Socio-Ecological Factors and the Double Burden of Malnutrition (DBM) Among Children and Adolescents in Low- and Middle-Income Countries (LMICs)

October 19–20, 2022

Virtual

DAY 1

WELCOME AND OPENING REMARKS

Welcome and Overview

Jenelle R. Walker, Ph.D., M.S., NICHD

Dr. Jenelle Walker welcomed the attendees to the NICHD Global Health Conference on behalf of the NICHD Office of Global Health and Director, Dr. Vesna Kutlesic. Dr. Walker introduced the conference planning group members and moderators. The purpose of the conference was to better understand recent etiological and socio-ecological factors that are contributing to the increased prevalence of the DBM and the implications for long-term health outcomes among children 3 to 18 years of age in LMICs. The DBM has been defined as the coexistence of undernutrition (i.e., micronutrient deficiencies, underweight, and childhood stunting and wasting) and overweight, obesity, and diet-related (DR) noncommunicable diseases (NCDs) at the individual, family, and/or community levels. The goal of this meeting is to explore evidence-based interventions, identify important research questions, and discuss policy implementation toward improving nutrition and health outcomes of youth globally.

Dr. Walker expressed the warm regards of NICHD Director Diana Bianchi, M.D., who was unable to attend the meeting, and introduced NICHD Deputy Director Alison Cernich, Ph.D., to provide opening remarks.

Opening Remarks

Alison Cernich, Ph.D., ABPP-CN, Deputy Director, NICHD

Dr. Cernich reported that NICHD celebrated its 60th Anniversary in 2022 with research on nutrition, growth, and human development being fundamental areas since the founding of the institute and supported by several of NICHD extramural branches and intramural programs.

Most notably, the NICHD Pediatric Growth and Nutrition Branch and the NICHD Global Network

for Women's and Children's Research have played key roles in leading nutrition-related research and collaborations in LMICs.

In fact, several of the speakers at this NICHD Global Health Conference are either researchers supported by NICHD or other institutes at the National Institutes of Health (NIH) or have served on an array of NIH working groups and initiatives, like the NICHD "BOND-KIDS" Project and the Global Network Preconception Trial.

In 2021, the Biden-Harris Administration announced plans to invest up to $11 billion over three years, to combat global malnutrition with important goals including:

- prioritizing women's and children's nutrition needs
- identifying the causes of malnutrition in LMICs
- examining the effects of COVID-19, climate change, and ongoing military conflict on malnutrition and food insecurity globally

In September 2022, the "White House Conference on Hunger, Nutrition, and Health," was held to catalyze the public and private sectors to accelerate progress and drive transformative initiatives to end hunger, improve nutrition and physical activity, and close the health disparities surrounding them.

At NIH, nutrition, growth, and human development research and associated activities are supported by the Office of Nutrition Research and several NIH Institutes, Centers, and Offices independently or as part of trans-NIH and interagency collaborations. This includes the United States Government (USG) "Global Nutrition Coordination Plan (GNCP) 2021-2026" which guides the collaborative work of twelve USG departments and agencies engaged in scaling up proven approaches toward achieving better nutrition. A major program priority within this plan includes an emphasis on nutrition during childhood and adolescence, particularly addressing obesity and overweight, and diet-related noncommunicable diseases during this period.

The NIH Director's Office has also worked to expand and intensify research collaborations with the Bill and Melinda Gates Foundation in several research areas which include improving pregnancy outcomes, growth and nutrition, and neurodevelopment in low and middle countries.

Introductory Remarks

Roger Glass, M.D., Ph.D., Director, Fogarty International Center (FIC), NIH

Dr. Glass recalled that his interest in nutrition was sparked early in his career, when he spent 4 years in Bangladesh working with severely malnourished children. Their malnutrition included vitamin A deficiency, which caused blindness and vision problems; iodine deficiency, which resulted in goiters and cretinism; and various other infections that interfered with their nutritional development. Over the years, as the average family size significantly decreased and women were able to join the workforce and become better educated, malnutrition declined, but the dual burden of malnutrition and obesity continues to be a significant health problem.

Currently, some research in Bangladesh is focusing on the microbiome to improve the nutritional status of children who are severely malnourished but do not respond to intense

feeding. The FIC Center for Global Health Studies continues to highlight research projects on nutrition, food security, and health outcomes in the global setting. This conference would complement and build on these research advances and on President Biden's pledge of funding to strengthen global health and food security.

Without good nutrition, which is fundamental to human health, the world cannot begin to achieve its sustainable goals. This meeting would address a great challenge. Identifying evidence-based interventions, research gaps, and policy implications as being essential for eradicating the DBM and improving long-term nutrition and health outcomes in children and adolescents in LMICs.

Introduction of the First Keynote Speaker

Vesna Kutlesic, Ph.D., Director, Office of Global Health, NICHD

Barry Popkin, Ph.D., is the W. R. Kenan, Jr. Distinguished Professor of Nutrition at the University of North Carolina at Chapel Hill (UNC-Chapel Hill) and founder of the Global Food Research Program (GFRP) at UNC-Chapel Hill. Dr. Popkin developed the concept of nutrition transition, the study of the dynamic shifts in our environment and the way they affect dietary intake and physical activity patterns and trends, obesity, and other nutrition-related noncommunicable diseases.

First Keynote Address: The DBM and the New Nutritional Reality

Barry M. Popkin, Ph.D., UNC-Chapel Hill

Dr. Popkin focused his presentation on the classical definition of the DBM, which is the linkage of stunting or low weight for age (LWA) and obesity at the country level. For his own research, he has used the criteria developed jointly by the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the World Bank to measure levels of stunting at the country level.

In the past decade, the burden of overweight and obesity has shifted from higher- to lower-wealth populations across the globe. Today, the areas with the highest burden of undernutrition, as evidenced by high levels of stunting and overweight among their lower-income populations, are sub-Saharan Africa and South and Southeast Asia.

In relating this shift to the DBM, Dr. Popkin explained that in LMICs, undernutrition is declining while overweight is rapidly increasing. However, because stunting was so prevalent in these countries, increases in overweight prevalence (20% or higher increases in all countries across the globe) are leading to high DBM levels. Of 126 LMICs, 38% face a DBM prevalence defined as very high or severe and likely to lead to overweight and obesity levels of 30%. The DBM is clearly shifting toward countries in the poorest income quartile.

Global overweight and obesity are significant risk factors for NCDs. Body mass index (BMI) is increasing among all age groups, and waist circumference enlarges at each BMI level. This has resulted in body shapes with much fatter midsections, a troubling trend considering the linkage of NCDs with weight gain. Moreover, increased NCD susceptibility is also seen at lower BMI levels, implying that as-yet-undefined genetic differences may also lead to higher NCD risk. Across the globe, people of all races and ethnicities are getting fatter, and the fat is moving to

the waist. There are now only a few countries in the world where the overweight and obesity prevalence in the population is lower than 30%.

Dr. Popkin next discussed stunting. In some LMICs (Chile, China, Egypt, India, Indonesia, Kenya, Mexico, South Africa, and Thailand), the percentage of stunting in children less than 5 years of age decreased between 1980 and 2016. During that same period, the percentage of overweight and obesity increased in each of those countries except Chile, India, and Kenya. Among children 3 to 5 years of age in all these countries, a much more significant decline in stunting and a much more significant increase in overweight/obesity has occurred. In general, over the past 40 years, in children 5 to 11 years old and in adolescent girls and boys, the prevalence of overweight and obesity has increased rapidly and that of underweight has decreased.

The COVID-19 pandemic likely greatly exacerbated the DBM, because both undernutrition and obesity are associated with significant reductions in immune function and increased susceptibility to COVID-19. Globally, the pandemic also caused a lessening of physical activity and reduction of employment.

Dr. Popkin reviewed some of the dynamics behind the diet shifts that have affected both undernutrition and overnutrition. Most regions have experienced a burgeoning consumption of ultra-processed food and less nutritious, cheaper food, with preschoolers consuming increasing levels of highly processed junk food. Biological preferences, which evolved over millennia, have been leveraged by modern technology. Manufacturers have taken advantage of the evolutionary biological preference for sweetness by introducing sugar into 30% to 40% of formula across the globe and of the biological need for fatty food by manufacturing edible oils, which are more saturated and less healthy. Snacking, which was not prevalent a few decades ago, has been vastly increased by the marketing and accessibility of unhealthy snacks.

Increases in overweight can be traced to the fact that in the poorest countries, as physical activity has declined, 15% to 20% of infant calories come from ultra-processed foods. The global food system makes ultra-processed and less nutritious foods (e.g., snacks, confections, sugary beverages), which are consumed in both urban and rural areas in LMICs, cheaper and more accessible. Effective policies that address the challenges of the DBM across the life cycle are urgently needed.

Dr. Popkin described the food system transformation in Latin America, Asia, and Africa. Diet changes have been driven by income increases, decreasing opportunities for women to shop and cook as they have taken jobs in urban areas requiring long commutes, a lack of money for firewood or space to cook in slum areas, and the domestic investment in the modern food industry. This has led to the rapid consumption of ready-to-eat convenience foods, many of which are nonessential, ultra-processed foods that are aggressively marketed.

Because food affects children in their first 1,000 days of life and beyond, the trend toward ultra-processed food is very concerning. A large, NIH-randomized, controlled crossover trial that compared a less-processed “real food” diet (i.e., high in vegetables, grains, fruits, meats, fish, eggs) with an ultra-processed diet (i.e., high in sugary drinks, candies, sweetened food products) in normal-weight adults found that over a 2-week period, participants on the ultra-processed diet gained almost a kilogram of body weight, which they lost when they were

switched to the healthy diet for the same amount of time. Some shifts in inflammatory and other biomarkers that are key measures of cardiovascular disease (CVD), cancer risks, and type 2 diabetes were also seen. The study suggested that two potential mechanisms were driving the results: hyperpalatability (i.e., making processed food tastier) and the high energy density of ultra-processed foods. The results from this sophisticated clinical trial comported with more than 45 national and international previous studies (mostly in adults) that suggested a link between diet and the increasing risk of NCD markers, obesity, and mortality.

Dr. Popkin concluded with a review of questions that remain to be answered:

- How can healthier diets be promoted in LMICs?
- What are the best ways to regulate or reduce consumption of the unhealthiest ultra-processed foods?
- Can these ultra-processed foods be defined precisely and simply for policy purposes?
- Should these products be reformulated to reduce the amount of sodium, sugar, and unhealthy saturated fats?
- What should be done about refined carbohydrates and their powerful impact on health?

Both LMICs and high-income countries must address these issues. The ultimate goal is to use multiple approaches on both the governmental and individual levels (e.g., regulations, marketing controls, nutrition education, fiscal measures) to affect both supply and demand in a way that will change the cultural and societal norms of healthy eating and produce healthier infants, preschoolers, children, and adolescents.

Discussion with Dr. Popkin

- ***Daniel Raiten, Ph.D.,*** *noting that the focus of the DBM is on coexisting conditions within countries, asked whether there are any data about an actual double burden within individuals and whether there is a concern about the potential for double counting, particularly with the obese population.* **Dr. Popkin** agreed that there might be some double counting, saying that his earlier studies showed that some higher-income countries had large burdens of overweight and underweight within the same household and even sometimes within individuals. Although his focus is on the larger dynamic at the country level, these conditions exist at the community, household, and individual levels.
- ***Trias Mahmudiono, Ph.D.,*** *asked whether some of the nutrition problems caused by the COVID-19 pandemic had improved as people moved during and after the pandemic to work remotely, perhaps from better environments.* **Dr. Popkin** said this could account for nutritional improvement in higher-income countries and also among the most educated people in some of the urban areas of LMICs. However, most people in areas like South Asia and sub-Saharan Africa are not working from home but are traveling hours each day to work in factories or on farms, so they do not have the opportunity for remote work in better environments. This will be the situation for a long time, because technological advances are very slow to reach rural and slum areas in LMICs.
- ***Boitshepo Bibi Giyose, M.S.N.,*** *noting the lack of simple metrics to measure what people are actually eating, asked how to influence policy makers to improve the food*

environment in LMICs without having good data, especially when people who eat healthy diets also have nutritional deficiencies. **Dr. Popkin** agreed that measuring what people eat is increasingly complex and expensive. However, it is possible to get a sense of food distribution, focus on policies to reduce ultra-processed food consumption, and subsidize increased consumption of healthy food. Noting the reduced risks of NCDs with a healthy diet, he cautioned against thinking of healthy and minimally processed food as being dangerous. **Dr. Raiten** added that Ms. Giyose's point about having deficiencies even with healthy diets illustrates that nutritional status is a result of many processes and that food quality is only the beginning. A comprehensive and precise approach for assessing nutritional status beyond just what food is eaten is needed.

- ***An attendee*** *asked whether measurements of weight, waist, and BMI should be remeasured post-pandemic at the population level to determine whether overweight and obesity gradually decrease as normal physical activity resumes.* **Dr. Popkin** said the ability to accurately measure waist circumference as well as weight and height would be very important, because waist circumferences are growing, and the implications of that are not fully understood.

Introduction of the Second Keynote Speaker

Andrew Bremer, M.D., Ph.D., NICHD

Elaine Borghi, Ph.D., is the head of the Monitoring Nutrition Status and Food Safety Events Unit in the Department of Nutrition and Food Safety at WHO. She is responsible for coordinating efforts on nutrition and food safety surveillance and liaising with other departments within WHO and with external partners.

