs and their relevant indicators which were selected in this study are presented in Table 1. Data was compiled in Microsoft Excel sheets for version of 2019 and descriptive analysis was used to present the data into line charts. Since

these were secondary data and raw data was not accessible statistical analysis was not permissible and descriptive analysis of the rates and percentages was used as the basis of our qualitative analysis. Correlations were either positive or negative based on the directions of the associations with stunting. Correlations were either high (if above 0.6) or moderate (around 0.5) or low (if below 0.4). Correlations were used as a mean of descriptive analysis and not for statistical analysis. The degree of association was presented using line charts and trend lines to indicate the direction of the association. Countries with data for the relevant indicator ranged from 22 to 15.

Table 1. The sustainable development goals and relevant indicators used in this study for the Arab countries.

Sustainable Development Goal (SDG)	Relevant Indicators of SDGs used for this study
SDG1: End poverty in all its forms everywhere	Poverty rate; Poverty headcount ratio $1.9; Poverty headcount ratio $3.2 and children living under poverty line.
SDG2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	Stunting is measured by the prevalence of stunting in children under age 5 years, % whereby Stunting is defined as below −2 SDs from the median height-for-age of the reference population. Wasting (2.2.2a) Prevalence of wasting in children under age 5 years, % Wasting is defined as below −2 SDs from the median weight-for-height of the reference population. The indicator 2.2.2 was separated into wasting (2.2.2a) and overweight (2.2.2b).
SDG3: Good health and well-being	Maternal mortality rate (per 100,000 live births); Neonatal mortality rate (per 1000 live births); Mortality rate, under-5 (per 1000 live births); Incidence of tuberculosis (per 100,000 population); Age-standardized death rate due to cardiovascular disease, cancer, diabetes, or chronic respiratory disease in adults aged 30 - 70 years (%); Age-standardized death rate attributable to household air pollution and ambient air pollution (per 100,000 population); Births attended by skilled health personnel (%); Universal health coverage (UHC) index of service coverage (worst 0 - 100 best); Subjective well-being (average ladder score, worst 0 - 10 best).
SDG4: Quality Education	Net primary enrollment rate (%); Lower secondary completion rate (%); Literacy rate (% of population aged 15 to 24).
SDG5: Gender equality	Demand for family planning satisfied by modern methods (% of females aged 15 to 49); Ratio of female-to-male mean years of education received (%); Ratio of female-to-male labor force participation rate (%); Seats held by women in national parliament (%).
SDG6: Clean Water and Sanitation	Population using at least basic drinking water services (%); Population using at least basic sanitation services (%); Freshwater withdrawal (% of available freshwater resources); Anthropogenic wastewater that receives treatment (%); Scarce water consumption embodied in imports (m^3/capita).
SDG7: Affordable and clean energy	Population with access to electricity (%); Population with access to clean fuels and technology for cooking (%); emissions from fuel combustion for electricity and heating per total electricity output ($MtCO_2$/TWh).
SDG8: Decent work and economic growth	Adjusted GDP growth (%); Victims of modern slavery (per 1000 population); Adults with an account at a bank or other financial institution or with a mobile-money-service provider (% of population aged 15 or over); Unemployment rate (% of total labor force); Fundamental labor rights are effectively guaranteed (worst 0 - 1 best); Fatal work-related accidents embodied in imports (per 100,000 population).

Continued

SDG9: Industry, Innovation and Infrastructure	Mobile broadband subscriptions (per 100 population); Logistics Performance Index: Quality of trade and transport-related infrastructure (worst 1 - 5 best); The Times Higher Education Universities Ranking: Average score of top 3 universities (worst 0 - 100 best); Scientific and technical journal articles (per 1000 population); Expenditure on research and development (% of GDP).
SDG10: Reduced inequality	Gini coefficient adjusted for top income; Palma ratio.
SDG11: Sustainable cities and communities	Proportion of urban population living in slums (%); Annual mean concentration of particulate matter of less than 2.5 microns in diameter (PM2.5) ($\mu g/m^3$); Access to improved water source, piped (% of urban population); Satisfaction with public transport (%).
SDG12: Responsible consumption and production	Municipal solid waste (kg/capita/day); Electronic waste (kg/capita); Production-based SO_2 emissions (kg/capita); SO_2 emissions embodied in imports (kg/capita); Production-based nitrogen emissions (kg/capita); Nitrogen emissions embodied in imports (kg/capita).
SDG13: Climate action	CO_2 emissions from fossil fuel combustion and cement production (tCO_2/capita); CO_2 emissions embodied in imports (tCO_2/capita); CO_2 emissions embodied in fossil fuel exports (kg/capita).
SDG14: Life below water	Mean area that is protected in marine sites important to biodiversity (%); Ocean Health Index: Clean Waters score (worst 0 - 100 best); Fish caught from overexploited or collapsed stocks (% of total catch); Fish caught by trawling or dredging (%).
SDG15: Life on land	Mean area that is protected in terrestrial sites important to biodiversity (%); Mean area that is protected in freshwater sites important to biodiversity (%); Red List Index of species survival (worst 0 - 1 best); Permanent deforestation (% of forest area, 5-year average); Terrestrial and freshwater biodiversity threats embodied in imports (per million population).
SDG16: Peace, justice and strong institutions	Homicides (per 100,000 population; Population who feel safe walking alone at night in the city or area where they live (%); Birth registrations with civil authority (% of children under age 5); Corruption Perception Index (worst 0 - 100 best); Children involved in child labor (% of population aged 5 to 14); Press Freedom Index (best 0 - 100 worst).
SDG17: Partnership for the goals	Government spending on health and education (% of GDP); For high-income and all OECD DAC countries: International concessional public finance, including official development assistance (% of GNI); Other countries: Government revenue excluding grants (% of GDP); Corporate Tax Haven Score (best 0 - 100 worst); Statistical Performance Index (worst 0 - 100 best).

