



**Building future health
and well-being of thriving
toddlers and young children**



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Foreword:

Building future health and well-being of thriving toddlers and young children



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According to the World Health Organisation the early child period, which includes the age up to 5 years, is considered to be the most important developmental phase throughout the lifespan.

This period of a child's life is fundamental in building the foundation for physical growth, development, health, social and emotional skills. In fact, the first three years, which include a good portion of toddlerhood, shapes a child's brain structure in preparation for lifelong learning. Development and fine motor skills, language, social and behaviour skills are all categories that toddlers are seeking to master.

As it was stated in the 2018 Global Nutrition Report, despite reductions in stunting, 150.8 million children (22.2%) under five years of age are stunted, 50.5 million children under five are wasted, while 38.3 million children under five years of age are overweight.

In such significant disparities an appropriate nutrition, stable, responsive and nurturing care-giving, as well as safe and supportive environments are the three critical elements of healthy child development.

The 95th Nestlé Nutrition Institute Workshop, "Building future health and well-being in thriving toddlers and young children", was the first NNI Workshop presented 100% virtually, and explored in some details current scientific research, challenges and opportunities in cementing a healthy foundation for life in toddlers and young children.

The program brought together three outstanding experts in areas of health care, public health and developmental science. The first session chaired by professor Atul Singhal (University College London) focused on the overview of the nutritional challenges in toddlers and young children across the globe, such as overweight and obesity, which can be very detrimental during an important period of toddler's development and growth. The theme of

the second session, led by professor Maureen Black (RTI International and University of Maryland School of Medicine), revealed the journey from infancy to toddlerhood and role of nutrition in it. The large focus of the scientific debates also was given to the social aspect, responsive, responsible and nurturing care-giving.

The third session of the workshop on the health behaviour and developing brain was built to explain the steps of the motor skills development and role of physical activities and nutrition in influencing cognitive development and learning abilities of a child. This session chaired by professor Charles Hillman (Center for Cognitive & Brain Health Northeastern University) has concluded the 3 days fascinating scientific forum.

"The early child period (up to 5 years) is fundamental in building the foundation for physical growth, development, health, social and emotional skills."

The key learnings from this workshop provide valuable insight for healthcare providers, policy makers and researchers on how appropriate nutrition, nurturing care-giving and environment can influence development and health in children below 5 years.

We would like to thank the three Chairpersons Atul Singhal, Maureen Black and Charles Hillman for putting the outstanding scientific program together.

We also would like to thank all speakers and experts in the audience who contributed to the workshop content and scientific discussions.

Finally, we thank Dr. Tamara Lazarini, her Team in Brazil and the Nestlé Nutrition Institute Team in Switzerland for their effort to make this workshop happen in the challenging time of the world pandemic.

Session I:

Challenges in Nutrition in Toddlers and Young Children



Chair:
**Atul Singhal -
University College London**

It is widely accepted that nutrition in the first three years of life is of vital importance. If food intake is limited or excessive or if food is of poor quality, this can set the course for lifelong health impairment. At this stage of life, toddler behaviours such as impulsivity and increasing autonomy can make mealtimes challenging. Undernutrition continues to be a problem in many developing countries, but toddler overweight and obesity is also a serious and growing problem.

Atul Singhal discusses the risk factors for obesity in early years, consequences of obesity in the long term and importance of taking preventive actions. High protein intake in early life is related to increased risk of later obesity. Factors such as portion control, reducing consumption of high-fat and high-sugar foods, and promoting healthy lifestyles have an important role to play in reducing early obesity. The bottom line is that children will gain weight if they consume more energy than they expend.

The complexity of nutrition for young children is revealed by Mauro Fisberg, who explains how Brazil's

population faces challenges with obesity, undernutrition and malnutrition, and how these are influenced by intersecting factors. Strategies must encompass the family, schools, government and industry in order to produce real change.

Parents often find that giving their toddlers healthy food is not as easy as it sounds. Maureen Black confirms that the early years are often a time when children assert autonomy by refusing new foods, but argues that persistence and responsive feeding usually help children develop healthy feeding behaviour and emotional wellbeing.

In parts of the world such as Eastern and Southern Africa and Southern Asia, undernutrition means many children's physical and cognitive development is impaired because of deficiencies in their diet. Alison Eldridge talks about food consumption surveys in different parts of the world and the existence of important nutrient gaps in toddlers' diets showing that many children globally do not eat the minimal acceptable diet. Andrew Prentice details the strategies that can help to ameliorate nutritional shortfalls, which can have impact on short- and long-term health.

