The 91st Nestlé Nutrition Institute Workshop

Nurturing a Healthy Generation of Children: Research Gaps and Opportunities

Manila, March 18–21 2018
Infant and childhood nutrition form the basis of an individual’s health in later life. Multiple lines of evidence – from experimental to epidemiological – are converging to highlight the importance of this early period for metabolic programming, physiological growth and cognition. This is the cornerstone of the ‘developmental origin of health and disease’ (DOHAD) paradigm, underscoring the significance of infancy and early childhood for setting the foundation for health. Any public health intervention that seeks to improve the general health of a population or combat disease should therefore target infants and children in order to reap the greatest benefits.

Yet there is little mechanistic evidence to reveal how. Some of the answers can be found in studying diet and eating behavior: food choices and dietary habits go hand-in-hand with nutrition. Eating is a key skill that develops during early life. Between conception and childhood, the mode of feeding drastically evolves, from amniotic fluid, to breastfeeding, weaning, and independent feeding. Not only does the child learn how to eat, but also what to eat, how much and in what context. During this time, infants discover the intrinsic properties of foods, along with the variety of tastes, flavors, and textures. These earliest sensations pave the way for food choice, steering an individual towards a lifetime of healthy (or unhealthy) eating patterns.

The 91st Nestlé Nutrition Institute Workshop showcased three fascinating aspects of childhood diet and eating behavior. The first session examined the development of taste in infants, revealing how taste preferences are shaped in utero and throughout weaning, and guide the individual’s later food choices. And what do children really eat? This was the topic of the second session. The Feeding Infants and Toddlers Study (FITS) and Kids Nutrition and Health Study (KNHS) study provided a glimpse into the diets of children around the world, identifying nutrition gaps and potential areas for intervention. The workshop ended with a final session on the most important meal of the day: breakfast. The workshop was chaired by Sophie Nicklaus (Centre des Sciences du Goût et de l’Alimentation, University of Bourgogne-Franche Comté), Christiani Jeyakumar Henry (National University of Singapore), and Theresa A. Nicklas (Baylor College of Medicine).

The key learnings from this workshop provide valuable insight for policy makers, researchers, and healthcare professionals on how diet and feeding behavior during each of these stages can influence health and disease.

Dr Natalia Wagemans
Head of Nestlé Nutrition Institute
Switzerland
SESSION 1

Early Eating Behavior and Taste Development: Influence of Early Nutrition, Eating Behavior and Potential Health Outcomes

Chairperson: Sophie Nicklaus (Centre des Sciences du Goût et de l’Alimentation, University of Bourgogne-Franche Comté)

Taste and smell begin to develop in utero and continue to evolve from birth into early childhood. The first session focused on how these early influences metamorphose into taste preferences and later, food choices. Sophie Nicklaus kicked off the session by tracking the rise of taste preferences in infants from birth up to 22 months of age. Following this, young children enter a neophobic phase that can last from age 2 to 5 years. Andrea Maier-Nöth reviewed the parental feeding strategies for navigating this difficult period. Indeed, parental feeding strategies are important modifiable risk factors for promoting healthy eating and preventing obesity, as discussed by Kimberley Mallan. Lisa Fries classified the parental responses to picky eaters, highlighting the importance of balancing the feeding strategy against the child’s cues of hunger and satiety.

What could explain individual variations in taste acceptance patterns? One factor is dietary exposure to a variety of tastes. Longer duration of breastfeeding was associated with a higher preference for umami at 6 months of age. A preference for sweet, sour and umami that was already present at the beginning of complementary feeding was associated with a higher acceptance of sweet-, sour- and umami-tasting foods. Finally, olfaction plays an important role in the acceptance or rejection of different foods, driving individual reaction towards the odors that characterize items such as fish and sulphurous cheeses.

After birth, when foods are orally exposed, infants discover the intrinsic properties of foods, with a variety of tastes, flavors, textures, as well as energy densities.