Second Keynote Address: Global Regional Differences in the DBM Among Children and Adolescents in LMICs

Elaine Borghi, Ph.D., WHO, and Francesco Branca, M.D., Ph.D., M.Sc., WHO (not present)

The multiple forms of malnutrition, including stunting in children under 5 years of age, anemia in women of reproductive age, low birth weight, overweight in children under 5 years of age, inadequate breastfeeding, and wasting in children under 5 years of age, should be addressed as a group, not in isolation, because very few countries are afflicted by just one of them. Of these six forms of malnutrition, progress has been made toward the 2030 global nutrition targets only for exclusive breastfeeding and child stunting. Dr. Borghi noted that the State of Food Security and Nutrition in the World (SOFI) 2020 suggests that it will not be possible to make progress toward global nutrition targets without addressing inequalities. For example, children in rural, poor, or less-educated households are more vulnerable to stunting and wasting; children in urban centers are at higher risk of overweight.

The coexistence and overlapping of different forms of malnutrition is the "new normal." Looking at anemia, stunting of children under 5 years of age, and adolescent underweight, 60 of the 151 countries that had data for the indicators for all three conditions crossed both anemia and adolescent overweight thresholds; 43 crossed thresholds for all three conditions. No country was below the threshold for all three indicators. The presence of all three conditions is particularly prominent in sub-Saharan Africa.

Dr. Borghi presented data on regional and global levels of the DBM for stunting, wasting, and overweight for children under 5 years of age and underweight and overweight for children ages 5 to 9 and adolescents (ages 10 to 19). The DBM was most significant in the Eastern Mediterranean region for children under age 5, while the DBM levels were more prevalent in the Southeast Asian region for the two older age groups. Available data from 2000 to 2016 for the older age groups show a trend toward stagnating underweight and rising overweight. Data from 2000 to 2020 for children under age 5 showed much lower signs of overweight, but this is still concerning, because a child who reaches 5 years of age and is already even slightly overweight has a higher risk for overweight later in life.

Dr. Borghi showed a schematic illustrating the prevalence of the overlap of both stunting and overweight in children under 5 years old and how this combination was related to household wealth scores in three countries: Guinea, Morocco, and Albania. This type of study highlighted the importance of having granular data that so clearly show disparities by wealth. Dr. Borghi also showed the trend in underweight and overweight by income in children and adolescents 5 to 19 years old between 1975 and 2016. In general, overweight has increased more than underweight, especially in the low-income groups. Moreover, in LMICs, and especially in low-income countries, girls are moving toward overweight faster than boys are, while underweight is decreasing for boys. Data on mean BMI compared with mean height on male and female 19-year-olds indicate that weight is increasing faster than height. A study in a number of regions in Guatemala looking at socioeconomic data (i.e., household wealth score and adolescents' education level) in 2014 and 2015 showed that for adolescents 15 to 19 years old, higher household wealth correlated with a lower prevalence of DBM (measured by height and BMI for age). A higher proportion of adolescents with secondary and higher education (compared with adolescents with no education or only primary education) correlated with a decreasing DBM.

Dr. Borghi referred to the article in *The Lancet* outlining 10 double-duty actions that could address the DBM in the areas of health services, social safety nets, educational settings, agriculture, food systems, and food environments. This approach is a reminder that multifaceted actions are required to address the DBM. Nutrition goals and solutions should not be considered in isolation. In LMICs, undernutrition is declining, while overweight is increasing in children and adolescents in patterns that vary by sex. This trend will continue as the global food system makes less nutritious food cheaper and more accessible. Effective policies that address the challenges of the DBM across the life cycle are urgently needed.

Discussion with Dr. Borghi

- ***An attendee*** *noted that children with chronic health conditions are more vulnerable to underweight. Are there data on this large subsection of the pediatric population in LMICs?* **Dr. Borghi** said the actions for addressing underweight are much clearer; it is the overnutrition that requires more attention.
- ***Dr. Bremer,*** *noting the challenge of assessing nutrition status in growing children, asked about the use of anthropometric indices for assessing nutritional status, particularly in adolescents as they grow and develop.* **Dr. Borghi** said that in terms of opportunities to codify diagnoses or assess nutritional status in a more uniform fashion, there are still many gaps in determining which indicators would be most helpful. She cited a project

for the management of overweight and obesity that is studying alternative measurements and indicators to diagnose overweight and obesity in children of all ages. For undernutrition, especially for wasting, some investigators are using weight for length and height; others are using BMI. There is potential for improvement to harmonize testing. **Dr. Borghi** said she plans to undertake a project to look at indicators for the 5- to 19-year-old group with the help of experts from the malnutrition community.

SESSION I: BROADER CONTEXT AND ENVIRONMENTAL INFLUENCES FOR CHILDREN AND ADOLESCENTS IN LMICS

Moderator

Daniel Raiten, Ph.D., FASN, NICHD

Dr. Raiten observed that children and adolescents have complex internal and external biological environments. This session will further explore some key factors in the external environments.

How Adolescents Perceive Nutrition and Food Security Around the World

Rafael Pérez-Escamilla, Ph.D., Yale School of Public Health

Although evidence clearly demonstrates the importance of the DBM as a global health problem affecting children and adolescents, very little is known about what should be done. Dr. Pérez-Escamilla shared adolescents' own perspectives on the challenges they face related to nutrition and food security and the solutions they propose, as gleaned from a project (Adolescent Voice and Perspectives on Food and Nutrition: Feasibility of an Innovative Participatory Methodology) on which he was a senior scientific advisor.

The project conducted 37 workshops in 18 low-, middle-, and high-income countries across five world regions. The 656 participants (12 to 18 years old, 61% female) included very vulnerable groups, such as displaced refugees in Sudan. Data were collected on dietary intake, body image, influences on food choices, food environments, barriers to healthy eating, and food and nutrition security solutions.

Dr. Pérez-Escamilla reviewed the key findings and provided quotations from the participants:

- Both male and female participants understood the importance of healthy eating and nutrition for their own health. "We get power from nutritious food." (India)
- Despite their awareness of the importance of nutrition, adolescents in several countries (especially Australia, Guatemala, Mexico, Serbia, and the United States) reported eating unhealthy foods, such as ultra-processed, sugary foods and sweetened beverages, and most listed junk food and fast food as their ideal meals.
- Adolescents' food choices are influenced by family and social media, television and radio, friends, branding and advertising, body image, and food taste. Many adolescents have dinner at home alone, because both their parents work, so there is no opportunity to have healthy family meals. "Ice cream, chocolate, and chips are delicious, so these are my favorite foods." (Bangladesh)
- Structural barriers for healthy eating include financial constraints and food environments at home, school, and in the community. "Cheap food is not healthy;

healthy food is not cheap." (China) "We can't get [healthy] foods in our local shops, because shopkeepers are selling low-quality foods and vegetables." (Afghanistan)
- Solutions proposed by adolescents included addressing food insecurity and the easy access to unhealthy foods, improving nutrition knowledge in schools, and, most importantly, developing action plans to improve food choices by bringing communities together and having adolescents be key actors in designing the solutions.

Dr. Pérez-Escamilla offered the following conclusions:

- Adolescents around the world care about healthy eating but consume unhealthy foods.
- Key structural barriers to healthy eating among adolescents include lack of economic and physical access to healthy foods and aggressive food industry marketing of ultra-processed foods and beverages.
- Adolescent-centered solutions to unhealthy eating must involve multilevel and multisectoral society efforts, with strong input from adolescents themselves.
- Areas to be addressed include the transformation of unhealthy food systems, food environments, marketing of ultra-processed foods, healthy family meals, and body image and other peer pressure issues.

Dr. Pérez-Escamilla added that maternal and child nutrition must be at the heart of climate change agendas.

Environmental Influences for the DBM for LMICs: An African Perspective and Current Opportunities for Action

Namukolo Covic, Ph.D., M.Sc., Regional Director, Consultative Group for International Agricultural Research, East and Southern Africa

Dr. Covic began with three key messages:

- Africa is facing the DBM.
- Not much work has been done on environmental influences, but this is an emerging area of research.
- Current momentum must be leveraged on efforts to promote positive food systems transformation to foster better diets and, in turn, better nutrition and health outcomes.

The food systems in Africa are leading to a clear DBM situation. Between 2018 and 2020, stunting declined, although not fast enough to meet sustainable development goal (SDG) targets, and the prevalence of overweight in adolescent girls and adult women increased significantly, with 41% of adult women overweight or obese. In general, the overweight trajectory in many countries is rising faster than the reduction in undernutrition.

These issues illustrate the importance of the 2021 United Nations Food System Summit (UNFSS), which launched bold new actions to transform how the world produces and consumes food to promote progress on all SDGs. The UNFSS addressed global and local problems for existing food systems, including widespread poor diets and malnutrition, the climate crisis and the contributions of food systems to environmental challenges, and the issues of inequities, safety, and sustainability of livelihood, especially in LMICs.

Dr. Covic discussed three areas that food transformation efforts must focus on:

- The environmental influences that have been observed in research studies across the continent must be addressed. Examples of such research include a study of an Ethiopian adolescent urban school environment that found widespread availability and significant consumption of unhealthy foods; a study of urban Ghanaian adolescents that found that students, although aware of healthy diets, did not make positive food choices and were unaware of the marketing influences on them; and a South African birth-to-age-20 study that showed that consumption patterns are influenced by the environment at school and at home (e.g., adolescents who helped with food tasks at home had a higher risk of excess consumption and being obese).
- Improving the quality of the complementary diet, in part because of the unaffordability of nutritious foods, must be addressed. The high cost of eggs led researchers in Ethiopia to examine the use of dried egg powder to reduce the cost of the complementary diet by 14%. The challenge is to devise additional creative ways to make healthy diets more affordable.
- Food transformation efforts must include attention to environmental influences on affordability, both inside and outside the home.

The African continent has responded to the UNFSS by developing food systems transformation pathways. The African Union has advanced a common position from elements across those pathways, providing an opportunity to create collective momentum across the continent. Currently, only 9 out of 54 African countries have food-based dietary guidelines, but additional guidelines could now be developed within the context of the efforts that were brought about by the UNFSS and the growing determination to address the DBM.

One example of a food transformation pathway targeting the DBM is the Ethiopian plan, which involves a holistic transformation of Ethiopia's food systems, from production to consumption, to promote enhanced food safety, better nutrition and diets, improved livelihoods, and greater land preservation. This plan will require strong collaboration across all food system actors uniting around a common goal. Dr. Covic presented a framework for monitoring food systems transformation across different countries that takes diet, nutrition, and health; environment and climate; and livelihoods, poverty, and equity into account. Crosscutting monitoring issues include governance, reliance and sustainability. This framework provides an opportunity for multiple African countries to monitor food systems transformation and offers the possibility to create a synergistic momentum across the continent.

The Global Syndemics of Obesity, Food and Nutrition Insecurity, and Climate Changes on the DBM

William H. Dietz, M.D., Ph.D., George Washington University

The food system is both a major target and a major consequence of climate change. Since 1850, the earth's surface temperature has risen. This phenomenon, driven by increases in greenhouse gases (GHGs), has led to droughts and floods. The United States, which is the world's second largest contributor of GHGs, generates significant GHGs from its handling of its food supply, fossil fuels, and food waste. Dr. Dietz suggested that the United States has a moral imperative to address this problem.

During Dr. Dietz's tenure as co-chair of The Lancet Commission on Obesity, *The Lancet* published a 2019 report, *The Global Syndemic of Obesity, Undernutrition, and Climate Change*, illustrating how obesity (which affects 2 billion people worldwide), undernutrition, and climate change are interrelated and costly. The global cost of obesity is $2 trillion per year; malnutrition in all its forms costs $3.5 trillion per year. Dr. Dietz suggested that climate change, which accounts for 5% to 10% of the world's gross domestic product, is the biggest threat to planetary and individual health.

Syndemics are defined as clusters of diseases within a population that have adverse disease-promoting interactions at both biological and biosocial levels. Social forces drive the clustering of diseases at the same time and place. Disease clusters have a disproportionate impact on marginalized populations, with LMICs the most significantly affected. Examples of interactions of obesity, undernutrition, and climate change include the double burden of obesity and stunting in the same children and same population; reduced yields and micronutrient content of crops; the association of car use, obesity, GHG emissions, and inactivity; and NCDs (e.g., diabetes, colon cancer, CVD) due to cattle production, GHG emissions, meat consumption, and obesity.

Dr. Dietz discussed the contribution of two main types of systems to the global syndemics: agricultural and food processing systems and urban design, land use, and transport systems.

Climate change has had a significant impact on food and nutrition security and undernutrition. The increase in GHGs has resulted in higher temperatures, rainfall variability, extreme weather, higher levels of carbon dioxide, and warmer and more acidic oceans, leading to reduced crop yields with reduced nutrient content, higher prices, and changes in fish catch and fish nutrient content. These deleterious effects on the agricultural and food processing systems are driven by beef and dairy production, which generates GHGs and degrades the environment, and beef and dairy consumption, which contributes to obesity and NCDs. Cultural norms (e.g., believing that beef consumption is a right) and subsidies for commodity crops (keeping the price of beef low) are key contributors to global syndemics. Assuming that ingrained resistance to policy change is overcome, solutions might include increasing plant-based foods and reducing beef consumption, adding environmental costs to the cost of food, and redirecting subsidies for commodity crops. Better communication strategies to increase demand for healthier food alternatives, such as implementing sustainable dietary guidelines, are needed. These solutions would constitute a triple-duty action by positively affecting all three major issues: obesity, undernutrition, and climate change.