3. Results

The results from analysis of the global data on the indicators for SDGs 1 to 6 and 10 were grouped together to represent "People related indicators" while SDGs 7 to 9 and 11 to 17 were grouped as "Planet, Prosperity and Peace". There were associations with at least one indicator for each of the 17 SDGs. Out of the 77 SDG indicators that were studied 47 (61%) i.e. almost two thirds showed some positive or negative correlation with stunting as shown in Table 1. The associations of the SDG indicators under study with stunting were demonstrated in Figures 1-7. Poverty rate (SDG1), mortality rates, universal health coverage, wellbeing (SDG3), quality education (SDG4), gender issues (SDG5), clean water, sanitation and hygiene (SDG6), affordable and clean energy (SDG7), science and technology (SDG9), climate action (SDG13) and peace and justice (SDG16) and
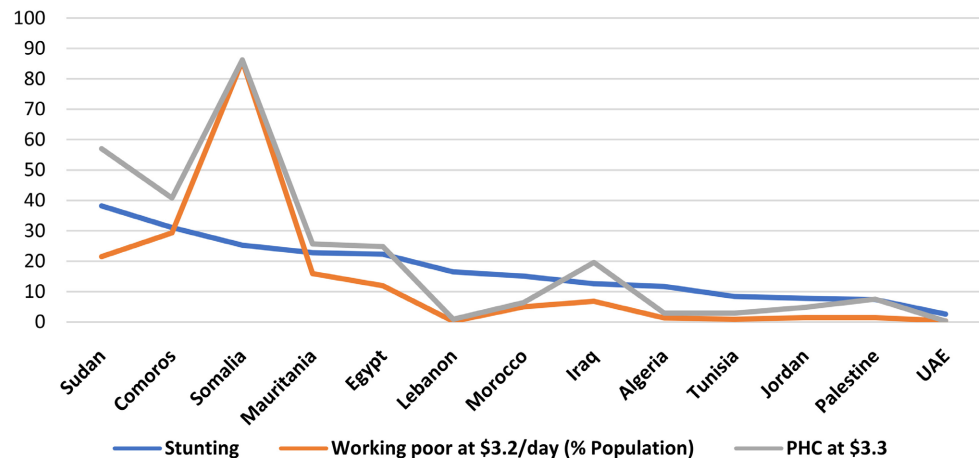
Figure 1. Relationship of stunting with working poor at $3.2 (% population) and poverty head count ratio at $3.2 (SDG1) in 13 of the 22 Arab states. *Source of data from 2022 Arab Region SDG Index and Dashboard Report and Cambridge University SDG report, 2021.
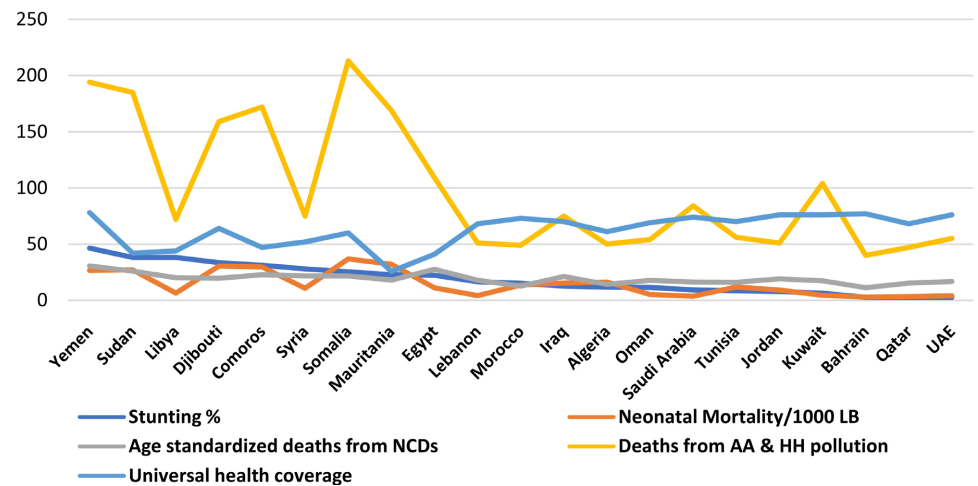

Figure 2. Relationship of stunting with neonatal mortality rate, deaths from NCDs and household and ambient air pollution and universal health coverage (SDG3) in the 21 Arab countries. *Source of data from 2022 Arab Region SDG Index and Dashboard Report and Cambridge University SDG report, 2021. Data for Palestine was missing for two items.
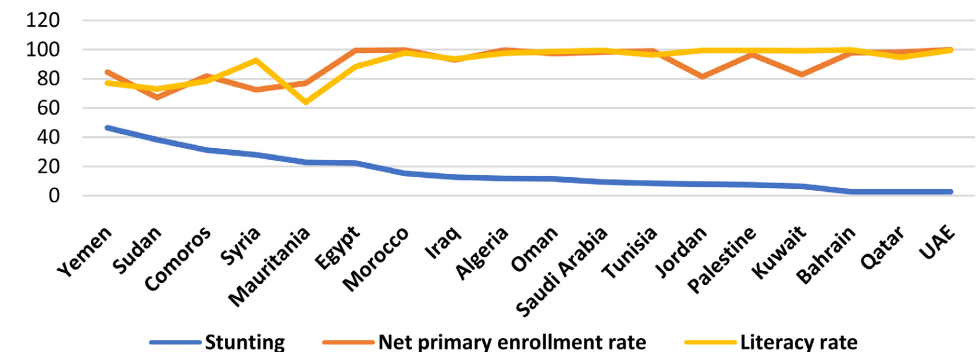