Sophie Nicklaus

Early Development of Taste Preference and Consequences of Early Taste Exposure on Later Development

Sophie Nicklaus examined how taste and olfaction can help shape early eating behavior.

Previously published data has shown that infants at birth have an innate preference for sweet taste and a rejection of bitter taste. However, little attention has been paid to how taste and flavor preferences evolve after birth. The French OPALINE birth cohort provided a framework for understanding how taste and flavor preferences develop within the first 2 years of life.

Within this cohort, a group of 258 infants were the subject of a longitudinal study that mapped the evolution of flavor preferences between 3–20 months, and 8–22 months of age. The data showed that the acceptance of salty taste increased sharply between 3–12 months. For sweet, sour and umami, the acceptance trajectories were similar between 3–20 months, with sweet being the preferred taste. Interestingly, despite a decline in the acceptance of all tastes between 12–20 months, the acceptance of sweetness remained. The reaction to bitterness was stable throughout this period. Although unpleasant food odors (i.e. trimethylamine, dimethyl disulphide, and butyric acid) triggered avoidance behavior between 8–22 months of age, pleasant food odors did not elicit any specific response.

Early Development of Food Preferences in Relation to Early Sensory Development and Early Flavor Exposure

Vegetable consumption in children often falls below current recommendations. Andrea Maier-Nöth (Eat-Health-Pleasure GmbH) outlined evidence-based strategies to help parents promote healthy eating habits in children.

Beginning in pregnancy, flavors from the maternal diet are transmitted to the fetus and sets the groundwork for taste preference. This process continues after birth as the infant experiences flavors from the maternal diet via breast milk. At weaning, repeated exposure to a variety of foods contributes to a long-lasting acceptance or rejection of different foods (including fruits and vegetables). It is important to know that infants have a fine palate and more taste buds than adults.

During the third year of life, many children enter a neophobic phase. During this period, introduction of new foods is difficult. This underscores the importance of the earlier complementary
feeding period as a critical window of time to build the foundation for taste acceptance. Variety, repeated exposure, timing of introduction of foods, and their sensory properties are important factors that contribute towards acceptance.

Recent data have identified several promising interventions to increase acceptance of vegetables and new foods. Breastfeeding, followed by the introduction of a wide variety of foods during weaning, results in the greatest acceptance of new foods. Infants should be offered a high variety of vegetables during weaning. Frequent (daily) changes in the vegetables offered appears to be more effective than changing every few days. Offering an initially disliked vegetable at eight subsequent meals results in markedly increased acceptance of that vegetable. Altogether, these strategies provide the basis for promoting long-lasting healthy eating habits in children.

Parents’ Feeding Practices and Associations with Children’s Food Acceptance and Picky Eating

Many children are reported to be picky eaters, with this behavior peaking between 2–5 years of age. Lisa Fries (Nestlé Research Center) reviewed the definition of picky eaters and summarized how parents can cope with this difficult stage.

Although there is no standard definition of picky eaters, a recent review of the literature identified several consistent common traits. These include neophobia, low fruit and vegetable intake, food refusals, less enjoyment of eating, and other sensory sensitivities.

What techniques can parents use to overcome this difficult stage? Parental feeding practices are central for shaping their child’s mealtime behavior. First, parents need to address the specific behavior that manifests in their child. For children with neophobia and low dietary variety, repeated exposure can be used. In addition, involving children in food preparation, parental modeling, and the use of non-food rewards are also potential strategies. In children who avoid particular food groups, parents can try to adapt the sensory properties of the food, the cooking methods, or the presentation. Children who seem to have a small appetite may improve with structured mealtimes and authoritative parenting practices with less pressure to eat.

Finally, it is important to note that the parent-child feeding relationship is a two-way interaction, with the child’s behavior having a great influence on the parents. Identifying the behavior of the child and reciprocating with the appropriate feeding practices is key to encouraging healthy eating habits.