Transportation and urbanization also contribute to global syndemics. Studies indicate that car use is associated with physical inactivity, obesity, and climate change, with 15% of GHGs in the United States attributable to car use. Drivers of these problems include structural racism, which affects destination availability, employment distribution, and neighborhood design; a car culture that is sustained by cheap fuel supported by the fossil fuel lobby; and increased exposure to pollutants in low-income communities. Solutions include addressing structural racism by connecting jobs to people and implementing interconnected and mixed-use neighborhoods; redesigning infrastructure to support public transport systems, parks, and biking and walking trails to increase physical activity; eliminating fossil fuel subsidies; and

increasing the gasoline tax. Together, these steps would constitute a triple-duty action to reduce obesity and undernutrition as well as GHGs.

Dr. Dietz acknowledged that generating the political will to make such sweeping changes, particularly in such partisan times, is daunting. He suggested that the best strategy would be to engage young people and show them that activities such as making changes in diet can help avert the destructive effects of climate change. He observed that change must begin at the local level, because of the partisan paralysis at the federal level.

Dr. Dietz concluded with The Lancet Commission's recommendations:

- Reduce poverty and inequities to reduce the impact of the global syndemic on the most vulnerable populations.
- Fully implement human rights obligations to protect socially disadvantaged populations, especially women and children.
- Reduce the impact of large commercial interest on policy development and in generating policy inertia.
- Eliminate subsidies for gasoline and commodity crops.
- Provide and communicate actionable strategies about products and practices that contribute to climate change.
- Support and mobilize community coalitions to pressure local actions.
- Establish a framework convention to increase pressure to create healthy and sustainable food systems.

Discussion with Session I Presenters

- ***Dr. Raiten*** *enumerated activities designed to address some of Dr. Dietz's concerns, including a new research focus that is engaging a young generation of research scientists and efforts by the government to address the intersection of climate and health, particularly as related to nutrition and the food system.*
- ***Dr. Raiten*** *asked the panel to consider how to integrate the factors affecting global adolescent diet and nutrition choices into clinical and population assessments to improve the ability to make the case about their importance.* **Dr. Covic** said that much of the research in Africa is devoted to describing the problems rather than looking for solutions. The fact that countries are looking for solutions provides researchers with opportunities to engage with them and to find solutions. **Dr. Dietz** agreed that there is a key role for solutions-oriented research, such as determining what adjustments would make crops resistant to drought and micronutrient loss.
- ***Dr. Raiten*** *noted that indicators of global targets (e.g., wasting, obesity, anemia) do not include climate, perhaps because datasets do not incorporate indicators of environmental factors. He asked the panel how to integrate climate in a meaningful way and develop a way to measure it.* **Ms. Giyose** raised three concerns: how to ensure that policy questions address the challenges in Africa, whether Africa will have a seat at the table at the upcoming 27th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP27) in Egypt in November 2022 to present its own issues, and how to know what factors influence diets in order to mitigate the prevailing

challenges. **Dr. Pérez-Escamilla,** referring to his recently published editorial on the need to consider the problems of women and children in the context of climate change, suggested that the COP27 agenda must garner political support for climate change. He found it troubling that Coca-Cola is a major sponsor of COP27, noting that political and economic structures, not lack of knowledge, are responsible for supporting unhealthy food systems globally. **Ms. Giyose,** saying there would be a food and nutrition pavilion at COP27, asked who is involved with it and what issues would be presented. **Dr. Raiten** agreed that it would be important to know who was responsible for bringing this agenda forward at COP27.

- ***Dr. Covic*** *said that the framework she presented for monitoring food systems transformation tries to address issues of exposure to different climate shocks and the resilience capacity of countries to absorb them.* Researchers should look at how this relates to nutrition outcomes and what to do about it. The issue now is to mitigate climate change. **Dr. Covic** suggested a group consultation to devise ways of looking at climate and nutrition from a research perspective to produce evidence that would complement the efforts that countries are making on food systems transformation.

SESSION II: INDIVIDUAL/PARENT/FAMILY/HOUSEHOLD LEVEL: PREVENTION AND EVIDENCE-BASED INTERVENTIONS FOR CHILDREN AND ADOLESCENTS IN LMICS

Moderator

Ashley Vargas, Ph.D., M.P.H., RDN, NICHD

Double-Duty Actions to Address the DBM

Corinna Hawkes, Ph.D., University of London

The double-duty approach was inspired by trying to find a practical way to more efficiently address the DBM in the new nutrition reality. Double-duty actions are interventions, programs, and policies that simultaneously prevent or reduce the risk both of nutritional deficiencies leading to underweight, wasting, stunting and/or micronutrient deficiencies and of problems of obesity and diet-related NCDs. The double-duty approach is based on the presence of shared drivers (i.e., early life nutrition, food environments, diet, and socioeconomic factors) that affect all of the different forms of malnutrition, which presents opportunities to address the malnutrition problems on shared platforms. Dr. Hawkes cautioned that undertaking actions designed to prevent undernutrition without considering the risk of obesity could cause harm. She cited a program in Mexico that offered either a food basket or a cash transfer to people in remote, poor households. Both of these interventions led to increasing rates of overweight and obesity among women, particularly those who were already overweight. The lesson is that it is critical to design the intervention to do double duty. If there is a cash transfer, there must be an accessible food environment with healthy foods that do not promote overweight. Food baskets should be designed to provide healthy foods, not just caloric foods.

Dr. Hawkes described the four platforms and the double-duty actions associated with each:

- **Health services:** Double-duty actions include scaling up programs to support antenatal counseling on healthy eating and programs and promote optimal breastfeeding and elimination of breast milk substitutes, redesigning guidance for complementary feeding

practices that emphasize health and diverse diets and not just focus on undernutrition, redesigning growth monitoring programs to include diagnosis of overweight and obesity and undernutrition, and preventing energy-dense and micronutrient-fortified foods and supplements from spilling out into the community and causing harmful weight gain.

- **Social safety nets:** Double-duty actions include redesigning social safety nets to include counseling on nutrition, healthy diets, and health education and either facilitating beneficiaries' access to healthy foods, snacks, and beverages or introducing rewards for transfers or vouchers spent on nutritious foods.
- **Education:** Double-duty actions include redesigning school feeding programs to offer meals that meet children's energy and nutrient needs and devising new nutrition guidelines that restrict unhealthy foods, snacks, and beverages in and around schools. The focus must be on increasing the healthy foods and reducing the unhealthy foods.
- **Food systems:** Double-duty actions include scaling up agricultural programs that promote production and consumption of nutritious foods rather than just addressing caloric intake, designing new agricultural and food system policies with healthy and affordable diets in mind, and devising public policies to improve food environments to tackle all forms of malnutrition. This could include marketing and such things as drink taxes that target not only obesity but also undernutrition.

Dr. Hawkes outlined a number of research needs to better elucidate how consuming foods associated with obesity also influence undernutrition:

- Analyses of the association between consuming foods, snacks, and drinks high in calories, sugars, fat, and salt and obesity, DR NCDs, and undernutrition
- Assessments of interventions focused on undernutrition during early life (e.g., ready-to-use therapeutic foods, follow-on formula), longer-term effects on obesity, and DR NCD outcomes
- Analyses of the role of food environments and the impact of food environment policies (typically focused on obesity) on different forms of malnutrition
- Assessments of the feasibility, cost, and staff workload of double-duty actions
- Pilot testing and evaluations of double-duty actions in terms of cost and impact

Dr. Hawkes reviewed the next steps for the double-duty approach:

- Decide where it is most needed.
- Design a double-duty strategy by:
    - Reviewing existing programs and policies targeting undernutrition to assess whether they present risks or do harm and what opportunities they provide to be retrofitted as double-duty actions
    - Redesigning existing programs and policies to align with the double-duty approach
    - Designing new actions to tackle malnutrition in all its forms at all stages of the life cycle
- Build evaluations into the design and redesign of double-duty actions.
- Ensure that governance of nutrition considers both sides of the double burden.
- Finance with a double-duty approach.

- Train nutrition professionals and policy makers on the double-duty approach.

The DBM: Targets for Interventions and Future Directions

Nancy Krebs, M.D., M.S., University of Colorado School of Medicine

Dr. Krebs suggested that there is a multiple, not just double, burden of malnutrition, because the global syndemic includes obesity, undernutrition, and climate change. Moreover, the first 1,000 days of life inform the origins of risk, and each life cycle stage (i.e., fetal growth and development, infancy and young childhood, childhood and preadolescence, adolescence, and, in women, reproductive age) provide clues to intervention points.

Dr. Krebs illustrated the potential for finding intervention points with a case study from the western highlands of Guatemala, an area with a 90% indigenous population whose citizens have been stressed by a recent civil war. The Guatemalan participants were one cohort of the multicountry Women First (WF): Preconception Nutrition Trial, which randomized participants to arms providing nutrition interventions prior to conception, interventions during the late first trimester, or no supplementation at all. The Guatemalan enrollees were of short stature due to stunting (80% under 146 centimeters); 50% had a BMI greater than 25 kg/m^2, and nearly 30% had a waist-to-hip ratio strongly predictive of later CVD. Fifty percent of the participants had adequate diet diversity, with 20% of calories coming from processed, sweetened foods. The study, which looked at birth outcomes, found that out of 50,000 births in the Guatemalan cohort, 15.6% of babies had low birth weight (LBW), 5.4% were preterm births (PTBs) with LBW, and 10.7% were term births with LBW, a result similar to the birth outcomes in the WF cohorts at other sites. The WF study at all sites, including Guatemala, found that maternal underweight was associated with a higher risk of PTB and LBW and that overweight was associated with lower risk for these outcomes. However, although positive effects of the study interventions (e.g., increase in birth length, decrease in stunting at birth) were observed at other sites, the Guatemalan participants exhibited essentially none of the positive effects of the intervention. Possible explanations for this disparity include the fact that across all sites, women who were nulliparous had a fourfold greater response to the intervention than women who had one other pregnancy. Only 6% of the Guatemalan cohort were nulliparous, compared with 21% in the overall study. Also, women who were anemic at baseline had a twelvefold greater response. Only 12% of the Guatemalan cohort were anemic, compared with 60% in the overall study. Other explanatory factors might include the high rate of obesity, overweight, waist circumference, stunting, and micronutrient deficiencies in Guatemalan women, who also have high rates of both systemic and intestinal inflammation. On the positive side, Guatemalan women who were anemic at baseline had a positive response to the intervention, and their prevalence of overweight might have been protective for PTB or LBW outcomes.

Dr. Krebs presented WF data from the Pakistan site that looked at the effect of heat (as high as 120 degrees Fahrenheit on some days) on body length at birth. For participants with no nutritional intervention, in the first trimester, each increase of 5 degrees Fahrenheit was associated with lower length-for-age z-scores (LAZs). Excessive heat stress (i.e., 102.2 degrees Fahrenheit on more than 20 consecutive days) was also associated with lower birth length for these participants. However, there was no difference in LAZ between participants who received the nutritional intervention in the first trimester and those who had no heat exposure,

suggesting that nutrition might have a mitigating effect in the first trimester. Dr. Krebs noted that for the South Asian sites, excessive heat exposure was seen to be a significant risk factor for hypertensive disorders, stillbirth, PTB, and LBW, depending on the trimester of the exposure. Dr. Krebs also cited a recent study in India showing that high rates of anemia in pregnancy were directly associated with air pollution, another indication that environment can influence reproductive outcomes.

Dr. Krebs reported that although reduced stunting was seen in the WF trial, the infants' LAZ scores declined sharply after 6 months; by 24 months, their linear growth had plummeted and more than 60% were stunted. Across all sites, including Guatemala, the weight-for-length z-scores (WLZs) in the stunted group, whether at birth, 12 months, or 24 months, were lower than in the non-stunted group. The strongest predictor of LAZ and stunting at 24 months was birth LAZ, followed by PTB and maternal height.

From a DBM perspective, reduced stunting was associated with maternal BMI and maternal education. Better neurodevelopment outcomes at 24 months were associated with maternal education, better linear growth from 6 to 24 months, normal birth weight, and having access to play materials in a nurturing environment.

Dr. Krebs suggested a number of evidence-based strategies to address the global syndemic as they relate to points of intervention at each stage of the life cycle:

- Fetal growth and development: Increase birth length and decrease LBW and PTB.
- Infant and young childhood: Increase birth weight and linear growth, improve maternal education, and provide access to play materials.
- Childhood and early adolescence: Improve diet, education, and growth (e.g., better pelvic diameter).
- Adolescence: Improve growth and education, and reduce anemia, especially as young women approach their reproductive phase.
- Women of reproductive age: Reduce anemia, improve diet, increase nutrition for nulliparous women, target gestational weight gain (GWG), and reduce heat stress.

Dr. Krebs emphasized the need for a holistic and multisectoral approach to the multiple burdens of malnutrition, including addressing biomedical, nutritional, socio-environmental, cultural, and climate factors.

Food Systems and Diet Quality: Role in the DBM for Children and Adolescents

Isabel Madzorera, Sc.D., University of California, Berkeley

In the global setting, 768 million people are hungry, and 3 billion cannot afford a healthy diet. The vast majority of these people live in LMICs, where diets are rapidly shifting to processed, refined, and fast foods.