Toddler Development and Autonomy: Baby-led Weaning, Neophobia and Responsive Parenting

Maureen Black (University of Maryland School of Medicine and RTI International) explained why toddlerhood is a crucial time for establishing healthy eating habits, and how this can be supported by caregivers.

Between the ages of 12 and 36 months, children grow in autonomy and independence. They transition from baby foods to sharing family foods, learn to walk, start to talk and carry out tasks like dressing and feeding for themselves. Excess weight gain in toddlers has been shown to increase the risk of overweight and obesity throughout later life. Toddlerhood is an ideal time to establish healthy eating habits that will benefit children throughout their lives. In the US, 13.9% of children aged 2-5 years are obese.

As toddlers, children learn through observation/imitation, exploration, and play. To influence toddler behaviour, positive habits should be modeled to them by caregivers at home or in childcare settings. This includes eating meals together and playing together to promote physical activity and reading to encourage language development.

Toddlers often develop food neophobia, or the refusal to eat new or unfamiliar food. The phase helps protect children from food that may be harmful, but neophobia can lead to conflict at mealtimes. Responsive feeding, in which the caregiver responds positively to the child, may help encourage children to overcome neophobia. Other factors such as routines, consistent timing of meals, limiting distractions, allowing a meal to end when a toddler is full and ensuring a pleasant mood can also help address neophobia and fussy eating.

“Toddlerhood is an ideal time to establish healthy eating habits that will benefit children throughout their lives.”



Obesity in Toddlers and Young Children: Causes and Consequences

Atul Singhal (University College London) looked at the scale and consequences of childhood obesity around the world. What can be done to combat the problem?

Nutritional excess is now a global problem alongside nutritional deficiency. Focusing on early years is crucial; the Early Bird study showed that 70-90% of obesity is established by the time a child starts school. Another study showed that children with rapid weight gain between 2-6 years of age were 1.4 times more likely to be obese as adolescents. Good nutrition for toddlers should help prevent obesity in later life.

“There are huge implications of childhood obesity into adult life.”

Weight gain is the result of energy intake exceeding energy expenditure. Even a slight imbalance can result in significant weight gain over time. Energy balance is influenced by developmental factors, genes and the childhood environment. Environment appears to be the critical factor of these three. The environment is shaped by overlapping biological, social and commercial factors. Individuals at increased genetic risk are at lower risk of obesity if they are in a supportive environment as opposed to an adverse one.

Today's toddlers consume 34 times more soft drinks and juice than previous generations and 25 times more sweets. Compared to the 1950s, children now eat more fats and sugars and less carbohydrate, they eat larger portions and more energy-dense food, resulting in around 10-15% increased energy intake and increased body size. Portion size affects energy intake at 5 years old, but not at 3 years old. This is because younger children respond to appetite while older children are more influenced by social cues.

Early nutrition impacts long-term health outcomes, according to the developmental origins of adult disease hypothesis. There is good evidence that breastfeeding reduces obesity risk by around 13-26%. This may be because breast fed infants have a slower growth rate than formula fed infants, which can be related to its protein level. Fast growth in infancy has been linked to obesity later in life. High protein intake in the first year of life has been associated with a doubled risk of excess body fat and increases peritoneal fat at 5 years of age. In 19 out of 24 studies, high protein intake was associated with greater risk of obesity.

Obesity has severe consequences for children and adults, leading to problems including: orthopaedic issues, sleep apnoea, liver disease, hyperlipidaemia, respiratory disease, psychological problems and related educational underachievement. To address the problem, a focus on parental education and encouraging physical activity is required.

Global Landscape of Nutrient Inadequacies in Toddlers and Young Children

Alison Eldridge (Nestle Research) set out nutritional issues facing young children around the world.

Stunting affects 21.9% of children around the world, with the highest rates in children aged under 5 in Southern and Eastern Africa and Southern Asia. Globally, children aged under 5 is 7.3% are affected by wasting, with the highest rates in Southern Asia. Overweight affects 5.9% of the global population of under 5s, a figure which has risen in recent years.

“Deficiency in four key micronutrients (iron, vitamin A, iodine and zinc) can have catastrophic impacts on child growth and development.”