“Parents’ Feeding Practices are central for shaping their child’s mealtime behavior.”

Lisa Fries
SESSION 2
What Children Eat

Chairperson: Christiani Jeyakumar Henry (Clinical Nutrition Research Center, National University of Singapore)

Understanding what children really eat is the basis for any intervention that aims to improve their nutrition and health status. But surprisingly, there is very little data on the different food items that comprise a child's diet, particularly in developing countries which experience both undernutrition and obesity. Christiani Jeyakumar Henry began Session II by exploring this mystery in Asian and African children. Ciarán Forde discussed the association between eating behavior, energy intake and body composition in children. Yet the data that comes from different studies around the world is widely heterogeneous. One challenge that faces nutrition researchers is how to compare the findings across studies which use varying methodologies and different study populations. Alison Eldridge described the Feeding Infants and Toddlers Study (FITS) and Kids Nutrition and Health Study (KNHS), which were launched to bridge this gap in knowledge. This was followed by case studies from individual countries, namely China (presented by Dantong Wang), Mexico (presented by Salvador Villalpando-Carrion), the USA (presented by Regan Bailey) and the Philippines (presented by Imelda Angeles-Agdeppa). Finally, the food and nutrition data from children in Malaysia were reviewed by Norimah Karim.

What Children Eat

Christiani Jeyakumar Henry explored what children eat in Asia and Africa, using this as a vantage point from which to understand the widespread undernutrition in these areas. Around 25% of all children in low and middle income countries (LMIC) are permanently stunted, both in height and cognitive development. In parts of Asia, the rates of stunting are as high as 35%. Why is the prevalence of childhood undernutrition so high in these areas, compared to the rest of the world?

One obvious starting point is to examine what children eat in these regions. Surprisingly, there is little reliable quantitative data on the energy intake in children in many LMIC. However, data from observational studies provide some clues. First, the primary staples given to young children in Asia and Africa consist of porridge made from rice, maize, cassava, yam, millet or sago combined with water. The resulting gruel is a viscous paste, which although filling, is low in nutrients and energy. As a result, children are unable to consume enough to meet their nutritional needs. Compounding the problem, the porridge is often diluted with water so that it can be fed with a drinking cup.

These findings highlight several major challenges facing infant nutrition in LMIC. First, the quality of the protein consumed is low, and foods have poor micronutrient bioavailability. It is known that linear growth is significantly influenced by the quantity and quality of protein intake, as well as the presence and bioavailability of key micronutrients such as zinc. Therefore, one challenge is to prepare complementary and weaning foods that contain enough nutrients to support growth and with optimal viscosity and mouthfeel. Advances in agriculture, nutrition and food technology will facilitate the development of infant foods with improved protein quality and enhanced micronutrient bioavailability.

An understanding of what children eat is at the heart of our ability to prescribe an optimal diet for growth, development and well-being.

Christiani Jeyakumar Henry

Eating Behavior and Energy Intake

What eating behaviors sustain the net positive energy balance that results in obesity? Ciarán Forde (Clinical Nutrition Research Center, National University of Singapore) showed data from the GUSTO cohort that illustrate the association between eating behavior, energy intake and body composition in children. Children were evaluated at 4.5 and 6 years in order to collect data on pre-meal portion selection, oral processing behaviors during the meal and response to food after the meal. These parameters were assessed alongside parental reports on the child's appetite and parental feeding practices.

The experiments revealed some interesting findings. First, children tended to pick more of foods they reported to like, but also smaller portions of foods they expected to be more filling, independently of whether they liked these items. Importantly, the children who selected the largest portions tended to serve and consume a larger portion during the meal. Second, those who ate faster also took larger bites, chewed less and consumed more energy per meal. Not surprisingly, faster eating rates at 4.5 years predicted faster eating rates and higher energy intakes at 6 years. Therefore, both portion selection and
eating rate are important factors that influence energy intake in children. Finally, those who ate in the absence of hunger had a greater cumulative energy intake. Parental assessments of their child’s eating behaviors were generally in-line with experimental observations.