Suboptimal diets are the number one risk factor for mortality and are associated with diet-related NCDs. Dr. Madzorera presented a framework showing the drivers (e.g., environment, technology, political, sociocultural, demographic) that interact to affect food supply chains, food environments, consumer behavior, and diets, all of which ultimately affect nutrition and health concerns.

A key challenge in assessing diet quality for children, adolescents, and women is the limited availability of validated diet quality metrics. Using diet diversity as a proxy measure of diet quality in LMICs does not capture the global dietary transition to unhealthy foods. Dr. Madzorera's work has focused on validating new methods of assessing diet quality by looking at measures of nutrient adequacy and food diversity that also account for moderating the consumption of unhealthy foods (e.g., saturated fat, sodium, sugar) while maintaining a balance of energy-yielding micronutrients.

The role of maternal diet during pregnancy is a critical component of the DBM in children and adolescents. Dr. Madzorera presented two of her studies illustrating the effect of maternal dietary factors on early child growth. The first, conducted in Tanzania with 8,428 pregnant women, looked at maternal dietary diversity quality scores in relation to birth outcomes, using the United Nations Food and Agriculture Organization Minimum Diet Diversity for Women (MDD-W), a simplified, validated metric that measures only one aspect of diet quality: micronutrient adequacy. The study found that women with more diverse diets were less likely to have small-for-gestational-age (SGA) babies. The study also assessed a Prime Diet Quality Score (PDQS) based on frequency of consumption of healthy foods (e.g., vegetables, fruits, eggs, fish, poultry, whole grains) and unhealthy foods (e.g., red meat, processed meats, desserts, potatoes). The study found that higher scores for eating healthy foods were associated with a lower risk of PTB, LBW, and fetal loss.

The second study used the MDD-W to examine whether prenatal maternal dietary diversity influenced underweight in infants in a Ugandan birth cohort. The outcome measures were child underweight, stunting, and wasting up to 1 year of age. The study found that women with diverse diets had up to a 30% lower risk of having underweight infants. No association with maternal diet during pregnancy was seen with stunting and wasting.

These two studies indicated that low maternal dietary diversity and quality could be modifiable risk factors for adverse birth outcomes. LBW and SGA are important predictors of child anthropometric growth (i.e., stunting, wasting, and underweight). Both dietary diversity and diet quality should be considered as important risk factors for poor birth outcomes and may be important for early child growth.

Dr. Madzorera next discussed the role of adolescent diets and nutrition status in LMICs. She described her recent cross-sectional, school-based study of more than 4,000 adolescents 10 to 15 years old in sub-Saharan Africa (Burkina Faso, Ethiopia, Sudan, and Tanzania) to assess their dietary intake (determined by a 7-day food frequency questionnaire [FFQ]) and dietary quality (measured by the Global Diet Quality Score [GDQS]). The study found low weekly consumption of fruits and vegetables (i.e., overall less than twice per week) and relatively high weekly consumption of unhealthy foods, especially refined grains and baked foods. Overweight and obesity affected at least 18% of the adolescent girls in all countries except Ethiopia, and underweight affected more than 18% in Sudan and Ethiopia, indicating a clear DBM. For adolescent boys, overweight and obesity affected 10% in Sudan and Burkina Faso; underweight affected at least 18% in Sudan and Ethiopia. Adolescent boys consumed unhealthy foods less frequently but also consumed fewer vegetables. Maternal unemployment was associated with lower adolescent diet quality; physical activity improved diet quality. In general, poor-quality

diets (i.e., insufficient fruits, vegetables, and animal source foods) and greater consumption of unhealthy foods may be exposing African adolescents to the DBM.

Dr. Madzorera concluded with three important questions:

- What are the metrics and tools available to assess diet quality in children and adolescents? These tools are key to understanding contributing factors to the DBM in this group.
- How is diet quality associated with the triple burden of malnutrition (i.e., undernutrition, overweight and obesity, and micronutrient deficiencies) in children and adolescents?
- What interventions in food systems can improve diet quality and address the triple burden of malnutrition in children and adolescents in both rural and urban areas? Access to and diversity of markets, food value chains, and women's empowerment will be very important for understanding contributory dietary factors for adolescents.

Discussion with Session II Presenters

- ***Dr. Vargas*** *asked about the tension between having a validated dietary assessment tool, often used in large-budget studies, and the need for a tool that is culturally tailored and applicable to research in LMICs.* **Dr. Madzorera** said tools depend on context, noting that in many LMICs, in rural settings, looking simply at the diversity of the diet to assess diet quality is sufficient, whereas in urban areas, a tool that considers overnutrition in terms of more available processed foods would be more valuable. The problem is that the simpler, easy-to-use tools, such as the MDD-W, cannot track unhealthy food consumption.
- ***Dr. Vargas*** *asked for examples of how to incorporate effective, culturally tailored, multisectoral interventions into a study design, perhaps using tactics such as focus groups or local partners.* **Dr. Krebs** said that context must be taken into account, because diets are so diverse across different settings. **Dr. Hawkes** said investigators must start by evaluating what forms of nutrition are most important in the particular context, what overlapping forms of malnutrition are present, and what conditions are contributing to the malnutrition. Then investigators must look at the food environment, people's cultural perceptions, and the supply chain and be very diagnostic in using qualitative and quantitative analyses to understand the whole picture. Without rigorous evaluations of what is needed to ensure a thorough intervention and a feasible policy design, an intervention will only address a small part of the problem. **Dr. Vargas** suggested that utilization of this type of planning is a research gap.
- ***An attendee*** *asked about the impact of imported beverages and processed food on obesity, undernutrition, and hunger in Africa, suggesting that a more integrated and holistic approach (e.g., One Health) is needed to address the complex food and nutrition burdens in Africa and elsewhere.* **Dr. Madzorera** agreed that cheaper, less nutritious food is being imported into Africa from many other countries and is being actively promoted by advertisers. The challenge is the lack of policies restricting unhealthy foods. Another concern is the vulnerability of the African economy, especially after COVID-19, which made healthy foods, such as poultry, eggs, and dairy, more expensive

than imported, unhealthy foods. **Dr. Covic** added that having a common vision for necessary food systems transformations would help align the efforts of different actors in different domains of a country's food system. Introduction of unhealthy foods into African markets is often presented as foreign investment and a contribution to job creation. Governments may have the misguided perception that the presence of these foods is "doing good" for the country. Nutrition-sensitive policies that limit this are needed, and research should shed light on what such policies might include in different contexts. **Dr. Krebs,** noting that it is impossible to avoid the fact that the market and policies are slanted toward unhealthy food, wondered whether imposing the broad cost of production on prices might help.

- ***An attendee*** *asked which supplements were used in the Guatemalan WF cohort.* **Dr. Krebs** said that the primary intervention was small-quantity lipid-based nutrient supplement (LNS). Women who were underweight or had low GWG were offered additional LNS-based balanced energy protein (BEP) supplementation. Less than 10% of Guatemalan women qualified for BEP; nearly 90% of women in other cohorts received BEP.

SESSION III: SCHOOL/COMMUNITY LEVEL: PREVENTION AND INTERVENTIONS FOR CHILDREN AND ADOLESCENTS IN LMICS

Moderator

Sujata Bardhan, Ph.D., M.S., NICHD

Socio-Ecological Factors and the DBM Among Children and Adolescents in LMICs

Trias Mahmudiono, Ph.D., Universitas Airlangga, Indonesia

Dr. Mahmudiono's presentation focused on the socio-ecological effects of DBM at the individual (central adiposity and anemia), interpersonal (stunted children and overweight mothers), and population and country (stunting among children and underweight, overweight, and obesity among women and children) levels.

At the individual level, a series of studies in Brazil, Indonesia, Bangladesh, and Mexico showed a consistent association between short maternal stature and stunting, raising the question of whether action should be more targeted to the first 1,000 days of life or even earlier. For example, in Indonesia, one of the driving factors of stunting is early marriage (girls under the age of 18), when there is a high prevalence of maternal anemia, indicating that interventions might be needed before pregnancy. Dr. Mahmudiono cited the Barker hypothesis that undernutrition and unfavorable intrauterine environment at crucial periods in early life can cause permanent changes (in both structure and function) in developing systems of the fetus (i.e., programming). This may manifest as disease over a period of time due to dysadaptation with changed environmental circumstances. Dr. Mahmudiono noted that in certain populations, the prevalence of overweight and obesity results in much higher fat distribution, irrespective of BMI. For example, compared with American White men, the odds of prevalent hypertension were significantly higher for Chinese men at every level of BMI above the range of 18.5 to 22.9 kg/m^2. Even with adjustments for waist circumference, waist-to-hip ratio attenuated the ethnic differences but did not eliminate them.

At the interpersonal level, Dr. Mahmudiono suggested that mothers play an important role. For example, breastfeeding has been shown to offer immunological protections to children and help in maternal weight loss. Other interpersonal-level risk factors for DBM include large family size and the movement away from traditional foods to modern meals, many of which can be ordered online with little regard for or regulation of nutrient value. Increasing consumption of fat, sugar, and alcohol will lead to an increase in overweight and obesity in developing countries. Dr. Mahmudiono pointed out that the prevalence of child stunting and maternal overweight is not correlated with wealth and purchasing power as much as it is with maternal education. Dietary and food diversity are known to reduce the likelihood of the DBM, and maternal nutrition knowledge is correlated positively with children's vegetable intake and negatively with snack intake. Dr. Mahmudiono suggested that education should be targeted as an intervention. He noted the importance of food diversity in households where the mother is obese and the child is underweight. In this situation, two different dietary approaches are required: The child needs more animal-based foods, and the mother needs more fruits and vegetables.

For the population and country levels, Dr. Mahmudiono compared rural and urban areas, saying that studies had shown significant differences in children's central fat distribution between those two areas in Argentina and higher overweight and obesity in urban areas in Indonesia. However, the DBM occurs in both settings, and there is an increasing prevalence of overweight among poor rural and urban women. Shifts in surface transportation leading to more walking have played a role in reducing rates of overweight and obesity, and an Indonesian study showed that increasing work-related physical activity positively affected BMI compared with sedentary work.

Policy changes also affect the DBM. For example, a 10% increase in the price of edible oil on macronutrients in China from 1991 to 2000 led to a reduced consumption of fat as a proportion of total energy, especially for the poor. Another study, looking at the prevalence of the DBM in households based on the country's gross national product, showed that the DBM was highest in middle-GNP (gross national product) countries, such as Indonesia.

Dr. Mahmudiono presented the following conclusions:

- The DBM is a public health phenomenon associated with multiple socio-ecological determinants.
- Populations undergoing demographic and nutrition transition are the most vulnerable to the DBM, especially among urban populations.
- Addressing malnutrition in all its forms requires an integrated agenda addressing the root causes of malnutrition at all stages of the life course.

School Feeding Programs

Maureen M. Black, Ph.D., University of Maryland School of Medicine, University of Maryland School of Medicine and RTI International

Children 5 to 19 years old have complex biological systems (e.g., neurological, cardio-metabolic), which are influenced by the complex external systems of the environment (e.g., climate, physical, social, food, home). Many health and nutrition interventions occur during the

school years (e.g., vision screening, vaccinations, oral health promotion), but one of the most important is the global program providing school meals, many fortified with micronutrients.

The United Nations World Food Program (WFP) was established in 1961 and instituted the first school feeding program in Togo. By 2020, 50% of school-aged children (388 million) were receiving school meals daily in at least 161 countries. In addition, the McGovern-Dole International Food for Education and Child Nutrition Program donates surplus U.S. agricultural commodities to school feeding programs in LMICs. These programs have improved school attendance, especially for girls in countries where they are permitted to attend school so long as a meal is provided. However, 73 million of the most vulnerable children are still not being reached.

School feeding programs are considered an aspect of social protection, providing multiple benefits to children. Governments view these programs as long-term social protection investments and short-term safety nets and are calling for greater rigor in the analysis of policy issues, evaluations, and trial designs.

India, Brazil, China, the United States, and Egypt have the largest school feeding programs. The coverage of school feeding programs is about 20% in low-income countries, 45% in lower-middle-income countries, and 58% in upper-middle-income countries. About 90% of school feeding funding comes from government sources, although low-income countries rely on international donors. Countries are increasingly linking their financial investment in school feeding to legal and policy frameworks, particularly in upper-middle-income and high-income countries. School feeding programs also have a positive community impact, creating 1,668 jobs for every 100,000 children receiving school meals as measured in 48 countries.

A 2020 meta-analysis of school feeding programs in LMICs that looked at 57 studies of children 6 to 15 years old showed that the programs had beneficial effects on weight, height, and school attendance but no impact on hemoglobin, serum ferritin, or math scores. Dr. Black said her double-blind, randomized trial in India, where rates of anemia are very high, showed that micronutrients added to preschoolers' midday meal significantly reduced anemia (from 48% to 9%) and iron deficiency (from 70% to 30%). In addition, the added micronutrients promoted expressive language among the more vulnerable children in low-quality (but not high-quality) preschools. Dr. Black said that the benefits of school feeding programs are so important that receiving a school meal should be a human right. In India, schools are legally required to provide school meals, an intervention that supports both the children and their communities.