Deficiency in four key micronutrients (iron, vitamin A, iodine and zinc) can have catastrophic impacts on child growth and cognitive development. The 'hidden hunger' index combines these factors to show where children aged under 5 are affected by stunting, iron-deficiency anaemia and vitamin-A deficiency. Dietary diversity is a measure that indicates nutrient adequacy. A diet is considered adequate if a child has access to 5 out of 8 categories of food (breastmilk; grains, roots and tubers; legumes and nuts; dairy; meat, fish, poultry and liver; eggs; vitamin-A rich fruits and vegetables; other fruits and vegetables).

Researchers also look at minimum meal frequency. An adequate daily diet should include breastmilk or formula/milk/yoghurt plus 2 or more solid or semi-solid feeds for 6-8 month olds and 3 or more solid or semi-solid feeds for 9-23 month olds. Combining the diet diversity and minimum meal frequency scores gives an indication of minimum acceptable diet. In much of the world, figures of children eating the minimum acceptable diet are low; 11.2% in Eastern Africa, 49% in Central Asia, 28.4% in South Asia and 50.1% in South and Central America.

Vitamin intake varies widely. In Brazil, toddlers and young children get almost all the recommended daily Vitamin A and C, but 93.6% less than the recommended daily amount of Vitamin D. In the USA, children have almost the recommended dose of Vitamin A and C but 80% less Vitamin D than recommended and 32% less Vitamin E. Certain countries also have low mineral intake rates. For example, intake of Calcium, Iron and Zinc for toddlers and young children in the Philippines is far below the recommended level. Dietary intake studies help to identify the foods and beverages which could help to alleviate nutrient gaps.

Challenges and Opportunities in Toddler's Nutrition in Brazil

Mauro Fisberg (Federal University of Sao Paulo, Pensi Institute, Sabará Children's Hospital) set out the complex problems affecting toddler nutrition in Brazil.

Malnutrition can be looked at on the level of the individual, the household and the population. In Brazil, there are problems with both undernutrition and underweight. Sometimes, the same individual can have two or more types of malnutrition, or experience different types over a lifetime. The Estudo Nutro-Brasil study found increased rates of obesity and overweight and increased hidden hunger, defined as iron deficiency and anaemia, vitamin D deficiency, iodine deficiency and low zinc and calcium intake.

In Brazil, 11% of children aged 2-5 years are obese, and 27.4% are overweight. In 1974, 10.9% of boys and 8.6% of girls aged 5-9 in Brazil were overweight; in 2009, the figure reached 34.8% and 32% respectively. Addressing obesity in Brazil requires a focus on food patterns and eating habits as well as lifestyle changes. Brazil is a large and diverse country, with wide variation in income, food access, disease, and the environment.

To improve nutrition, an integrated system involving families, schools, governments and the food industry is needed. Schools should teach nutrition as part of the basic curriculum, regular physical activity should be promoted and the availability of healthy, adequate meals and snacks should be improved. On a family level, active participation in children's feeding, cooking with children and eating together should help to increase the healthiness of food consumed in the home.

"To improve nutrition, an integrated system involving families, schools, governments and the food industry is needed."

The food industry can help by improving food quality, fortifying and supplementing food and communicating well on nutrition issues. The government should also adopt policies to regulate and control marketing aimed at children, promote outside physical activity and reduce inequality in access to healthy food.

Growth Faltering: Underweight and Stunting

Andrew Prentice (MRC Unit The Gambia London School of Hygiene and Tropical Medicine) explained why stunting and underweight are key metrics for nutritional deficits and their consequences.

Childhood stunting and underweight predict likelihood of survival and cognitive development. Most stunting takes place during the first two years of life. Wasting occurs when children grow well during the first few months of life when fully breastfed, but show a consistent pattern of wasting after this. The top three factors are birth length, mother's height and mother's weight.

"If children are growing well, it's likely their brains will be developing properly too."

There are windows of opportunity where interventions can correct poor growth, not only during gestation and in the early years, but also in toddlerhood, early childhood and adolescence. There is evidence that child weight drops off at around 2 years of age then increases as their immune system becomes stronger and there is the possibility of recovering some ground.

Brain growth is very active in young children, if children are growing well, it's likely their brains will be developing properly too. Challenges in nutrition include poor dietary diversity, subclinical viral, bacterial and protozoal infections, environmental enteric disease and persistent low-grade inflammation.