Figure 3. Relationship of stunting with net primary enrollment rate, and literacy rate, (SDG4) in 18 Arab countries. *Djibouti, Somalia, Lebanon and Libya had missing data. *Source of data from 2022 Arab Region SDG Index and Dashboard Report and Cambridge University SDG report, 2021.
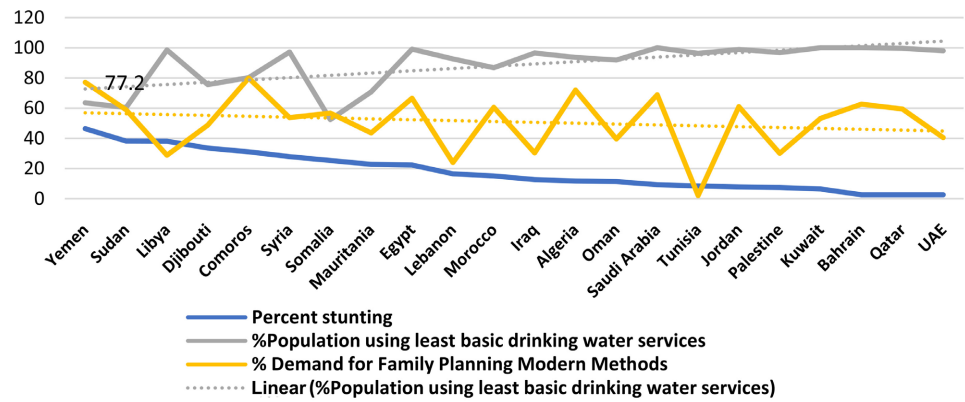
Figure 4. Relationship of stunting with percent demand for Family Planning Modern method (SDG5) and population using least basic drinking water services (SDG6) in 22 Arab States. *Source of data from 2022 Arab Region SDG Index and Dashboard Report and Cambridge University SDG report, 2022 and UNICEF database, 2020.
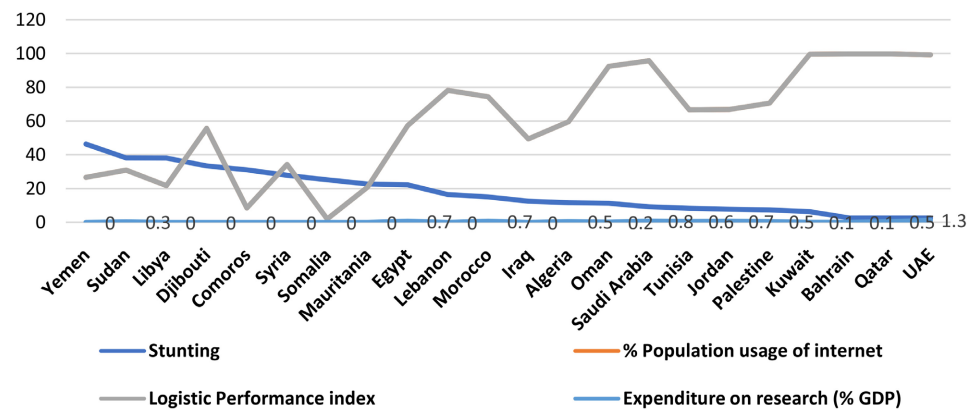
Figure 5. Relationship of stunting to percent population using internet, Logistics Performance Index: Quality of trade and transport-related infrastructure (worst 1 - 5 best); and expenditure on research (SDG9) in 22 Arab States. *Source of data from 2022 Arab Region SDG Index and Dashboard Report and Cambridge University SDG report, 2022 and UNICEF database, 2020.
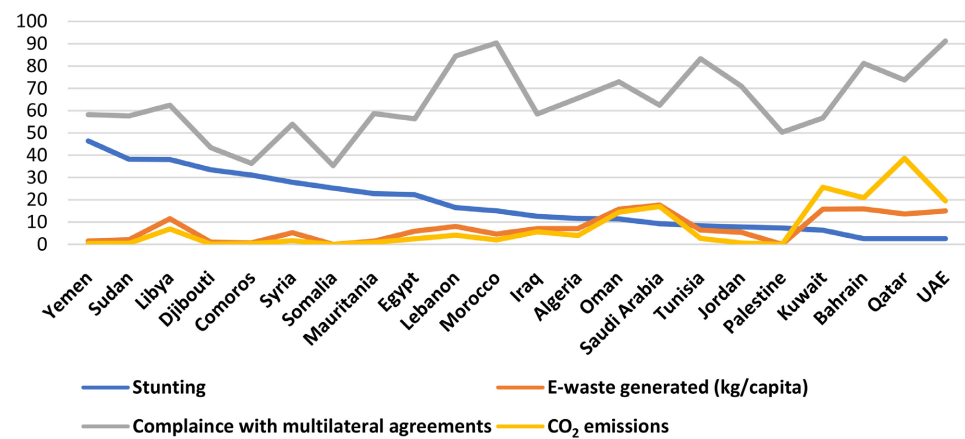
Figure 6. Relationship of stunting with E-waste generated (kg/capita) and compliance with multilateral agreements (SDG12), CO_2 emissions (SDG13) in 22 Arab States. *Source of data from 2022 Arab Region SDG Index and Dashboard Report and Cambridge University SDG report, 2022 and UNICEF database, 2020.