A systematic review (47 studies) of universal school meals (i.e., meals provided for everyone at the school) in the Organization for Economic Co-operation and Development countries (including the United States and higher-income European countries) showed that many countries have instituted nutrition standards for school meals. Positive associations with attendance, diet quality, food security, and academic performance were shown, with no adverse effects on BMI.

Dr. Black presented a list of research gaps and suggestions for moving forward:

- Expand access to universal meals, especially for schools in vulnerable circumstances (e.g., extreme poverty, conflict areas).

- Align school meals with nutritional guidelines (e.g., Dr. Black's addition of micronutrients to the midday meal in India).
- Develop inclusive policies that incentivize sharing and distribution of existing resources (e.g., locally available fruit and vegetables).
- Evaluate the financial impact of school meals on families, schools, and communities.
- Evaluate relations between universal meals and academic performance, considering pedagogical variations (school quality).
- Integrate relations between universal school meals and environmental issues, including climate, peace, social protections, and child rights.

School-Based Interventions Addressing Adolescent Malnutrition in LMICs

Sachin Shinde, Ph.D., M.P.A., M.A., Harvard School of Public Health

The strong link between health, nutrition, and education makes schools, even in LMICs, an important and sustainable platform to address the multiple forms of malnutrition in adolescents. This is especially important because 9 in 10 adolescents live in LMICs, with a large percentage in sub-Saharan Africa, and there are limited data to inform policies and programs addressing the unique developmental and health needs of adolescents in these settings.

Dr. Shinde described the work of the Africa Research, Implementation Science, and Education (ARISE) Network, which was launched in 2014 to advance collaborative education and research activities among 21 institutions in Africa. The ARISE Network focuses on two important goals: understanding the developmental needs of adolescents in LMICs and building evidence on effective interventions to address adolescent health. Activities that have been undertaken to achieve these goals have included:

- A community-based health study of more than 8,000 adolescents 10 to 19 years old to better understand their health-related behaviors, associated risk factors, and disease burdens and identify health intervention opportunities
- A school-based adolescent health and nutrition study aimed at understanding health risks and disease burdens, with a focus on the school food and nutrition environments, and an analysis of policies in five sub-Saharan African countries
- An adolescent health and well-being longitudinal study to address the critical gap in collection of regular and quality adolescent health data and to pilot selected adolescent health indicators

Key findings from these studies showed that 1 in 5 adolescents was underweight (boys more so than girls) and 1 in 10 was overweight (girls more so than boys). There was a high burden of anemia, a pattern of unhealthy eating habits (e.g., high consumption of processed foods), and a low prevalence of physical activity. School meal programs in sub-Saharan African countries were reaching only 30% of all children of primary school age. School food and nutrition budgets and supply chains were challenging, awareness of health-related policies and implementation of nutritional interventions was low, and there was inadequate provision of health, nutrition, and physical activity in schools to address adolescent malnutrition.

These findings led to the development of a comprehensive, three-pronged framework of interventions to address the multiple forms of malnutrition among adolescents in LMICs by

promoting healthy diets, physical activity, and nutrition education; providing school meals with nutrient supplementation to manage acute nutritional problems; and creating environments within the school to address overweight, obesity, and hygiene.

Two systematic reviews were conducted to assess and improve the quality of these interventions on educational and health outcomes. The first study found that most of the school interventions did not include specific nutritional objectives and often included food that was poor in nutritional quality and unappealing to young people. There was a lack of consensus and guidance how to design school meals in resource-limited settings and how to assess and improve school feeding program quality. The second review, which focused on interventions other than school feeding and supplementation interventions (e.g., physical activity, water, sanitation and hygiene services, combinations of interventions), found that the intervention development process was not adequately described and that the interventions relied heavily on conventional delivery mechanisms such as classroom-based seminars and workshops.

Two cluster randomized controlled trials on interventions are being implemented in sub-Saharan Africa. The first, with 750 students 14 to 17 years old, will compare the effectiveness of a complete or partial package of interventions that include school meals, school gardens, nutrition education, and community workshops against no interventions. The second will examine the effectiveness of high-impact micronutrient supplementation interventions on nutritional status and academic performance.

Dr. Shinde said that the extensive efforts to implement school-based adolescent nutrition interventions have provided lessons about the best way to move forward, including:

- Focusing not only on education and skill-building interventions but also on multifaceted and integrated interventions that are adapted for school environments in the specific context of the various LMICs
- Designing interventions that address the multiple environmental needs of adolescents and focus on the syndemic nexus of risk factors, pathways, and protective factors
- Ensuring that school-based interventions resonate with adolescents' values and social context, food environments, autonomy, need for peer approval, and norms
- Involving a broader community (e.g., parents, community members, social media influencers, healthcare providers) in the design and implementation of school-based interventions

Dr. Shinde highlighted three key areas for future research investments to support better actions for adolescent nutrition:

- Neglected age groups: Data are lacking for boys 10 to 14 years old and older, vulnerable adolescents (e.g., migrants, ethnic minorities, socially disadvantaged individuals).
- Areas for intervention: Tailored and context-specific research efforts and better awareness of bidirectional links among health, nutrition, and education are needed to understand the full range of the effects of multifaceted interventions in LMICs.
- Alternate platforms: Through a range of health and non-health resources (e.g., virtual networks, international social movements), alternate platforms are needed to reach out-of-school adolescents.

Dr. Shinde emphasized the need to build partnerships and collaborations of researchers to develop and evaluate multifaceted interventions to address adolescent health and nutrition.

Discussion with Session III Presenters

- ***Dr. Bardhan*** *asked whether the refugee population, especially those moving from LMICs to high-income countries that provide government assistance, had been studied.* **Dr. Shinde** said this is an important issue to explore, but no studies have looked at it.
- ***Dr. Bardhan*** *asked about the role of the school garden program as part of nutrition education.* **Dr. Black** said school gardens are an excellent example of community involvement promoting the use of local foods and extending an economic benefit beyond the school. **Dr. Shinde** added that this is an example of an intervention that has done well in high-income countries and can be successfully adapted to LMICs to bring multiple factors together to influence adolescent behavior.
- ***Dr. Kutlesic*** *asked about the level of awareness of the DBM in Indonesia and whether there are public health campaigns addressing the issue.* Dr. Mahmudiono responded that public health programs targeting undernutrition and stunting are national priorities in Indonesia, while campaigns to reduce overweight and obesity focus on weight loss and increasing physical activity. Dr. Mahmudiono reported that DBM is not currently being addressed within public health programs in Indonesia. He added that the potential for improvement in DBM lies in school-based interventions and including a focus to better educate girls to move away from early marriage. Government investment in school programs is currently focused mainly on the lowest income communities, not on a national effort.

SUMMARY OF DAY 1

Daniel Raiten, Ph.D., FASN, NICHD

Dr. Raiten traced the sweep of the day from the keynote speakers, who outlined the nature of the DBM and the scope of the problem, to the first series of presenters, who focused on the external environment, the factors that influence the DBM, and the need for more integrative interventions to deal with complex, multidimensional problems. The second group of presenters emphasized the need for context-specific design of intervention strategies and the importance of the early life stages in addressing the DBM. The final presenters refined the issue of context, the need for multisectoral and socio-ecological approaches, and the important role of schools in addressing the DBM. Identifying children's needs and assessing the impact of the interventional programs will require a concerted effort. The clear messages from this first day were that context matters, one size does not fit all, and unintended consequences must be avoided. The DBM among children and adolescents is a complex issue and a difficult challenge, but rather than be daunted by it, we must take it on and make a difference.

DAY 2

KEY THEMES FROM DAY 1 AND CHARGE FOR DAY 2

Andrew Bremer, M.D., Ph.D., NICHD

The Day 1 presentations focused on the global and regional differences in the DBM among children and adolescents in LMICs. Presenters elucidated the broader context of the environmental influences at the individual, parental, family, and household levels and discussed opportunities for prevention and evidence-based interventions in school and community platforms. Takeaway messages were that context matters, the DBM coexists with other diseases, and several indicators of the DBM, such as obesity and stunting, can coexist in the same individual, household, community, and population. Coexistence of multiple forms of malnutrition has become the new normal. The discussions reinforced the idea that children and adolescents are not simply small adults but rather individuals developing along a biological continuum, which must be taken into account when assessments and interventions are devised. There was a robust discussion about the influence of both the internal environment (e.g., family, school, community) and the external environment (e.g., climate's effect on the DBM) and the importance of double-duty interventions that address more than one nutrition-related issue simultaneously.

The charge for Day 2 is the same as for Day 1: to listen with open minds, learn from one another, and engage fully with the goal of developing actionable ideas. Dr. Bremer concluded with a quote from Brené Brown: "Be creative, stay curious, think outside the box, and use all of our collective wisdom and experiences to think about ways to move the field forward and make an impact."

SESSION IV: COUNTRY/GLOBAL LEVEL: PREVENTION AND EVIDENCE-BASED INTERVENTIONS FOR CHILDREN AND ADOLESCENTS IN LMICS

Moderator

Juanita J. Chinn, Ph.D., NICHD

DBM: Prospective Studies in Pune, India

Chittaranjan Yajnik, M.D., KEM Hospital Research Centre, India

Dr. Yajnik focused his presentation on his intergenerational studies in Pune over the past 30 years with a population that has faced rapid nutritional, epidemiologic, and economic transition. He began with a "confession of a thin-fat Indian," noting that he was one of the people in the famous picture that had been used in two previous presentations at this conference showing two men with an identical BMI: 22.3 kg/m^2. Dr. Yajnik's body fat was measured at 21%; the other man, an Englishman, had 9% body fat. This image illustrated the limitations of using BMI as a measure of adiposity across populations, possibly due to intrinsic contributory factors, such as long-term nutrition, that result in differences in body composition in different populations.

The Pune Maternal Nutrition Study (PMNS), a prospective study begun in 1993 in six villages near the city of Pune, was designed to look at the nutritional determinants of fetal growth and

the life course evolution of various phenotypes at the preconception, intrauterine, birth, prenatal, and 6-, 12-, 18-, and 24-year-old stages. A biobank of DNA, plasma, urine, buccal swabs, and, later in the study, microbiota was developed. Data on the families in the study, which now extends to three generations, include information on body size and composition, nutrition, growth, cognition, and disease risk factors. From 1993 to 2022, the villages have undergone a significant social and nutritional transition. The population has doubled, water and electricity are plentiful, transportation includes two- and four-wheelers, literacy and education has increased greatly, and fast foods have become a common part of the diet.

This rapid socioeconomic development is reflected in various forms of the DBM. Over the years, underweight in mothers and fathers progressively decreased; in children, it decreased until children were 6 years old, at which point it rose, especially in girls up to 18 years old. After that age, many girls married, became pregnant, and gained weight. Stunting affected about 30% of parents and children at the beginning of the study, but over the years, children have grown well; now, two generations later, only 10% of children are classified as stunted. Parents exhibited a progressive increase in overweight and obesity (BMI greater than 25 kg/m^2); children's BMI remained fairly stable until 18 years of age, after which there was a substantial increase in overweight and obesity, especially in men. By 24 years of age, men were at the same overweight/obese percentage as their parents (40%), while only 18% of women were overweight or obese. The clear trend is a decrease in undernutrition and a gradual increase in overnutrition.

The PMNS also looked at nutrients in the blood of this predominantly vegetarian population, especially vitamin B12 and folate, which are associated with fetal and maternal outcomes. During pregnancy, two out of three mothers were B12-deficient, although about 40% of mothers and 50% of fathers are routinely B12 deficient. A rapid increase in B12 deficiency in both boys and girls has been significantly mitigated by an intervention trial. Folate deficiency was very rare. Dr. Yajnik noted that the combination of a B12 deficiency with adequate folate status could have implications for the growing fetus.

The study has shown a gradual increase in glucose intolerance over the past 30 years, presenting as prediabetes and diabetes in both parents, and a striking prevalence in their children. By the time they are 18 years old, prediabetes is seen in 40% of boys and 20% of girls, even though only 8% of boys and 5% of girls are overweight or obese at that age. The study indicated that the life course predictors of prediabetes by 18 years of age were short birth length, small head circumference, and a mother who was not overweight. One-third of glucose-intolerant boys and two-thirds of glucose-intolerant girls at 18 years of age were underweight; this combination of underweight and glucose intolerance is a strong DBM. Of the boys in the PMNS who had low lean mass and high fat mass, almost 60% had prediabetes by age 18. In terms of phenotype, Dr. Yajnik noted that being "thin-fat" (i.e., not looking fat but having a high fat mass) or "short-fat" (i.e., being short with a high fat mass) increases the risk of diabetes and other NCDs. The pathophysiology of type 2 diabetes in young people in LMICs is predominantly driven by insulin deficiency; in the higher-income countries, however, it is driven by insulin resistance, which may involve different mechanisms that require different treatment.

Dr. Yajnik observed that life is complex, and defining mechanisms requires multiple studies. He cautioned that looking only at the first 1,000 days misses the critical preconception and periconception windows of epigenetic programming that occur within 48 to 72 hours of conception, when the mother does not even know she is pregnant. This fact informed the Pune Rural Intervention in Young Adolescents trial, a preconception maternal vitamin B12 and multi-micronutrient supplementation program that was found to improve neurodevelopmental outcomes at 2 years of age. The hope is to also show improvement in diabetes risk.