Altogether, these findings highlight the need to go beyond modifying individual eating behaviors when designing interventions to target overweight or obese children. Instead, we must consider the cumulative impact of overlapping behaviors that affect energy intake, including portion selection, eating behaviors and parental feeding practices.

Children who ate faster at 4.5 years also had higher adiposity at 6 years, emphasizing a role for these behaviors in prospective weight gain.

Ciarán Forde

FITs/KNHS Overview Followed by Case Studies

Alison Eldridge (Institute of Nutritional Science, Nestlé Research Center) reviewed key aspects of the Feeding Infants and Toddlers Study (FITs), describing how this has helped to fill a gap in our understanding of dietary patterns among infants and young children.

FITs is a periodic, cross-sectional survey that examines the diet and feeding practices in infants and children from various countries. The ages of the children are categorized to represent periods of important dietary transition, from birth to older preschoolers.

The FITs began in 2002 as a large-scale national telephone survey to study the eating patterns and nutrient intakes of infants and young children in the USA. This was followed in 2008 by a second FITs. Based on the FITs model, the Kids Nutrition and Health Study (KNHS) was launched in 2014 to include older children.

Both the FITs and KNHS evaluated nutrient intakes, food groups consumed, food sources of nutrients, meal patterns, feeding practices, household demographic factors and key behaviors related to energy intake and expenditure in infants and children around the world. Dietary intake was assessed using interviews and 24-hour recalls. Data from national nutrition and health surveys were also included when available.

Among the countries that participated in the FITs and KNHS were Australia, China, Mexico, the Philippines, Russia, and the USA. A standardized approach to analysis was used across data from the participating countries. Age categories, means and distribution of food intake, meal patterns and timing were among the parameters that were aligned, so that comparisons could be made. In addition, similar food groupings were applied to all foods and beverages reported. These were analyzed to examine key eating patterns, including the complementary feeding transition, and to understand the main sources of energy and nutrients in the diet.

This overview set the stage for individual case studies from the FITs and KNHS that identified important nutritional deficiencies in the diets of infants, toddlers and children including those from China, Mexico, the USA and the Philippines.

“... These two studies helped to fill a gap in knowledge and confirmed Nestlé’s commitment to understanding dietary patterns among children in these vulnerable ages. "

Alison Eldridge

China Case Study

Dantong Wang (Institute of Nutritional Science, Nestlé Research Center) presented KNHS data from the perspective of China, highlighting the nutrition deficiencies in children 4–13 years of age.

Data for the study originated from the 2011 China Health and Nutrition Survey (CHNS). This survey recruited participants from nine provinces and three of China’s large cities (Beijing, Shanghai, and Chongqing), representing different geographies and stages of economic development, as well as urban and rural areas. Dietary intake data from 1481 children were analyzed. Individual dietary data were collected using 24-hour recalls; these were subsequently coded and nutrient intake calculated using the 2009 Chinese Food Consumption tables.

The results from KNHS China revealed a nutrition gap that was related to geographic location and socioeconomic status. Compared to dietary recommendations, Chinese children had low intakes of micronutrients, such as calcium and vitamin D. Intake of dietary fiber was low in 97% of children, whereas the intakes of saturated fat and sodium were excessive in 57% and 85% of children, respectively. Not surprisingly, those from urban areas and higher income households were more likely to have better micronutrient intakes and consume more animal

“... We observed the double burden of malnutrition in Chinese children; the prevalence of overweight or obesity in children was higher in urban areas and higher income families than in rural settings and those from lower income households. "

Dantong Wang
source foods, especially dairy products, than those from rural areas and from lower income households. Older children (aged 9–13 years) consumed more salty snacks, and less fruits or dairy products compared to younger children (aged 4–6 years).