There are many nutrition-sensitive actions to combat stunting. The key element is a nation's gross domestic product - as a country develops, child nutrition improves and stunting disappears. Stunting and wasting are usually problems that have impacted multiple generations, and it can take a long period for interventions to produce substantial improvement

Session II:

Advancing from Infancy to Toddlerhood through Food



Chair:
**Maureen Black -
University of Maryland**

As children transition from infants into toddlers, they need energy and nutrients from their diets. How do you make sure they establish healthy eating habits and get what the right nutrition?

Steve Abrams reviews the evidence for the key nutrients needed for growth, neurodevelopment, immune functioning and bone health. He explains the recommended levels of key nutrients for young children, and how the recommendations compare with real intake levels. Lorrene Ritchie explains about the standard she has helped develop for nutrition in childcare settings to guide feeding young children, addressing both what and how to feed them. The indications are hopeful that even the smallest, family-based childcare providers can adapt their practices to improve children's health.

Catherine A Forestell takes us through the fascinating science behind taste development, flavour perception and food preference in young children. Young children

have an innate preference for sweet flavours, but with time and encouragement they can learn to love the bitter taste of many fruits and vegetables.

Susan Johnson looks at whether a preference for sweet foods is innate, or influenced by environmental factors. Newborns around the world show the same distaste for bitter flavours and acceptance of sweet ones, but these food preferences can be shaped by multiple factors including familiarity with a taste and a supportive atmosphere.

Dennis Bier argues that there is insufficient evidence to show a causal link between consumption of sugar and the detrimental outcomes that are commonly associated with it. He says that sugars are essential to life and can be metabolised well by lean children. Instead of a narrow focus on sugar, Biers says obesity should be tackled through a broader approach to encouraging energy balance and healthy lifestyles.

Transition from Breastfeeding & Complementary Feeding to “Toddler Nutrition” in Childcare Settings

Lorrene Ritchie (University of California) talked about a nutritional standard for childcare settings and how this could improve the diet of toddlers in the US.

Maternal employment is on the increase in the US; 65.3% of women with children aged under 5 are employed outside the home. There are almost 11 million children aged under 5 in the US, and 1 in 3 of these is in licensed child care. We know that 1 in 5 children start school already overweight or obese, so early years are a crucial time for establishing healthy habits and childcare can be an optimal setting to promote healthy eating.

Current dietary guidelines in the US do not cover children aged under 2 years, but a new standard for this group is under development. The standard looks at what to feed and how to feed, for ages 0-12 months and 1 year plus. Options for the standard were ranked according to impact and feasibility by experts. A test group was used to evaluate how the draft standard would be used in practice.

“There is potential for infant and toddler nutrition standards to impact young children in childcare in the US and elsewhere.”

The study showed that some standards could easily be implemented, such as not offering sugar-sweetened beverages, offering more vegetables and limiting salt. Compliance with guidance on how to feed was high, with providers following recommendations such as allowing enough time to eat and not using food as a punishment or comfort without much difficulty. Three months after training, providers were found to comply with 25 out of 37 nutrition standards. There was a 12% increase in compliance with food and beverage guidance and 9% increase in compliance with the standard on feeding practices. Most carers said the change had little or no impact on costs.

The results indicate there is potential for infant and toddler nutrition standards to impact young children in childcare in the US and elsewhere. These could be included in childcare site policies and inform statewide policy tied to childcare licensing. To gain further evidence, a cluster randomised trial is recommended.

Flavor Preference Development in Children

Catherine A. Forestell (William & Mary, Williamsburg, Virginia) explained how an understanding of flavour perceptions can assist in encouraging children to eat a varied diet.

The USDA recommends that children should have a diverse, nutrient-dense diet with a variety of fruit and vegetables. However, in the US and around the world, families often fail to give children the recommended levels of fruit and vegetables, not least because most children have a strong preference for sweet foods and beverages.

An appreciation of the sensory world of the infant can help us understand taste preferences and how to shift them. Perceiving flavour is a complex process, combining taste, olfaction and human sensation. Taste and olfactory systems develop prenatally; newborn babies are sensitive to tastes and smells at birth. A preference for sweet tastes appears to be universal across the globe, indicating that the preferences are innate rather than learned.