Food Environment Regulations

Camila Corvalán, M.D., Ph.D., University of Chile, Santiago

Food environment is defined as the stage where consumers interact with the food system. It is related to economic and cultural decisions about what to eat and to marketing, price, and food availability. Although the general approach has been to try to increase the intake of healthy foods, as LMICs are exposed to an increasing amount of unhealthy food, actions that affect the food environment are also being used to stem the consumption of unhealthy food products. An important example of this approach is Chile's three-pronged law that requires warning "stop signs" on the front of packages containing unhealthy food (e.g., foods high in sugar), limits on the marketing of unhealthy products to children, and banning unhealthy products from school feeding programs.

An analysis of the effect of Chile's regulations showed that 40% of packaged foods carried labels identifying them as unhealthy, marketing of unhealthy foods to children declined by 70%, and unhealthy food products in the school environment declined by 85%. Chilean adolescents were found to prefer warning labels to nutrient fact panels, finding the labels easy to understand. Marketing restrictions resulted in a 50% decrease in children's exposure to unhealthy food ads. A modest but significant decrease in the purchase of foods high in saturated fat, sodium, and calories was observed, and there was a 24% decline in the purchase of sugared beverages, a higher decline than seen in other countries as a result of taxing these beverages. Analyses of dietary intake showed a significant decline in the intake of sugars and sodium but not in the intake of fat. At the school level, a comparison of Chilean adolescents with adolescents from Australia, Mexico, Canada, the United Kingdom, and the United States found that the Chilean adolescents were eating the least unhealthy food at school and the most fruits and vegetables.

Dr. Corvalán said that to combat the challenges that lie ahead, more research and knowledge about those who suffer the highest DBM, such as indigenous populations, low-income people, and racial minorities, are needed. More information about the response of the food industry to regulations is also needed. For example, in Chile, although the law did not result in price changes, the industry reformulated some products to have less sugar and sodium to avoid being covered by the regulations; increased additives, particularly noncaloric sweeteners; and designed their own positive labels to be put on packages right beside the warning labels. More research is also needed to develop tools for assessing complex interventions, keeping in mind that food interventions are complex and affected by multiple factors, including the responses of consumers and the food industry.

Dr. Corvalán said that the way forward includes:

- Action by financial and public institutions and business incentives
- Mandatory statutory policies, such as those implemented in Chile, that result in product reformulation for the better
- Monitoring of food environment indicators, such as food composition, labeling, marketing, pricing, and accessibility; outcomes on populations; and how well public policies are working
- Collaboration with researchers and advocates from a variety of disciplines and regions (e.g., the Latin American and Caribbean Nutrition and Health Community of Practice) to share successes and evaluate failures of initiatives to improve food environments

Transformation of Diets and Supply Chains in LMICs: Policy Implications

Thomas Reardon, Ph.D., Michigan State University

Dr. Reardon said that food supply chains are the main factor affecting the availability of food and the patterns of food consumption in low- and middle-income countries today. Most food consumption (65%) occurs in cities, and nearly 100% of the urban diet and at least 65% of the rural diet is purchased (i.e., through supply chains). People in rural areas grow very little food for their own consumption. They get their food through purchases from supply chains and sell items to buy the food.

The amount of processed food has risen rapidly, a phenomenon that is mostly positive. For example, in rural Tanzania, 29% of the 63% of the food that is purchased is unprocessed (e.g., fruit), 56% is low-processed (e.g., flour, bread), 1% is highly processed and unpackaged (e.g., sweet buns), 6% is ultra-processed (e.g., soda pop, cookies), and 5% is meals away from home. In urban Tanzania, 29% of purchased food is unprocessed, 49% is low-processed, 2% is high-processed and unpackaged, 9% is ultra-processed, and 18% is meals away from home. The key points from the Tanzania data, which are similar to many other countries' data, are that processed food, which has been on the rise for 50 years in Africa, is very important to urban and rural consumers, is mostly low-processed, saves time, and improves quality of life, especially for women, who used to spend 4 hours per day pounding grain. Ultra-processed food is a minor part of the diet. Processed food consumption, which is deeply rooted in employment and lifestyle needs and patterns, is here to stay. Dr. Reardon suggested that policies and education will not uproot processed food consumption. Convenience foods have helped relieve stress in overburdened households, and policies should focus on reducing incentives for the emerging ultra-processed food consumption, not on reversing consumption of processed food.

Dr. Reardon discussed trends and policy implications of the consumption of healthy foods (e.g., fruits, vegetables, fish, chicken, milk), which has risen steadily in LMICs in the past 20 years. Together, these items now exceed the consumption of basic grains and starch staples in Africa and Asia, with both the middle and lower classes spending 15% of their food budget on fruits and vegetables. In rural areas, 65% to 80% of fruits and vegetables are purchased, not homegrown, and the percentage of animal products that are purchased is even higher. These data show that in urban and rural areas combined, supply chains (i.e., markets) are delivering about 90% of the healthy foods that adolescents and others should be eating. Dr. Reardon suggested that international attention to promoting home gardens in LMICs is unhelpful, because it will not affect the 90% of healthy products that the markets are delivering, and it

distracts from what should be the center of the nutrition debate on how to increase consumption of healthy foods, which is to encourage governments to invest in improving wholesale markets and roads as their central pro-nutrition policy.

Policies that tax sodas and sweets may have an effect on the consumption profile over time in some countries, but they are not likely to have an effect in places like Africa, because those policies require substantial administrative capacity and political will. In practice, the availability of healthy foods is not decided by nutrition programs, policies, or taxes; it is decided by wholesalers, markets, truckers who move the products, and the quality of the roads. The quality of the wholesale markets is overwhelmingly the most important factor in determining whether children and adolescents in LMICs are getting to eat fruits and vegetables.

Discussion with Session IV Presenters

- ***Dr. Krebs*** *asked whether overweight in early childhood or adolescence might drive some of the increase in linear growth and reduce stunting over time.* **Dr. Yajnik** said answering this question would require a special analysis. His study population had very few overweight or obese children, so overweight in the first 1,000 days is unlikely to contribute to improved linear growth and reduced stunting, but overweight during adolescence might be a factor. The significant improvement in stunting in just one generation could also reflect the fact that the first generation was more stunted.
- ***An attendee*** *asked what percentage of Chilean women and mothers are working, whether families are relying more on processed and prepared foods as a result, and whether fruits, vegetables, meat, and fish are expensive.* **Dr. Corvalán** made a distinction between ultra-processed foods, which have no trace of real food in their composition, and processed foods, which are treated to make them last longer. There is no gain in having women out of the house and having a majority of the population overweight or obese and prone to diseases. Investments must be made in social determinants of dietary behavior, including gender equality, and the cost and accessibility of healthy foods. This will require the participation of not only health experts but also economists and transportation specialists.
- ***An attendee*** *asked for examples of countries that are making changes in their supply chains.* **Dr. Reardon** cited Bangladesh as an example of investing in market conditions and providing incentives for the private sector to thrive. The Bangladeshi government addressed concerns about the rising cost of fish, a dietary staple, by improving feeder roads and highways, incentivizing fish wholesalers, makers of ice, and transporters to set up rural markers. Thousands of farmers started fish aquaculture businesses, producing fish for the domestic market. The fish market increased dramatically in just two decades, the price of fish went down, and fish protein became more accessible to the poor. Similar examples include incentivizing fruit and vegetable markets in China and Zambia through improvements in highways and wholesale markets, allowing thousands of farmers to move into fruit and vegetable production. Providing favorable market conditions is a central intervention that makes both producers and consumers gravitate toward healthy foods and can be the basis for making other interventions, such as taxes and education, far more effective.

SESSION V: GLOBAL DISSEMINATION AND IMPLEMENTATION SCIENCE

Moderator

Susan Vorkoper, M.P.H., M.S.W., FIC, NIH

Policy and Implementation Challenges for Addressing the DBM Among Children and Adolescents in LMICs

Edward A. Frongillo, Ph.D., University of South Carolina

Food support programs sometimes can contribute to weight gain. A program in Mexico that provided either food baskets or cash to very poor rural households was found to increase women's weight over a period of 2 years, with the greatest weight gain in women who were already obese. A maternal and child health and nutrition program in Guatemala that provided food resources and education related to health and food was found to increase women's weight in the perinatal period in the group receiving a full family food ration or an individual ration of corn–soy blend.

Dr. Frongillo noted that although these two studies illustrated the challenge of implementing programs to reduce undernutrition without exacerbating the problem of overnutrition, there have been successes. A study with Costa Rican women who experienced overweight, food-insecurity, and resided in low-income households found those who participated in a multilevel intervention that included peer group meetings were successful in reducing their overweight status and food insecurity and increasing their reported psychological empowerment and ability to find a job to help support their households. The incorporation of the intervention into municipal programming has been sustained over the course of 4 years, largely due to the study intervention being designed to meet the needs of the participants.

Peer support groups in Zimbabwe have been found to have similar positive effects for adolescents, and schools are often an effective delivery platform for multiple interventions, including providing meals and food fortification, introducing locally grown foods, banning sugar-sweetened beverages, providing supplements, and encouraging visits to health centers. School curricula might also include nutrition education to influence dietary diversity and school gardens to provide practical knowledge.

Children and adolescents are also influenced to varying degrees by markets and regulations, such as taxes on sugar-sweetened beverages, front-of-package food labeling, and subsidies on nutritious foods. But in general, there are few cost-effective programs to shift dietary practices.

Social safety net programs that support families (e.g., food stamp programs) can be effective, but more research is needed on outcomes. Social protection programs seldom specifically target adolescents, so these programs' impact on this population has not been fully assessed. Bangladesh's Female Secondary School Stipend and Assistance Program, which provides cash transfers to adolescent girls to motivate them to continue in school and delay pregnancy, has had positive results.

Social media influences dietary choices for adolescents through advertising and peer interactions, but most interventions on this platform focus more on management of overweight and obesity rather than on prevention. One example of a successful social media campaign is

the Bangladesh Eat Well, Live Well program, which was led by adolescents and supported by more than 5 million people who pledged to buy and eat more healthy food.

Common features of adolescent diets include inaccessibility of nutritious food, low cost and high appeal of unhealthy foods, and a wide variety of adolescent contexts, such as differing degrees of autonomy and agency of adolescents with regard to eating traditional, mixed, and modern diets.

Dr. Frongillo described three studies illustrating people's food choices and perceptions:

- A study interviewing adolescents in Ghana found that although they had a general concept of healthy and unhealthy food choices, their social networks informed their food guidance. They chose portion sizes based on different settings (e.g., home, school, community) as a way to seek social acceptance or keep up appearances and exercised some autonomy in food choice within the constraints of their home or school environments. Dr. Frongillo noted that understanding how children and adolescents perceive these issues is critical for designing effective interventions.
- A national qualitative study in the United States interviewed people to understand what they thought caused obesity. They described obesity as "sinful behavior" (e.g., gluttony), disability, eating disorder, food addiction, time crunch, industry manipulation, and toxic food environment. The study found that these descriptors were associated with the policy options that the participants were willing to endorse.
- A study in India looked at how the policy environment related to the DBM and found that nutrition-related policies were not oriented toward addressing the DBM and that there was a wide variation in framing nutrition-related NCDs. The DBM was not yet a priority, there was little coherence about what to prioritize and why, and there was a lack of convergence from stakeholder disciplines and agencies to work on reducing nutrition-related NCDs.

Dr. Frongillo said that knowledge gaps around adolescent nutrition begin with the lack of basic data. Adolescent nutritional problems are invisible without established targets or standardized data collection systems to inform action; given many adolescents' autonomy, assessing their diets is difficult. Many countries lack dietary data, there are wide variations in methods of assessment, and a globally accepted set of measures and indicators of healthy diets is only now being developed.

Simultaneously addressing under- and overnutrition requires an in-depth understanding of children and adolescents to identify root causes, needs, and sustainable actions. This calls for careful research, implementation, and evaluations. In contrast to undernutrition, societal and policy stakeholder framing and consensus about nutrition-related NCDs is nascent in most countries. Dr. Frongillo emphasized the lack of data and data systems on diets and physical activity of school-aged children and what actions work, and he cited the need for a widespread platform for data collection.

Addressing the DBM: Applying Implementation Science (IS) and Knowledge Brokering to Accelerate Progress

Isabelle Michaud-Létourneau, Ph.D., M.P.H., RD, University of Montreal

Double-duty actions to address the DBM, as outlined by Dr. Hawkes on Day 1, are intervention programs and policies that can simultaneously prevent or reduce the risk of both nutritional deficiencies and diet-based NCDs. However, for double-duty actions to have an impact at scale, two challenges must be addressed: problems that arise during the implementation process and ensuring that the practitioner's knowledge is both accessible and used for the implementation.

The mission of the Society for Implementation Science in Nutrition (SISN) is to address these challenges worldwide by bringing the best available scientific knowledge and practical experience to the design and implementation of actions that improve nutrition. SISN identifies five domains that influence the quality of implementation in a framework: objects of implementation (e.g., medications, policies), implementation staff (e.g., ministries, the private sector), environment, intervention target (e.g., household, community), and implementation process (e.g., initiation, planning). SISN's goal is to build on the strengths and address the weaknesses in the five domains during all phases of the planning and implementation.

The triple-A cycle is a strategy used to assess the problem, analyze its causes, and design and implement actions. To better focus on the implementation aspect, the Implementation Science System (ISS) Operational Model was devised to operationalize the triple-A framework by putting multiple systems into practice for maximum impact.