Nutrition education, nutrition intervention programs, and promotion of physical activity inside and outside of school are some of the strategies that can be used. However, the disparities identified in this study indicate that tailored approaches are needed to improve diet quality in children, depending on geographic location and socioeconomic status.

Mexico Case Study

Salvador Villalpando-Carrion (Hospital Infantil de Mexico and Universidad National Autonoma de Mexico) discussed the FITS Mexico findings as a basis for identifying deficiencies in the dietary and feeding patterns in Mexican children.

In recent years, the type of foods and beverages consumed has changed drastically in Mexican infants and young children, but there is little reliable data on this. Compounding this problem is the fact that physicians and healthcare professionals in Mexico are mostly bystanders, with no real influence on nutrition or complementary feeding.

The FITS Mexico was initiated to address these uncertainties. Combined with a secondary analysis from a nationally representative sample of over 5000 children from the 2012 Mexican National Health and Nutrition Survey, these findings were used as a basis for developing new feeding recommendations for healthy infants.

Analysis of these data revealed several disturbing trends among Mexican infants and young children. First, there was a low rate of exclusive breastfeeding in infants below 6 months of age. Furthermore, around one-third of infants aged 6–12 months consumed cow’s milk or sugar-sweetened beverages (SSBs), and few received iron-rich foods. Although half of children aged 6–48 months consumed fruit, 85% consumed no vegetables. Beyond 12 months, over 80% of toddlers consumed sweets or SSBs daily. A large percentage of toddlers (18–40%) did not meet the estimated average requirement for iron or zinc, but over 30% exceeded the daily upper intake level for sodium.

These trends in infants and young children may explain the poor nutritional condition of the general Mexican population. Data from the FITS is being used to set guidelines for child feeding and to shape public policy, in order to improve the health of the Mexican population throughout all age groups.

USA Case Study

Data from the FITS 2016 provided a recent snapshot of the diets and feeding practices in US infants and toddlers, as covered by Regan Bailey (Purdue University).

The initiation and duration of breastfeeding was improved compared to previous FITS surveys, but still remains below public health recommendations. The rates of exclusive breastfeeding varied according to ethnic group, and the transition to complementary foods occurred earlier in formula-fed infants.

As the toddlers grew older, there was an increase in energy intake and dietary diversity. However, there was also an increase in consumption of sugar-sweetened beverages and sugary snacks, alongside a low intake of whole grains, fruit, vegetables and low-fat dairy products. Although nutrient intakes in younger infants were generally adequate, several deficiencies were identified, namely iron, vitamins D and E, potassium, and fiber. Around 60–70% of preschoolers exceeded the recommended levels for sodium and saturated fat intake. Fruit consumption was adequate, but vegetable consumption was low. Beyond 12 months of age, all the children exceeded the recommended levels of energy obtained from added sugars.

Several conclusions can be drawn from these findings. First, although the dietary intakes for infants up to 12 months was nutritionally adequate, there was a trend towards higher levels of sodium, added sugars, and saturated fat beyond 12 months of age. The nutritional deficiencies identified are probably due to the increasing consumption of processed foods, sugary snacks and sweetened beverages as children grow older. Finally, these underscore the need to shift dietary patterns towards whole grains, fruits, vegetables and low-fat dairy products, while limiting consumption of processed items that contain added sugars, sodium and saturated fat.

Nutrient imbalances noted in FITS 2016 are likely the result from lower than recommended intakes of vegetables and whole grain foods, and higher than recommended intakes of sugar-sweetened beverages and savory snacks.

Regan Bailey

Feeding patterns in Mexican children seem to be established in early life.

Salvador Villalpando-Carrion
Philippines Case Study

Imelda Angeles-Agdeppa (Food and Nutrition Research Institute, Manila) presented an overview of the energy and nutrient intakes and food sources of school-aged children in the Philippines.