Figure 7. Relationship of stunting and obesity with corruption index, political instability and government spending on health and education (%GDP) in 21 Arab States. *Source of data from 2022 Arab Region SDG Index and Dashboard Report and Cambridge University SDG report, 2022 and UNICEF database, 2020.
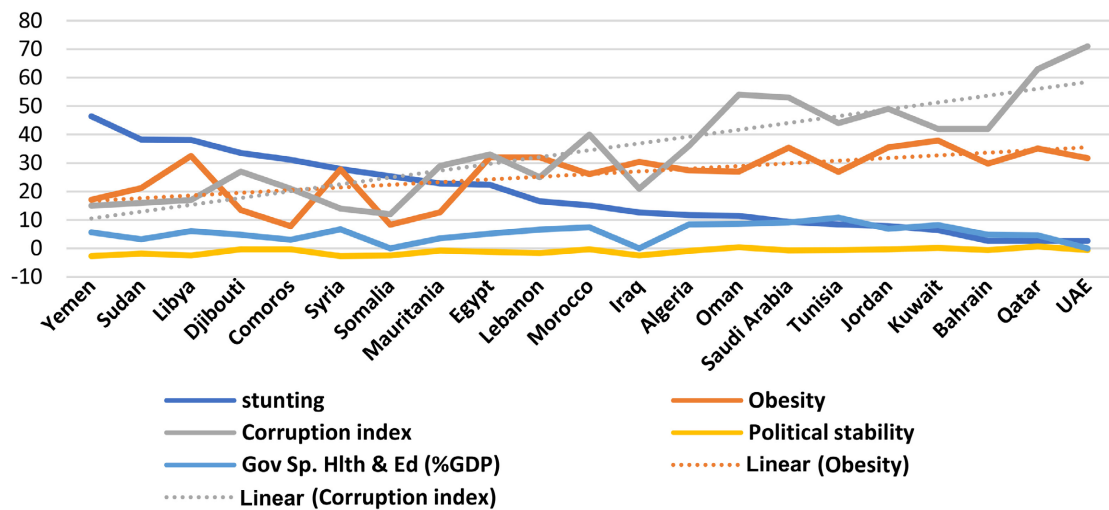
partnerships and government spending on health and education (SDG17) showed high correlations with stunting.

Figure 1 shows there is a positive relationship of stunting to poverty rate at \$3.2 for working poor and poverty head count ratio at \$3.2 (SDG1) in 13 of the 22 Arab countries. Figure 2 demonstrates the positive association of stunting with neonatal mortality rates, deaths from noncommunicable diseases (NCDs) and death from household and ambient air pollution and universal health coverage (SDG3) in 21 Arab States. Figure 3 demonstrates a reverse relationship of stunting with net primary enrollment rate and literacy rate, (SDG4) in 18 Arab States. Figure 4 shows there is a reverse relationship of stunting with percent demand for Family Planning Modern method (SDG5) and population using least basic drinking water services (SDG6) in the 22 Arab States. Figure 5 shows a reverse association of stunting to percent population using internet, Logistics Performance Index: Quality of trade and transport-related infrastructure (worst 1 - 5 best); and expenditure on research (SDG9) in the 22 Arab States. Figure 6 illustrates that there is a negative correlation between stunting with E-waste generated (kg/capita) and compliance with multilateral agreements (SDG12), CO_2 emissions (SDG13) in 22 Arab States. Figure 7 demonstrates a reverse association between stunting and corruption index (SDG16: peace and justice indicator) on the one hand, and government spending in health and education (SDG17) on the other hand, while obesity was positively associated with corruption index showing an increase in the HICs of the 21 Arab States (Palestine incomplete data).

There was a reverse relationship of stunting with access to electricity (SDG7), percent adjusted growth and labor freedom index (SDG8) in 22 Arab States. The highest positive correlation of stunting was shown with Poverty headcount ratio \$3.2 and highest negative correlation was with corruption index.

4. Discussion

Overall all SDGs contributed in one or another towards overcoming the problem of malnutrition. The discussion below discusses some of the relevant indicators for the SDGs that contribute significantly to this problem and can be used in developing a comprehensive roadmap, monitoring progress in prevention and making the relevant improvements to promote the nutritional status of children.

There was an evident relationship between stunting with food production and supply indicators (Cereal Yield and Nitrogen Management Index) in the Arab countries. Wasting appeared to show similar relationships. Cereal yield tended to rise in the HIC on the right side of the X-axis coinciding with the lower rates of stunting and wasting. Cereal yield was flattened towards the left side of the axis and the gap between it and malnutrition was much wider in the LIC compared to the MIC in the middle part of the axis. The wider gap between cereal yield and stunting indicates the long standing degree of malnutrition in the LIC compared to the MIC. Yemen, Sudan and Djibouti are the worst off with very high rates of stunting and wasting. There were no significant differences in the nitrogen management index across the spectrum of countries (Figure 2). The long standing malnutrition causing these very high rates of stunting needs to be addressed by radical strategies beyond the mere provision of food supply (Roediger et al., 2020).

Ending poverty in all its forms everywhere (SDG1) is showing considerable progress in the fight against poverty. Since 1990, over 800 million people worldwide are affected 70% of whom are women, who still live in extreme poverty. The Sustainable Development agenda aims to eradicate extreme poverty by 2030. Target 1.1 urges the eradication of extreme poverty for all people everywhere by 2030 and is currently measured as people living on less than $1.25 a day. While target 1.2 aims at reducing at least by one-half the proportion of men, women and children of all ages living in poverty in all its dimensions by 2030 (22). Our study showed significant associations of malnutrition with extreme poverty i.e. poverty headcount ratio $1.9 (r0.7 for both stunting and wasting) and poverty headcount ratio $3.2, both indicators are associated with food insecurity. The level of income appears to be a delineating factor with the HIC performing better than the low income (LIC), while the middle income countries (MIC) lie on the border of LIC and are staggering to move towards the HIC. Figure 1 illustrates the relationship between indicators of ending poverty for SDG1 and stunting. The countries of the LIC were shown to be grouped on the far end left side of X-axis indicating that poverty was associated with stunting being higher in LIC followed by MIC on the far right side of the horizontal axis of the chart (Figure 1). Poverty headcount ratio $1.9 and working poor at $3.2/day were also correlated with stunting. Syria has recently shifted from a MIC to a LIC and appears to be shifted to the LIC on the left side of the X-axis. On the other hand State of Palestine and Tunisia appear to be shifting towards the right of the X-axis with the HIC, indicating a progress in its indicators for SDG1 and SDG2.