Dr. Michaud-Létourneau described the ISS Operational Model, which is based on using three different forms of knowledge to initiate action: contextual knowledge and experience (CKE; e.g., the knowledge of actors in a country, retrieved by a doing a multilevel bottleneck assessment that identifies constraints or problems that are blocking the flow of the operation), global knowledge and experience (GKE; e.g., search, examination, and curation of existing knowledge to help find potential solutions and identify bottlenecks), and contextual implementation research (CIR; e.g., design and conduct implementation research [IR] studies to further understand bottlenecks and potential solutions). Dr. Michaud-Létourneau explained the difference between IS and IR. IS an interdisciplinary body of theory, knowledge, frameworks, tools, and approaches used to strengthen implementation quality and impact. IR is the component of implementation science that generates new knowledge through empirical studies.

Knowledge brokering is another central implementation strategy that facilitates movement from knowledge to action. Knowledge brokers include the linking agent (e.g., identifies opportunities to connect different actors), capacity builder (e.g., develops training sessions to share IS principles), facilitator (e.g., facilitates agreement on modalities), evaluator (e.g., identifies and assesses the system-level factors creating bottlenecks), and knowledge manager (e.g., conducts literature reviews). The knowledge brokering team plays a key role in undertaking assessment activities and bottleneck solution inventories that drive action. Knowledge brokering is an important complement to the ISS Operational Model.

Dr. Michaud-Létourneau provided some guiding principles for an IS approach:

- Mobilize existing knowledge, frameworks, and tools to address implementation bottlenecks, wherever possible.
- Whenever research is needed, use methods with the level of rigor, practicality, and timeliness appropriate to the decision context.
- Collaboratively identify research topics based on priority implementation challenges and bottlenecks.
- Facilitate formal and informal interaction, knowledge exchange, and collaboration between researchers and program and policy actors in an ongoing manner so that research is based on knowledge that is already available and can be applied quickly.
- Knowledge brokering (whether individual or team) can facilitate all processes to strengthen implementation and lead to impact.

Fostering Information Systems and Networks to Support LMIC Decision Makers in Addressing the DBM: Learning from Sub-Saharan Africa

Rebecca Heidkamp, Ph.D., Johns Hopkins University

The 2014 Global Nutrition Report stated unequivocally, "Nutrition needs a data revolution." Dr. Heidkamp suggested that this revolution is particularly needed for recognizing and prioritizing the DBM in adolescents and children 3 to 18 years of age to characterize their problems and monitor responses.

Dr. Heidkamp's presentation focused on the periodic and routinely collected data that are used for population-based monitoring of and response to problems in LMICs. These data are generated by the countries themselves and include population-based surveys, such as multi-topic health, economic, and development surveys (e.g., Multiple Indicator Cluster Survey); facility surveys (e.g. school-based surveys); and nutrition-focused surveys (e.g., micronutrient status), as well as administrative data (e.g., school-related price monitoring data). They are the foundation of a national nutrition information system (NNIS), which countries use to guide decisions, actions, and accountability. Because country-level priorities differ from global accountability priorities, countries have a high demand for subnational data and less demand for modeled estimates.

Dr. Heidkamp acknowledged the importance of taking action but emphasized that data are always needed to monitor actions, define the population being reached, and evaluate the effectiveness of interventions. Schools are an obvious target for gathering data, but data to assess whether non-school–based social protection interventions are reaching target populations are also needed. Assessments of the effectiveness of multisector nutrition strategies requires co-coverage and composite data coverage across schools, households, priority populations, community, and government levels.

Nutrition-relevant data that are periodically and routinely collected on children and adolescents in LMICs are mainly focused on children 0 to 5 years old and adolescents 13 to 17 years old. There is a large gap of missing data for children 6 to 12 years old, many of the questionnaires do not elicit nutrition-relevant data, and the limited data that are collected are neither standardized nor comparable.

Improving data collection on children and adolescents in LMICs to influence decision making will require instituting a multistage nutrition data value chain to delineate how data are prioritized, defined, collected, analyzed, and used. Although every stage of the chain is critical, Dr. Heidkamp focused on the first two stages: identifying and defining what to measure and creating high-quality collection methods. These two stages are already being promoted through a program of ongoing global metrics development, which includes the Schools Meals Coalition (developing global indicators for monitoring school nutrition), the WHO Life Course Quality of Care Metrics Coordination Working Group, the Healthy Diets Monitoring Initiative, and the WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring. These organizations have the resources to underwrite the costly process of collaborative metric development, and their resulting metrics will inform the data that are regularly available as part of the NNIS.

Dr. Heidkamp provided an example from Nigeria, where a nutrition information system (NIS) task team that included data users and producers across multiple sectors developed a set of recommendations to address common national data coordination challenges. The challenges included the high cost of collecting nutrition data and the fact that nutrition data came from multiple sources that are controlled by different actors. The collaborative team's extensive preparatory work (e.g., reviewing policies, talking to data users, consulting experts, mapping available data, identifying costs) and task team facilitation led to a consensus about which indicators were important to collect over a 10-year horizon. Considerable attention was given to both monetary costs (e.g., buying equipment; collection, transfer, and analysis of data; dissemination) and nonmonetary costs (e.g., loss of data quality if surveys were too long) to address the dearth of information in the nutrition space about data costs in general.

The recent National Food Consumption and Micronutrient Survey in Nigeria illustrated how financial challenges can delay data collection. The study required 4 years of planning and fundraising to reach a $13 million budget, but the funding is still insufficient to complete the analysis. A Nigerian national NCD STEPS survey is also being delayed for several years due to lack of funding. Dr. Heidkamp noted that a recent report from the National Health and Nutrition Examination Survey showed that survey response rates decline over time and that sustainability of funding becomes more challenging. These funding and response challenges must be kept in mind when planning for and investing in national data collection systems.

Dr. Heidkamp discussed ways to foster advocacy networks to support LMIC decision makers going forward. She cited research by a team from Johns Hopkins University, which found that the main factors that influence whether certain issues rise or fall on global policy agendas are defining, framing, and positioning the problem. The framing of "the first 1,000 days" has been very effective in focusing countries on pregnancy and early childhood. Now, to shift policy attention to older children and adolescents, a different framing, "the first 8,000 days," has been proposed, and time will tell whether it is effective. It is also important to be aware that although global priorities shape national priorities, many policy makers will listen more closely to advocacy from their own constituencies. Nigeria Health Watch and the African Population and Health Research Center are excellent examples of advocates influencing policy makers at the country and regional levels and offer positive, effective strategies for others to emulate.

Discussion with Session V Presenters

- ***Ms. Vorkoper*** *asked how to arrive at a consensus for the framing of the DBM that would stimulate a move to action.* **Dr. Frongillo** said the framing would have to be country-specific, because different countries want to concentrate on different problems. **Dr. Michaud-Létourneau** suggested that it is important to have actors and organizations in the nutrition field facilitate discussions with an understanding of how to frame the issues that are of most concern to the decision makers. **Dr. Heidkamp** said that multisector issues, which are difficult to turn into implementation, is an example of the type of framing that is struggling and needs to be contextualized.
- ***Dr. Raiten*** *was concerned about the monolithic definition of the DBM, observing that the fact that there is more than one double burden affects the ability to influence policy and intervene with evidence-based programs. Policy will be determined by how the problem is defined.*

SESSION VI: EVIDENCE-BASED PROGRAM AND POLICY IMPLEMENTATION

Moderator

Layla Esposito, Ph.D., M.A., NICHD

Nutrition-Related Evidence-Based Program and Policy Implementation at the United States Agency for International Development (USAID)

Lindy Fenlason, M.D., USAID

Key nutrition-related research, program, and policy activities at USAID have led to increases in the equitable provision and utilization of high-quality nutrition services, country capacity and commitment to nutrition, multisectoral programming for improved nutrition outcomes, and global nutrition leadership. The USAID conceptual framework's central aim is optimal nutrition by promotion of adequate dietary intake and reduction of disease burden, with many of these priority areas solidly anchored in the first 1,000 days of life.

The COVID-19 pandemic caused disruptions in three shock pathways: livelihoods and food systems, health systems and humanitarian assistance, and social protection programs. Priority actions to stabilize and strength these three programs had to be identified. In 2020, USAID and other partners developed a comprehensive nutrition and COVID-19 pandemic analytical framework to connect the secondary impacts of COVID-19 in both children and adults, and it has proven useful for identifying effective actions for COVID-19 and for other shocks, such as the Ukraine crisis. COVID-19 innovations include broader involvement of family members, enhanced use of social media platforms to broaden communication, and leveraging digital applications to provide agricultural extension support and create markets to increase sales of nutritious foods. One successful digital approach is Cambodia's use of an app for group training and home visits to make early childhood development assessments.

Knowledge gaps requiring more exploration include:

- Context-specific subnational trends and drivers at the individual, household, and population levels

- Delivery platforms and modalities for double-duty actions relating to health, social safety nets, education, and agriculture
- The role of food environments in dietary patterns, influences on various forms of malnutrition, and how food systems processes and policies affects both the DBM and the environment in LMICs

USAID priorities for improving malnutrition among children and adolescents include:

- Increasing access to and consumption of affordable, safe, and nutritious foods, particularly in the first 1,000 days
- Strengthening community- and facility-level health systems to deliver high-quality nutrition services
- Improving access to quality nutrition services in humanitarian response settings
- Facilitating an enabling environment that supports sustainable food and health systems, such as improving access to diverse markets

Dr. Fenlason concluded by recommending three USAID publications: *Multi-Sectoral Nutrition Strategy 2014-2025, U.S. Government Global Nutrition Coordination Plan 2021-2026,* and *U.S. Government Global Food Security Strategy Fiscal Year 2022-2026.*

The DBM Among Children and Adolescents in LMICs

Carmen Burbano de Lara, M.P.A., WFP, Italy and Peru

The child development that occurs in first 1,000 days of life is essential for nutrition actions, but the next 7,000 days, which are equally important for maintaining early gains and providing support during the vulnerable growth phases, including puberty and adolescence, represent WFP's conceptual framework. Children who have appropriate education, nutrition, and health are the human capital that is the source of a country's growth and economic strength. In low-income countries, only 30% of wealth is derived from human capital, a great loss of potential growth, which is why the "8,000 days" approach of investing in human capital is so important.

School-aged children are a very large percentage of the population, particularly in Africa and the Middle East, making school-based platforms among the most important venues for interventions for this population. Properly designed school meals and complementary programs are the key to investments in young people. School meal programs in the areas of social protection (e.g., income transfers), education, agriculture (e.g., buying nutritious foods from local farmers), and health and nutrition (e.g., dietary diversity to support growth and development) are the largest safety nets in the world. They are valued by governments, because they return up to $9 for every $1 invested and create 2,000 new jobs for every 100,000 children fed.

The COVID-19 pandemic changed the school meals landscape. The safety net collapsed as school closures deprived 370 million children of their meals, education, and well-being. Their literacy skills dropped precipitously, their mental health declined, child marriage doubled, and child labor rose for first time in two decades.

In 2021, responding to the African Union's request, France and Finland assembled a global alliance of countries to restore these vital safety nets by creating the School Meals Coalition.

Seventy-three countries and 76 organizations from around the world have signed on to this effort. The goal is to ensure that every child has the opportunity to receive a healthy, nutritious meal by 2030 by restoring school meal programs to 440 million children, reaching the 73 million children not previously covered, and raising the quality of the school health and nutrition programs. The Coalition, led by a task force of 12 countries, has also focused its resources on research to evaluate the effectiveness of its programs and the funding of other initiatives. A data and monitoring initiative is underway to develop an official, reliable, and trusted school meals database to support evidence-based decision making. The school meals agenda is measured every 2 years through the *State of School Feeding Worldwide* report. The next issue will be released in 2022.

Evidence-Based DBM Program and Policy Implementation Roundtable Presentation

Boitshepo Bibi Giyose, M.S.N., African Union Development Agency (AUDA)

Ms. Giyose discussed the crises people are facing today, including climate change; conflicts; COVID-19; the costs of food, fuel, and fertilizer; and, importantly, the lack of coordination across sectors, a problem at both the international and national levels. Other crises include dwindling physical activity, the takeover effect of modern technologies, the transition from traditional to modern diets, the lack of data and information about nutrition in children and adolescents, and overwhelmed health systems.

Today, one in seven people is hungry and facing serious malnutrition, yet one-third of food is wasted. The global malnutrition numbers are staggering: 1.9 billion adults are overweight or obese, 2 billion people have some form of micronutrient deficiency, 161 million children under 5 years old are stunted for their age, and 795 million people do not get the food they need for a healthy life. At least one form of malnutrition significantly affects 143 countries worldwide, with 37 countries, mainly in Africa, experiencing all three forms (overweight, stunting, and anemia). These conditions lead to the early onset of NCDs. Attention to first 8,000 days of life must be a priority in addressing global malnutrition.

It is critical to know what children are eating, but there are insufficient data on this. Many factors, such as peer pressure, lack of nutrition education, inadequate societal and parental guidance, the movement away from traditional foods, and poor food choices, are contributing to malnutrition. In Africa alone, 59 million children under 5 years old are stunted and 10 million are overweight, 40% of adult women are overweight, and 38% of women of reproductive age are anemic. The concomitant burdens of overweight, stunting, and wasting make it difficult for governments to define priorities and allocate resources.