The 2013 National Nutrition Survey provided the basis for the data, which included 24-hour dietary recalls from 6565 children aged 6–12 years. In general, the mean energy intake was below the Estimated Energy Requirements (24.6% lower), with the majority of energy provided by carbohydrates. Around 16% of the children had protein intake below the requirements. In rural areas, 60% of children had inadequate total fat intake, with children from the poorest households being the most severely affected. Conversely, 14% of children from the wealthiest quintile exceeded the recommended limit for fat intake.

In terms of micronutrients, this cohort of Filipino children had inadequate levels of vitamins C, A, B6, B12 and niacin, as well as folate and riboflavin. The average intake of vitamins D and E were also below recommended values. Other micronutrient deficiencies identified in this cohort were calcium, iron, phosphorus, and zinc. Levels of sodium, however, exceeded the recommended requirements.

Overall, this study revealed that Filipino children had inadequate intakes of fat and many micronutrients. The nutrient shortfall can be explained by the high intake of refined rice, while there is a paucity of nutrient-dense foods such as milk, fruits and vegetables in the diet. There is a need to revise nutrition policy and education particularly for parents and healthcare professionals in order to improve diet quality in Filipino children.

This general trend was reflected in the data for individual macronutrient and micronutrient intakes. The majority of children achieved the recommended levels for energy and protein, but at least two-thirds did not attain recommended levels of calcium or vitamin D. Examination of eating patterns revealed that regular consumption of breakfast had beneficial effects on micronutrient intake: those who were regular breakfast eaters had higher intake of calcium, vitamin A, C and D compared to irregular breakfast eaters. Only 9–13% of children aged 7–9 years met the daily requirements for fruit and vegetable intake. Similarly, a low percentage of children met the daily requirements for dairy products. Ready-to-eat cereals (RTEC) were an important source of dietary whole grains and (indirectly) milk consumption, as milk was commonly consumed at breakfast by those who had RTEC.

The data from this representative cohort of Malaysian children indicate that efforts are needed to promote healthy food choices and eating habits, particularly for foods that fall short of the recommended intake levels. Strategies for improving the nutritional status of Malaysian children need to consider both over- and undernutrition, placing emphasis on approaches for the prevention of overweight and obesity as well as micronutrient insufficiency.

“It is important to assess the food intake of children aged 6–12 years in order to possibly link this with other nutrition-specific interventions to address malnutrition.”

Imelda Angeles-Agdeppa

Food and Nutrition in Malaysian Children

Rapid socio-economic growth has fueled the nutrition transition in Malaysia, bringing childhood obesity to the forefront of public health concerns. Norimah A. Karim (Universiti Kebangsaan Malaysia) reviewed the findings from the SEANUTS and MyBreakfast studies on the dietary trends and nutrition status in Malaysian children.

Data from both the SEANUTS and MyBreakfast studies show that 13–17% of Malaysian children between 6–12 years of age were either overweight or obese. Importantly, this prevalence was similar regardless of rural or urban locations.

“Overweight and obesity problems among Malaysian children should be of concern, as three in 10 children are either overweight or obese.”

Norimah A. Karim
SESSION 3
Revisiting the Importance of Breakfast for Children’s Health and Development

Chairperson: Theresa Nicklas (Baylor College of Medicine)

Breakfast is widely accepted as the most important meal of the day. Children who regularly consume breakfast are more likely to have better micro- and macronutrient intake, optimal weight, and higher physical activity levels. Yet despite the benefits, there are major knowledge gaps in several areas. Michael Gibney began the session by addressing the lack of guidelines to help define the composition of the optimal breakfast for children. Leonidas Karagounis explained the importance of breakfast protein for maintaining protein homeostasis. This was followed by Theresa Nicklas’ presentation on breakfast patterns, including the effects of skipping breakfast. Finally, Sandra Sünram-Lea discussed the relevance and impact of postprandial glycemia at breakfast and its role on cognitive performance of children.