On the other hand Oman is moving away from the HIC towards the MIC group, again a shift that warrants attention. With the falling oil prices, Oman's high debt levels and the gradual implementation of austerity measures later in the forecast period may weigh on its economic growth in 2024-2026 (World Bank, 2006). The Ukraine crises may also impact Middle East and North African country's (MENA) economy. At the top of our concerns are that MENA's already fragile countries—like Syria, Lebanon and Yemen—where the Ukrainian crisis risks to dramatically jeopardize access to food. Syria imports roughly two-thirds of both its food and oil consumption, and most of its wheat is specifically from Russia. Lebanon imports from Ukraine and Russia over 90% of its grain and only has about a month of grain reserves. Yemen imports about 40% of its wheat from the two countries at war. People experiencing crisis or, even worse, acute food insecurity in Yemen, have climbed from 15 million to over 16 million in just 3 months, at the end of 2021. The war in Ukraine, (as it did in Bosnia-Serbia conflict) will only worsen this already bleak dynamic in Yemen. The compounding shock of the war in Ukraine can cause tragic outcomes in some MENA countries if humanitarian and development assistance are not scaled up in 2022". This was quoted from World Bank blogs by Ferid Belhaj vice president of Mena World Bank (World Bank, 2022). This indicates that political events strongly influence Arab world food security and challenge the nutritional status of the children in this region.

A metanalysis study showed that early childhood food insecurity is associated with poor developmental outcomes in HIC (Danaei et al., 2016), de Oliveira et al., 2020). Stunting also coexists with obesity and micronutrient deficiency states (hidden malnutrition) (Berger et al., 2007; Julia et al., 2004; Rachmi et al., 2016). Community awareness of the types of food that need to be introduced to children is another factor that influences malnutrition and stunting. A metanalysis showed that household food insecurity and suboptimal dietary diversity were significantly associated with child stunting in children 0 - 23 months in sub-Saharan poor African countries (Gassara & Chen, 2021). Moreover, stunting, wasting and undernourishment are interrelated through low diet diversity and suboptimal early feeding practices as a continuation of fetal programming from hidden starvation in prenatal life (Aguayo & Menon, 2016) which influence developmental outcomes of children (de Oliveira et al., 2020; Hashad, 2021; Horta et al., 2015). In Palestine, Gaza strip and Western Bank, food insecurity was associated with poor living conditions. Donations, are usually short-term with sporadic aids given to these communities to prevent wasting and may have a counter effect leading to dependency and thereby stunting on the long term, when these donations come to an end. Donations can be counterproductive if not used to teach these communities to sustain their income through capacity building in economic development (teaching trades or creating work opportunities that are secure and sustained (Rashad & Sharaf, 2018).

The SDG target 2.4 ensures sustainable food production systems and imple-

ment resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality. The Arab countries showed trends by income group in SDGs related to cereal yield, exports of hazardous pesticides and stunting but fewer associations of sustainable nitrogen management index with stunting. Hence mapping interactions between SDGs and malnutrition can be a useful strategy to guide policy in preventing stunting in these countries (Nilsson et al., 2016). Differences in-between Arab Member States indicate the risk of food security, on the long term in low and middle income states, can accentuate and impede progress towards eradicating malnutrition. Success stories from countries that have shown progress can be used to gear progress in other countries. Minimizing waste and quality management of resources are needed to sustain development in these targets. Interventions that encourage communities to sustain their yields of cereal and minimize waste and poor regulation of consumption can have a significant effect on the eradication of malnutrition (Ratcliffe et al., 2011).

Good health and well-being are reflected in the mortality rates of children and morbidity rates from Tuberculosis (TB) and non-communicable diseases (NCDs) in adults. These indicators were significantly associated with stunting and wasting. Reported cases of TB are highest in LIC and some MIC. While deaths from NCDs appear to be high and were associated with stunting and wasting probably related to the double burden of stunting and overweight or obesity in all income groups; unhealthy food intake and poor control of marketing practices that promote these foods. Stunting and wasting showed the highest association with mortality linked to exposure to ambient air pollution (AAP) and household air pollution (HAP). A meta-analysis identified up to a 13% and 90% increased risk of stunting in children exposed to increased levels of AAP and HAP respectively (Pun & Dowling, 2019). Universal health coverage (UHC) index of service coverage and subjective well-being are associated with reduction in malnutrition. Ensuring access to health care particularly preventive services such as growth monitoring, and continued breastfeeding for two years with nutrition education for adequate complementary feeding (Gassara & Chen, 2021) and avoidance of processed foods and fast foods with high grease and salt, beverages high in sugar (Relvas et al., 2019) are needed to prevent chronic and acute malnutrition which carry risks of micronutrient deficiency states and their consequent effects on cognitive development (Horta et al., 2015) and economic development (El Bilbeisi et al., 2022).

Early feeding practices by promoting breastfeeding can reduce morbidity from communicable and non-communicable disease and thereby reduce stunting. Tuberculosis (TB) remains strongly associated with acute and chronic malnutrition and is particularly higher in LIC followed by MIC and least in HIC. While death from noncommunicable diseases (NCDs) appears to be high in all countries ir-

respective of income group and is linked to obesity which appears to be rising even in LIC. There was also an apparent association between obesity with prevalence of diabetes mellitus. The HIC had the highest rates of obesity and were on the left side of the X-axis; LIC had the lowest rates and was on the left side of the x-axis. MICs were in-between. However all countries showed a steady high prevalence of death from NCDs rising more in the LIC. However DM appeared to be higher in the HIC than in the LIC and some MIC, probably because of low detection rates in LIC as shown by the tendency for lower universal health coverage rates in the LIC to the right side of the horizontal axis. Deaths from cardiovascular disease in the region have been shown to be particularly high in countries of the Eastern Mediterranean region (Abul-Fadl et al., 2018).