Ms. Giyose suggested that initiatives to get more nutritious and appealing food on the plates in LMICs are needed, and schools are an obvious platform for these interventions. She used South Africa as an example of a country that has an abundance of nutritious foods, including fruits and vegetables, but is not achieving “the four betters” (better production, better environment, better nutrition, and better life) to combat the triple burden of childhood malnutrition. Progress can be made if countries take advantage of the opportunities that are at hand, including the African Common Position on Food Systems and the African Union Year of Nutrition, outcomes from COP27 and other global summit meetings, UNFSS coalitions and alliances, and the Biomarkers of Nutrition for Development–Knowledge Indicating Dietary

Sufficiency (BOND-KIDS) program. Revamping data and information systems will also be required.

Ms. Giyose offered the following key messages:

- Invest in appropriate and context-specific research targeted to local nutrition problems (e.g., the domestication and nutrient analysis of traditional, indigenous, and underutilized foods).
- Ensure a multisectoral, integrated approach and coordination from research to pedagogy, policy, program design, and implementation.
- Increase national budget investments in early childhood and development, using public, private, and innovative financing.
- Educate consumers, especially children, to create a demand-driven culture for nutrient-dense products for healthier diets and prevention of obesity.
- Understand the links among climate change, soil health, food production, and healthy diets and nutrition, using school environments as an informational springboard.

Childhood and Adolescent Overweight and Obesity Prevention and Reduction in Mexico—Investment Case Study

Mauro Brero, M.Sc., UNICEF, Mexico

Mexico is significantly affected by the triple burden of malnutrition, with stunting in 1.5 million children under 5 years old (13.9%), anemia in 2.1 million children 1 to 4 years old (32.5%), and overweight or obesity in 12.7 million children (41.0%). There is also a high micronutrient deficiency rate among young children and pregnant women. All of these forms of malnutrition have a common cause: poor diets.

COVID-19 had a significant impact on nutrition and health in Mexico. Obesity was the main comorbidity among infected and deceased children, especially in the 12- to 19-year-old age range. The pandemic led to increases in the levels of all forms of malnutrition and the consumption of unhealthy foods and caused a decline in physical activity.

To help inform the Mexican government's health priority of preventing overweight and obesity, UNICEF developed a study, modeled over 65 years, to show the cost of childhood obesity in terms of health (i.e., disability-adjusted life years [DALYs]) and economics (i.e., costs and benefits of implementing five priority interventions, their cost-effectiveness, and the expected return on investment). Two economic models specific for childhood were used: one examining childhood obesity's impacts on future mortality and one measuring healthcare costs and productivity losses and assessing the cost-effectiveness of childhood and adolescent overweight and obesity prevention interventions.

The study found that if no further interventions were instituted, the cost of childhood and adolescent obesity would be an estimated 143 million DALYs, for a total cost of $1,840.7 trillion or a $202,445 average lifetime cost per child with obesity. There would also be 12.4 million children 6 to 17 years old with psychosocial challenges and about 25.5 million cases of school absence.

The introduction of the five selected interventions (breastfeeding promotion, fiscal programs [e.g., tax on sugary beverages], restriction on marketing unhealthy foods to children, social marketing in schools to promote healthy diets and physical activity, and strengthening various school-based interventions) into the model resulted in a savings of 8.6 million DALYs. The economic benefits totaled $124 billion ($104 billion from averted mortality, $1.8 billion for saved healthcare costs, $13.7 billion from productivity gains, and $4.6 billion from wage gains), or $2.1 billion per year. Additionally, 6.2 million cases of children with psychosocial challenges would be prevented, as would 12.8 million cases of school absence. All five interventions were found to be cost-effective in reducing overweight and obesity.

The study showed that the health and economic impacts of childhood overweight and obesity are substantial, and although the implementation of the five interventions would be highly cost-effective, some of them need to be strengthened (e.g., raising the beverage tax from 10% to 20%) to increase impact. The investment was shown to be a coherent public policy response to the challenges posed by the increased rates of child and adolescent overweight.

The Mexican government has made important progress by strengthening marketing regulations, reforming school-based interventions, implementing social marketing in schools, and promoting breastfeeding in the first 1,000 days as a national strategy.

Intensify In-Country Nutrition Discovery and Research and Development

Jian Yan, Ph.D., Bill & Melinda Gates Foundation (BMGF)

The BMGF recently committed $922 million to advance global nutrition and help women and children by working across food, health, and social protection systems to increase consumption of nutritious diets; leverage large-scale food fortification; provide nutritional support to pregnant and lactating women, infants, and young children; and support fundamental nutrition research and product innovation. In concert with its partners, the BMGF has taken an integrative approach to address complex problems and reduce preventable death to ensure that people not only survive, but also thrive.

Dr. Yan focused on one aspect of the Foundation's work: the support of nutrition research and product development to optimize health outcomes of adolescent girls, women of reproductive age, pregnant and lactating women, as well as young children in LMICs. The research strategy has shifted to pregnant and lactating women with a goal of preventing adverse birth outcomes. Research and primary data generated directly in LMICs is needed to move more toward a precision public health approach to avoid relying only on data from high-income countries. Fundamental research on multiple micronutrient requirements as well as the role of gut microbiome in health could lead to host- and microbiome-directed maternal interventions. The research focus is expanding beyond the first 1,000 days to 8,000 days to optimize interventional approaches women's and girl's health. Dr. Yan said that normal brain and cognitive development is key for children to thrive and realize their full potential, but substantial gaps in understanding of neurodevelopment in LMICs exist. Neurobehavioral assessment tools lack reproducibility and predictability in LMIC settings, and stunting, a common proxy measure, is poorly correlated with brain development.

In an effort to address power asymmetries in global health, the BMGF is committed to providing more direct support to LMIC-based researchers by funding in-country researchers directly, strengthening capacity building to support the South-South collaborations, and strongly fostering public-private partnerships.

Discussion with Session VI Presenters

- ***Ms. Giyose*** *asked how best to take the rich body of knowledge from this meeting forward and communicate it to a wider audience or to policy makers to catalyze transformational change.* **Dr. Kutlesic** said that the meeting proceedings would be published in a journal and that NICHD would discuss its role from a research perspective in moving the topic forward. There will be debriefings with multiple NICHD branches to discuss effective interventional approaches, particularly in the wake of the COVID-19 disruptions. NIH considers issues from a research perspective but is aware that having an impact requires ongoing collaboration with public and private partnering agencies.
- ***Ms. Burbano*** *asked the group to think about approaching the issues from the 8,000 days' standpoint, because there are neglected age groups, particularly school-aged children, who have been invisible to the researchers and practitioners because of the lack of ways to measure the impact of interventions, especially school meals.*

HIGHLIGHTS OF DAYS 1 AND 2

Moderator

Kimberlea Gibbs, M.P.H., RDN, CHES, NICHD

Keynote speakers provided an important framework for expanding the definition of the DBM, its prevalence, and the shifts between under- and overnutrition in LMICs and elucidated global and regional differences in malnutrition. Presenters provided information on research in Indonesia, described intervention points in early life, and highlighted research needs and implementation changes needed to address the DBM in health systems.

Presenters provided information about research in Tanzania looking at dietary diversity and modifiable risk factors related to adverse health outcomes, an impactful sub-Saharan Africa study on adolescent eating patterns, and the connections among obesity, underweight, and climate change. Presenters also discussed food transformation systems, how adolescents perceive nutrition, and the history, importance, research gaps, and multisectoral approaches related to school feeding programs.

Other topics included a longitudinal study on fetal undernutrition, the effect of micronutrient deficiencies on linear growth and stunting, and how policy changes influenced positive nutritional changes in Chilean adolescents.

The call for mandatory governmental policies and monitoring, the importance of collaborations among researchers from different disciplines and countries, and the need for dietary data tools to measure the impact of interventions were consistent themes.

The roles of social safety net programs and social media to address the DBM were discussed, and speakers highlighted the importance of data to encourage and empower stakeholders to

act to drive change. A more effective framing of problems may be needed to influence global and national priorities.

The roundtable discussions with representatives from USAID, UNICEF, the BMGF, WFP, and AUDA further clarified the issues and offered potential solutions.

GENERAL DISCUSSION

- ***Ms. Vorkoper,*** *noting the high cost of collecting data at scale, asked what indicators or information should be prioritized for inclusion in national nutrition information systems and what the priority DBM implementation areas are. She also asked, for those new to IS, what lessons have been learned in applying IS, where the best place to start IS might be, and who should be involved.* **Dr. Frongillo,** citing a recent paper outlining the challenges in using anthropometry as an indicator, said that much more work is needed to dispel confusion about indicators. More clarity is needed about what reference data should be used and how to track changes as children age. WHO is working on implementing a process to grapple with these issues and achieve consensus. **Dr. Frongillo** added that more data about the diets and dietary intake of school-aged children and adolescents are needed. WHO and UNICEF are working with the Rockefeller Foundation to develop a roadmap for achieving consensus on how to measure diets, to include looking at how countries provide data and implementing survey platforms that do not tax countries' systems. **Dr. Heidkamp** said that for routinely collected data on who is being reached by school feeding programs, the priority should be on data that show that programs are actually being implemented and who they are reaching, which might be a higher priority than data characterizing the burden on the entire population. It is a tradeoff, because data collection is expensive, but the priority should be on what serves the country's needs most directly.
- ***Dr. Raiten*** *noted his concern about the nutrition community having a one-dimensional, monolithic view of the DBM when none of the problems are one-dimensional. For example, anthropometry is an excellent indicator of a perturbation within the system, but it does not indicate what is going on with an individual or what mechanisms are involved. He asked for input about what questions are needed or what algorithms developed to comprehensively capture the internal and external ecology so that when a child arrives with a problem or some combination of problems, that child can be precisely evaluated and treated with a context-specific intervention that is equitable and appropriate for the situation and the setting. The global health issues, such as anemia or stunting, are not monolithic; they are multidimensional problems. Treating them as simply a matter of too much or too little food is not answering the question. There are disparate issues that must be better elucidated.* **Dr. Frongillo** recalled hearing a vice president of the World Bank chastise the nutrition community at a 2007 meeting for not identifying and coalescing around priorities that would stimulate progress. This admonishment led to the development of the clear message of the importance of the first 1,000 days. There should be a serious discussion about what priorities the nutrition community should converge around, because the notion of the DBM is not specific enough to clarify what actions are needed to affect child and adolescent development.

Dr. Raiten agreed about the need to reposition nutrition to make a better and stronger case that nutrition is not just food. The biology of nutrition plays an integral role in all aspects of human health, and the nutrition community has not made that clear. The BOND-KIDS initiative is based on the recognition that each child is part of a larger ecology and that this is integral to addressing complex, multifactorial issues. It is important to explain why nutrition is important irrespective of what the DBM might be in an individual or population. Many conditions are not nutrition-specific, but nutrition still plays a role. Anemia and obesity are considered to be nutrition conditions, but they are more than that, and this must be made clear. **Dr. Raiten** suggested that the ecological approach is the way to proceed, because it engages the entire continuum of activity required to address complex issues. **Ms. Giyose** said that that inconsistent nutrition terminology (e.g., DBM, triple burden) and rapidly changing technology have made it difficult for people to understand what the research is trying to accomplish. She suggested developing and adopting a common terminology to help make a strong case for nutrition research and interventions that will be understood by all stakeholders. **Dr. Madzorera,** agreeing that nutrition and its role in the DBM are very complex, cited the lack of data as a critical shortcoming. It is hard to convince policy makers of the importance of diets when there are scant data on what people are eating or how diet is linked to disease. Another problem is that the food systems space is a very new area. Frameworks are still being developed to understand how to intervene within food systems to address the DBM and the risk of NCDs. More work is needed to link the DBM to food systems in an understandable way, and the complexity of this issue must be recognized as a first step in this process. **Ms. Gibbs** suggested the need to connect the DBM to climate change to invite a better understanding of the influence that agricultural practices, social inequalities, food distribution practices, and food marketing have on consumption. **Dr. Raiten** said that the food system is very important and that nutrition is the biological link between the food system and health, but the case for the importance of the biology of nutrition and why it is so impactful across the entire range of complex problems has not been made. Climate change is being superimposed onto a complex global health scenario, but nutrition is not being integrated into that scenario in a way to make clear that nutrition is not just about food. **Ms. Giyose** said COVID-19 taught the global community lessons about self-reliance and being less dependent on external commodities in favor of preparing and enjoying indigenous foods.

- ***Dr. Michaud-Létourneau*** *said that interventions have a greater chance of success when the implementers have the benefit of a wide range of knowledge from other practitioners.* This type of CIR helps obviate the problems that can arise when researchers try to apply solutions that worked in one country to an entirely different country. Creating an alliance to foster rich communication between those with in-country knowledge and implementers can help avoid problems and lead to more successful interventions.

CLOSING COMMENTS

Jenelle R. Walker, Ph.D., M.S., NICHD

Dr. Walker thanked everyone for the thoughtful presentations and robust discussions that so clearly elucidated the challenges with the DBM and the global opportunities to address them. This workshop provided NICHD with critical information to help define next steps, but the conversations do not have to end here. Dr. Walker invited everyone to continue to comment as NICHD considers the multiple approaches required to address such complex issues. She thanked the NICHD staff, the moderators, the technical team, and all of the people who worked behind the scenes to make this conference such a success. She noted her special appreciation to Dr. Kutlesic, the director of the NICHD Office of Global Health, for her leadership and support.