Breakfast – Shaping Guidelines from Food and Nutrient Patterns

Although the value of breakfast as a key source of nutrients and energy is well-established, there are no strict guidelines to help define an optimal breakfast composition. Michael Gibney (Institute of Food and Health, University College Dublin) explored several principles that can be used to build breakfast nutrient guidelines.

What are the optimal food choices for breakfast? The majority of national standards for breakfast only exist in terms of definitions of food groups. None of the recommendations are based on evidence derived from local breakfast patterns. In some countries, guidelines are simply energy-adjusted targets extrapolated from the current adult dietary guidelines. Another over-simplification centers on the assumption that breakfast supplies roughly 20% of the daily energy intake.

In reality, however, the intakes of many desirable nutrients at breakfast exceed 20% of the daily intake. The International Breakfast Initiative is currently testing an approach whereby each individual in national surveys is assigned a value for the Nutrient Rich Foods (NRF) index. This index measures dietary quality for both macro- and micronutrients and has been used worldwide to reflect overall dietary quality. The intakes of foods and nutrients for each individual at breakfast is calculated and scored according to the NRF index. This approach is currently evaluated to test whether optimal breakfast nutrition targets can be defined. Ultimately, such a definition would include not only quantitative nutrient guidelines but should also transcend geographic patterns and reflect local foods and gastronomic customs.

The Importance of Dietary Protein at Breakfast in Childhood

Adequate dietary protein is crucial for growth and maintenance of lean body tissue in children. Leonidas Karagounis (Institute of Nutritional Science, Nestlé Research Center) revealed the importance of protein intake timing to encourage a net positive protein balance. Protein provides amino acids to the body that are used to build and maintain bones, muscles and skin, and to produce molecules with important physiological roles, such as enzymes, hormones, neurotransmitters, and antibodies.

Skeletal muscle is the most abundant bodily tissue comprising almost 50% of body mass in humans and forms a large component of the overall lean tissue. In addition to locomotion, skeletal muscle plays a key role in central metabolism, being responsible for 60–70% of total glucose uptake. The balance between protein synthesis and degradation, highlighting the importance of dietary protein and nutrient availability, tightly regulates skeletal muscle homeostasis. Contrary to adults, children are in a state of continuous growth. Adequate dietary protein is therefore essential to provide the substrates to support the remodeling of lean tissue, including muscles.

After an overnight fast in children, the body is in a state of increased catabolism, reflected in a higher rate of total protein

“Regular breakfast intake may help in body weight management, in cognitive function and in cardio-metabolic health.”

Michael Gibney

“As little as 7g of milk protein taken as part of a carbohydrate-containing breakfast is enough to stimulate a net positive protein balance.”

Leonidas Karagounis
breakdown. Breakfast is thus a strategic meal of the day: specific amounts of macronutrients must be consumed in order to attenuate the overnight losses in whole body protein. At breakfast, consumption of both carbohydrates and protein play a role in mitigating protein loss and stimulating whole body total protein synthesis.

Importantly, this effect has been shown to persist for up to 9 hours after breakfast consumption under conditions of normal diet and activity levels.

**Breakfast Skipping and Weight, Breakfast Patterns and Breakfast and Cognition**

**What is breakfast? How can breakfast skippers, or breakfast consumers be defined?** Theresa Nicklas (Baylor College of Medicine) discussed the challenges and implications of these definitions and their influence on studies’ outcomes.

Although the term “breakfast” is clear to almost anyone, there is no uniform scientific definition of breakfast, breakfast consumers or breakfast skippers. These uncertainties hinder the interpretation of individual studies and make between-study comparisons almost impossible. Not surprisingly, policy makers and educators find it difficult to make clear recommendations for the optimal breakfast.