Indicators of quality education (SDG4) showed significant negative associations with stunting and wasting and varied by country income group. Awareness campaigns cannot be effective and sustainable without achieving high levels of literacy and education since social media and internet technology are becoming leading strategies to achieve for achieving behavioral change. Improving the quality and level of education has been shown by many studies to impact the nutritional status of children. However in many instances, it may increase unhealthy food intake and lead to overweight and obesity due to the counter effect of marketing on education and strong impact it may have on affluent societies. Bardosono et al. (2007) also observed that inappropriate maternal nutritional knowledge and low paternal education were related to stunting in urban poor children 6 - 59 months. Media literacy and proper use of technology should be a mandatory subject starting from primary education. However traditional teaching remains the norm and adaptation of school curricula to meet the changing needs of the environment of technology needs to be reinforced in developing and underdeveloped countries by upgrading curricular content. A comprehensive implementation plan on maternal, infant and young child nutrition was addressed by the World Health Assembly in 2012 in this respect (WHO, 2012). Increasing caregiver education, especially maternal education, was shown to be strongly associated with declines in child stunting in numerous studies (SDG5). Reducing inequalities (SDG10) can influence differences in Gini index between countries (Danaei et al., 2016; Roediger et al., 2020).

We found strong associations between clean water and sanitation with decreases in stunting and wasting. A cross-sectional survey demonstrated that children 0 - 23 months living in a household with untreated drinking water had much higher odds of stunting if the household used an unimproved latrine (Torlesse et al., 2016).

SDG9 for promoting Industry, Innovation and Infrastructure was also closely associated with stunting. There were negative correlations between industrial and innovative infrastructure which were low or absent in the LIC and some MIC and more prominent in the HIC on the right side of the axis, indicating that stunting was linked to communities that do not have access to innovation, re-

search and opportunities for developing their human resources. Even opportunities to be linked to more developed countries that offer higher education and research opportunities were limited in these countries.

The indices of reducing inequalities (SDG10) correlated with stunting and were inconsistent in the LICs. This could be explained mostly by high negative correlations of stunting with indices of sustainable cities (SDG11) in particular water sources (pipes) which showed variations not only in LIC but also in MIC. These countries also have challenges in SDG12 for regulation of consumption mostly municipal solid waste and the production-based nitrogen emissions (kg/capita) as shown with the negative correlation with compliance with multilateral environmental agreements which was a particular challenge more in the MIC as shown in the charts. Regulation of consumption by reducing waste and regulating the supply can have a great effect on reducing inequalities and boosting sustainable cities without affecting the climate (SDG13). We found that CO_2 emissions were correlated with stunting, indicating the need for instigating action in these countries with high rates of stunting, as this may in one way or the other be related to stunting (Pun & Dowling, 2019).

We also found some relevant associations between stunting with SDG14 but not SDG15. These were related to negative association with protection of water resources related to biodiversity. It may indicate that in less developed countries, because resources are scarce, biodiversity may be at risk, as these populations use up any resources to meet their needs for survival, which again fires back to increase stunting and poor health and development as they deplete the biodiversity of resources. However there were significant correlations of several of the peace and justice indicators (SDG16) and Government spending on health and education (% of GDP) (SDG17) with stunting as they were also related to income group. All the LIC were grouped on the left side of the horizontal axis. The LIC coincided with countries were political instability and violence and wars continue. Although Libya is a MIC yet it was still on the left of the axis with the LIC.

Corruption index showed reverse associations with stunting and level of income of the country and was much higher in the MIC and HIC than LIC. The higher corruption index in HIC could be explained by higher bribes demanded from larger oil corporations as shown by Hashad dissertation in 2021 (Hashad, 2021). Their findings coincided with other research workers who showed that bribes increase with company growth (Nguyen, 2016; Nguyen, 2020). Stunting can also co-exist with overweight and obesity in more developed countries (Rachmi et al., 2016). In Egypt economic growth was associated with increased childhood overweight and obesity in Egypt (Rashad & Sharaf, 2018). Moreover Supplemental Nutrition Assistance Program is expected to reduce food insecurity but has a rebound effect once the assistance is stopped (Ratcliffe et al., 2011).

Impressive lessons can be learnt from countries where political will, leaders and champions of peace and will have changed the nation. These were seen when Nelson Mandala inspired his nation in South Africa (World economic fo-

rum, 2022) and also in India, by the Ghandi Peace Foundation (1980) whose values and leadership led the country to its present status, despite the major challenges of poverty. In Arab countries where the Islamic teaching prevail, peace and justice are mentioned in the Quran repeatedly. Corruption is associated with poverty and malnutrition. In the Quran the term "*fasad*" (corruption) and its derivatives have been used approximately 50 times and they appear in 22 chapters of the Quran. Similarly, according to al-Asfahanr, the word "*salah*" (which is usually used as the antonym for "*fasad*") and its derivatives have been used in the Quran approximately 150 times (Jomaa, 2008). This somewhat extensive use of these terms indicates the great emphasis of the Quran on promoting peace and justice (SDG17) through reform, integrity, transparency, avoiding conflicts, wars and social insecurity "*Fetna*". Promoting Peace is rooted in the Islamic values and is guided by the Islamic law "*Sharîa*" to ensure ownership, impact and legitimacy of measures. However, although Islamic law is implemented to some degree in most MENA countries and strongly influences their legal codes, there is little evidence available of how *Sharîa* law guides the prevention of means that lead to conflict mediated by corruption and injustice. Traditional Sharia Courts, complaint mechanisms or other Islamic institutions could potentially provide entry points for anti-corruption initiatives, to prevent conflicts and ensure peace to meet basic human rights and international legal standards (Chene, 2007). This can strongly influence prevention of malnutrition by ensuring health, food security and all the above mentioned SDGs for economic development.

Limitations: The main limitation in this study was that we were dealing with secondary data and not raw data from the countries for the indicators under study. However we have used the data derived from the report prepared for Arab nations that was more or less weighted to represent the 22 Arab nations under study. Another limitation is that we did not examine all the 269 indicators of the 17 SDGs. However this can be expanded in other studies. However number of indicators used may have been distracting. But since the focus of our study was to expand our understanding of factors influencing malnutrition we needed to include a minimum number of relevant indicators that represented all the 17 SDGs. Another challenge was missing data for indicators from some countries. These were mostly for poverty in which high income countries did not report, also in countries living in conflict as Palestine, Syria and Yemen or having economic or political instability as Somalia and Djibouti. We tried to include indicators that had a minimum of missed data.

In conclusion in this analytical study we identified several SDG indicators that were cross-cutting or related to malnutrition and stunting. These indicators were either directly or indirectly related to the nutritional status of under-fives. These include the "People" related indicators (SDG 1, 2, 3, 4, 5, 6 and 10) and the indicators on reducing inequities (SDG11) and regulating consumption (SDG12) and peace and justice (SDG16) as well as those encouraging government spending on health and education (SDG17). This entails that ending poverty, hunger

and inequalities while promoting health and wellbeing, quality education, access to clean water and sanitation as well as gender equity are drivers for preventing malnutrition. Indicators linked to values and faith as peace and justice are of profound importance to political stability and strengthening the physical and administrative infrastructure of these countries. This can play a significant role in empowering people to become better nations with hope towards a prosperous and peaceful future and eradicating poor feeding and nutritional practices and their consequences.

Disclaimer

The content, views and recommendations in this article do not represent World Health Organization and are solely the responsibility of the authors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Abul-Fadl, A. M., Mourad, M. M., Ghamrawy, A., & Sarhan, A. E. (2018). Trends in Deaths from Rheumatic Heart Disease in the Eastern Mediterranean Region: Burden and Challenges. *Journal of Cardiovascular Development and Disease, 5,* 32. https://doi.org/10.3390/jcdd5020032

Aguayo, V. M., & Menon, P. (2016). Stop Stunting: Improving Child Feeding, Women's Nutrition and Household Sanitation in South Asia. *Maternal & Child Nutrition, 12,* 3-11. https://doi.org/10.1111/mcn.12283

Al-Jawaldeh, A. A., Doggui, R., Borghi, E., Aguenaou, H., Ammari, L. E., Abul-Fadl, A., & McColl, K. (2020). Tackling Childhood Stunting in the Eastern Mediterranean Region in the Context of COVID-19. *Children (Basel), 7,* 239. https://doi.org/10.3390/children7110239

Argaw, A., Hanley-Cook, G., De Cock, N., Kolsteren, P., Huybregts, L., & Lachat, C. (2019). Drivers of Under-Five Stunting Trend in 14 Low- and Middle-Income Countries since the Turn of the Millennium: A Multilevel Pooled Analysis of 50 Demographic and Health Surveys. *Nutrients, 11,* 2485. https://doi.org/10.3390/nu11102485

Bardosono, S., Sastroamidjojo, S., & Lukito, W. (2007). Determinants of Child Malnutrition during the 1999 Economic Crisis in Selected Poor Areas of Indonesia. *Asia Pacific Journal of Clinical Nutrition, 16,* 512-526.

Bayoumi, M., Luomi, M., Fuller, G., Al-Sarihi, A., Salem, F., & Verheyen, S. (2022). *Arab Region SDG Index and Dashboard Report.* Mohammed Bin Rashid School of Government, (MBRSG), Anwar Gargash Diplomatic Academy (AGDA) and UN Sustainable Development Solutions Network (SDSN).

Beal, T., Tumilowicz, A., Sutrisna, A., Izwardy, D., & Neufeld, L. M. (2018). A Review of Child Stunting Determinants in Indonesia. *Maternal & Child Nutrition, 14,* e12617. https://doi.org/10.1111/mcn.12617

Berger, S. G., de Pee, S., Bloem, M. W., Halati, S., & Semba, R. D. (2007). Malnutrition and Morbidity Are Higher in Children Who Are Missed by Periodic Vitamin A Capsule Distribution for Child Survival in Rural Indonesia. *The Journal of Nutrition, 137,*

1328-1333. https://doi.org/10.1093/jn/137.5.1328

Chene, M. (2007). *Islamic Approaches to Corruption*. Anti-Corruption Resource Center, Transparency International.

Danaei, G. et al. (2016). Risk Factors for Childhood Stunting in 137 Developing Countries: A Comparative Risk Assessment Analysis at Global, Regional, and Country Levels. *PLOS Medicine, 13,* e1002164. https://doi.org/10.1371/journal.pmed.1002164

de Oliveira, K. H. D., de Almeida, G. M., Gubert, M. B., Moura, A. S., Spaniol, A. M., Hernandez, D. C. et al. (2020). Household Food Insecurity and Early Childhood Development: Systematic Review and Meta-Analysis. *Maternal & Child Nutrition, 16,* e12967. https://doi.org/10.1111/mcn.12967

de Onis, M., Dewey, K. G., Borghi, E., Onyango, A. W., Blössner, M., Daelmans, B., Piwoz, E., & Branca, F. (2013). The World Health Organization's Global Target for Reducing Childhood Stunting by 2025: Rationale and Proposed Actions. *Maternal & Child Nutrition, 2,* 6-26. https://doi.org/10.1111/mcn.12075

Dewey, K. G., & Begum, K. (2011). Long-Term Consequences of Stunting in Early Life. *Maternal & Child Nutrition, 3,* 5-18. https://doi.org/10.1111/j.1740-8709.2011.00349.x

El Bilbeisi, A., Al-Jawaldeh, A., Albelbeisi, A., Abuzerr, S., Elmadfa, I., & Nasreddine, L. (2022). Households' Food Insecurity and Its Association with Demographic and Socioeconomic Factors in Gaza Strip, Palestine: A Cross-Sectional Study. *Ethiopian Journal of Health Sciences, 32,* 369.

Fink, G. et al. (2016). Schooling and Wage Income Losses Due to Early-Childhood Growth Faltering in Developing Countries: National, Regional, and Global Estimates. *The American Journal of Clinical Nutrition, 104,* 104-112. https://doi.org/10.3945/ajcn.115.123968

Gassara, G., & Chen, J. (2021). Household Food Insecurity, Dietary Diversity, and Stunting in Sub-Saharan Africa: A Systematic Review. *Nutrients, 13,* 4401. https://doi.org/10.3390/nu13124401

Ghandi Peace Foundation (1980). *Peace with Justice: A Report of the Activities of Gandhi Peace Foundation*. Original Report from the University of California.