From an objective standpoint, the importance of breakfast can be evaluated in terms of its contribution to various outcomes, including nutrient intake, weight management, or cognition. It has been clearly demonstrated that the type of breakfast consumed affects nutrient intake, diet quality, and weight. Therefore, merely providing a definition of breakfast does not make a significant contribution to the literature or to clinical practice. The general consensus, however, is that nutrient intake and diet quality are better if breakfast is consumed. More carefully controlled studies are needed that apply a standardized definition of breakfast consumption (and breakfast skipping) in order to understand the effects of breakfast on various nutrition and lifestyle parameters. Similar studies are also needed on lunch and dinner before we can begin to unravel the interplay between nutrient intake, timing, and health outcomes.

**Breakfast, Glycemic Index and Cognitive Function in School Children: Evidence, Methods and Mechanisms**

Sandra Sünram-Lea (Lancaster University) focused on the concepts of glycemic index, glycemic load and glycemic response, as these parameters should be taken into account when designing the optimal breakfast for children.

How many carbohydrates should be consumed at breakfast?

A breakfast with a low glycemic index (or low glycemic load) was most consistently associated with beneficial effects on attention, but beneficial effects on memory and executive function have also been observed. Despite these promising findings, the evidence is not conclusive enough to allow firm recommendations so far. Most of the studies have enrolled heterogeneous subject populations (i.e. age, gender, habitual breakfast consumption), and different tests were used for the assessments of cognitive outcomes. Finally, very few studies have profiled the glycemic response in children.

How can we study the effects of breakfast on cognition throughout the day? Future trials should be designed to evaluate the role of different glycemic manipulations on cognition. The outcomes should include relevant cognitive tasks that are sensitive to nutritional manipulations. In addition, multiple assessments at various time-points are needed to understand the effects and timing of glycemic effects on cognition. For now, the available evidence suggests that a breakfast with a low glycemic index or glycemic load could be a promising strategy for optimizing cognitive performance across the morning.

“Dietary carbohydrates are of interest as they provide the main source of energy for the brain’s metabolic functioning, and there is mechanistic evidence linking postprandial glycemia to cognitive performance in both children and adult populations.”

Sandra Sünram-Lea

**“** Breakfast has been championed as a meal that makes a significant contribution to nutrient intake, can be used to lose weight or maintain weight loss, and improve cognition and school performance in children. **”**

Theresa Nicklas
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Understanding the synergistic effects of taste, eating habits and dietary choices across critical phases in the human life cycle will play a central role in improving public health. In developing nations, there is an urgent need to reduce the rates of stunting, micronutrient deficiencies and obesity. How can we influence the health of future generations by targeting infants and children? One of the key messages from this workshop is that eating behavior is an important modifiable risk factor that can be landmarked to improve health and minimize disease. Focused efforts are needed that emphasize infants and young children across the different stages of the key “window of opportunity” from preconception through pregnancy, infancy, weaning and later childhood. The breastfeeding and weaning stages are critical for shaping the preference for healthy foods, such as fruits and vegetables. It is important to keep in mind that young children enter a neophobic stage, during which introduction of new foods becomes very difficult. Parental strategies that offer variety alongside repeated exposure can be used to overcome this period. Finally, the timing of food intake plays an important role not only in nutrient uptake, but also in shaping cognitive potential throughout the day. More work needs to be performed to discern how breakfast, lunch, dinner and snacks affect physiological and cognitive outcomes in infants and young children.

Yet eating behavior and dietary choices represent more than just opportunities, because food and diet have a significance beyond their biological functions. Food and diet are also the net result of choices made by the parents, which in turn are shaped by the family’s economic circumstances, culture, religion, and geography. The smell, taste, flavor, and texture of different foods can also invoke sensations of aversion or pleasure – depending on the individual. This emphasizes the importance of using a holistic approach when comparing data across countries and defining potential interventions. Ultimately, the best interventions will be those which can transcend these factors and confer a true health benefit to the population.