Hashad, R. N. (2021). *Role of Public Policy in Nutrition, Stunting and Corruption*. Thesis Doctor in Economics, University of Illinois.

Horta, B. L., Loret de Mola, C., & Victora, C. G. (2015). Breastfeeding and Intelligence: A Systematic Review and Meta-Analysis. *Acta Paediatrica, 104,* 14-19. https://doi.org/10.1111/apa.13139

IAEG-SDGs (2016). *Report of the Inter-Agency and Expert Group on the Sustainable Development Goal Indicators*. Economic and Social Council. http://unstats.un.org/unsd/statcom/47th-session/documents/2016-2-SDGs-Rev1-E.pdf

Jomaa, A. F. B. (2008). Corruption According to the Main Sources of Islam. *Intellectual Discourse, 26,* 91-110.

Julia, M., van Weissenbruch, M. M., Delemarre-van de Waal, H. A., & Surjono, A. (2004). Influence of Socioeconomic Status on the Prevalence of Stunted Growth and Obesity in Prepubertal Indonesian Children. *Food and Nutrition Bulletin, 25,* 354-360. https://doi.org/10.1177/156482650402500405

Nasreddine, L., Ayoub, J. J., & Al Jawaldeh, A. (2018). Review of the Nutrition Situation in the Eastern Mediterranean Region. *Eastern Mediterranean Health Journal, 24,* 77-91. https://doi.org/10.26719/2018.24.1.77

Nguyen, T. D. (2016). Does Growth Reduce Corruption. Evidence from Cross-Country Firm-Level Data. In *Inaugural Conference of the Economics Steering Group of the*

Worldwide Universities Network (WUN).

Nguyen, T. D. (2020). Does Firm Growth Increase Corruption? Evidence from an Instrumental Variable Approach. *Small Business Economics, 55,* 237-256. https://doi.org/10.1007/s11187-019-00160-x

Nilsson, M., Griggs, D., & Visbeck, M. (2016). Policy: Map the Interactions between Sustainable Development Goals. *Nature, 534,* 320-322. https://doi.org/10.1038/534320a

Pun, V., & Dowling, M. R. (2019). Air Pollution and Child Stunting—A Systematic Review and Meta-Analysis. *Environmental Epidemiology, 3,* 318. https://doi.org/10.1097/01.EE9.0000609484.16985.4a

Rachmi, N., Kingsley, A., Mu, L., & Baur, L. (2016). Stunting Coexisting with Overweight in 2.0-4.9-Year-Old Indonesian Children: Prevalence, Trends and Associated Risk Factors from Repeated Cross-Sectional Surveys. *Public Health Nutrition, 19,* 2698-2707. https://doi.org/10.1017/S1368980016000926

Rashad, A. S., & Sharaf, M. F. (2018). Economic Growth and Child Malnutrition in Egypt: New Evidence from National Demographic and Health Survey. *Social Indicators Research, 135,* 769-795. https://doi.org/10.1007/s11205-016-1515-y

Ratcliffe, C., McKernan, S., & Zhang, S. (2011). How Much Does the Supplemental Nutrition Assistance Program Reduce Food Insecurity? *American Journal of Agricultural Economics, 93,* 1082-1098. https://doi.org/10.1093/ajae/aar026

Relvas, G. R. B., Buccini, G. D. S., & Venancio, S. I. (2019). Ultra-Processed Food Consumption among Infants in Primary Health Care in a City of the Metropolitan Region of Sao Paulo, Brazil. *Jornal de Pediatria, 95,* 584-592. https://doi.org/10.1016/j.jped.2018.05.004

Roediger, R., Hendrixson, T. D., Mark, J., & Manary, M. K. (2020). A Roadmap to Reduce Stunting. *The American Journal of Clinical Nutrition, 112,* 773S-776S. https://doi.org/10.1093/ajcn/nqaa205

Torlesse, H., Cronin, A. A., Sebayang, S. K. et al. (2016). Determinants of Stunting in Indonesian Children: Evidence from a Cross-Sectional Survey Indicate a Prominent Role for the Water, Sanitation and Hygiene Sector in Stunting Reduction. *BMC Public Health, 16,* Article No. 669. https://doi.org/10.1186/s12889-016-3339-8

U.N. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development.* United Nations.

UNICEF (2019). *UNICEF Global Databases, Based on MICS, DHS and Other Nationally Representative Sources.*

Victora, C. G. et al. (2010). Worldwide Timing of Growth Faltering: Revisiting Implications for Interventions. *Pediatrics, 125,* e473-e480. https://doi.org/10.1542/peds.2009-1519

WHO Resolution WHA65.6 (2012). Comprehensive Implementation Plan on Maternal, Infant and Young Child Nutrition. In *Sixty-Fifth World Health Assembly. Resolutions and Decisions, Annexes* (pp. 12-13). World Health Organization.

World Bank Blogs (2022). *Ferid Belhaj: Compounded Stress: The Impact of the War in Ukraine on the Middle East and North Africa.* https://blogs.worldbank.org/arabvoices/compounded-stress-impact-war-ukraine-middle-east-and-north-africa

World Bank (2006). *Repositioning Nutrition as Central to Development: A Strategy for Large Scale Action. Directions in Development.* World Bank.

World Economic Forum (2022). *Peace, Poverty and Race: Here Are Some of Nelson Mandela's Wisest Words.*

https://www.weforum.org/agenda/2020/07/nelson-mandela-freedom-quotes-inspiration

WHO World Health Organization (2006). *Child Growth Standards*.
https://www.who.int/tools/child-growth-standards/who-multicentre-growth-reference-study

WHO (World Health Organization) (2012). *Global Targets 2025 to Improve Maternal, Infant and Young Child Nutrition*.