From an evolutionary perspective, bitterness is often associated with toxicity while sweetness is associated with high sugar content. This is why children are predisposed to prefer sweet tastes to bitter ones. However, flavour preferences can be modified in children. The foetus is exposed to a rich sensory environment in the womb in which the odour and flavour of amniotic fluid reflects the mother’s diet. If a mother breastfeeds, the flavour of her breastmilk also changes in response to her diet.

Children not only detect flavours in amniotic fluid, but

“An appreciation of the sensory world of the infant can help us understand taste preferences and how to shift them.”

also form memories of the flavours. A test found that infants exposed to carrot flavour in the womb and through breastmilk later showed a stronger preference for carrot-flavoured cereal than those who had not been exposed to the flavour pre- and post-natally. Infants continue to learn about flavours after weaning. With repeated exposure to a food, infants show fewer facial expressions of distaste.

Fruit and vegetable intake in schoolchildren can be predicted by three factors: a mother’s own diet, the duration of breastfeeding and the types of foods used for weaning. Early exposure to a variety of healthy food sets the stage for a healthy diet in later life.

Introducing Hard-to-Like Foods to Infants and Toddlers: Perspectives from Moms and Young Children

Susan Johnson (University of Colorado) acknowledged the challenge of helping children learn to accept a new food.

Food preferences are likely to be influenced by both inborn and learned predispositions. Newborns show distaste at certain flavours, but over time and with repeated exposure, they begin to show greater acceptance. Environmental factors such as access, availability and culture can have an impact, while individual child temperament also play a role. Parent eating practices and feeding practices also influence food preferences.

When children first start to eat solid foods, between 6-24 months of age, they are going through rapid developmental growth. They gain motor control, show greater desire for autonomy and have varied appetites as their growth rate changes. Neophobia (the refusal to try new foods) and picky eating can emerge at this age, while teething and illness also impact eating habits.

Familiarity is the key factor that influences children developing a preference for a food. Repeated exposure to a food in a supportive environment is the best way to encourage children to eat that food, but parents do not always persist in offering a rejected food multiple times. Some parents offer a certain food 3-5 times, others will offer the food 10 or even 100 times.

“Familiarity is the key factor that influences children developing a preference for a food.”

A study looked at maternal-infant interactions in response to bitter tastes, such as dark green vegetables. Study participants were overwhelmingly white, well-educated and half were on middle incomes or higher. Babies aged around 6 months accepted the food, even if they appeared to dislike it. At 12 months, babies mostly accepted the food but some showed rejection. At 18 months, many infants would bat the spoon away and cry to reject the food. At 24 months, rejection of the food was prevalent.

Children of mothers who try to distract or ignore children’s dislike of a food show less self-regulation at 30 months of age than children whose parents did not react to the child’s dislike. Areas for investigation and discussion also include whether re-offering a food that a child clearly does not like is correct, if it is important for a child to like new foods and whether there is a critical window

for food exposure. Promoting self-feeding skills may help children increase their willingness to try new foods and promote self-regulation.

Micronutrient Needs of Children 1-3 Years of Age

Steve Abrams (The University of Texas at Austin) looked at recommended micronutrient levels for toddlers around the world.

Infants need access to a range of micronutrients to support healthy development. Around the world, regions have developed guidelines setting out adequate intake of particular micronutrients, recommended levels and the maximum safe intake level. Average intake levels do not always match the recommended levels.

Iron is an important micronutrient, and in most industrialised countries, intake is usually at recommended levels for small children. In non-industrialised countries there are often significant shortfalls, leading to anaemia.

Zinc intake is mostly adequate, but again intake is higher in industrialised countries than non-industrialised areas. Zinc should be considered in combination with iron and other minerals.

The intake of calcium for small children in industrialised countries does not always meet recommended levels. In the US and Canada, actual intake is around 20% below recommended levels. The calcium needs of toddlers can easily be met with a diet that includes dairy or fortified foods. Breastfed toddlers and those on vegan diets require an additional source of calcium.

“Most toddler diets are adequate for micronutrients, with some deficiencies, particularly around iron.”

A Cochrane review found that there was no overall benefit of vitamin D supplementation for healthy children with normal vitamin D levels, but that supplementation of vitamin D-deficient children may be clinically useful. Vitamin D deficiency is a low but definite problem in toddlers in most countries, particularly in certain at-risk groups. Rickets can become a clinical problem where low vitamin D levels combine with calcium deficiency.

In conclusion, most toddler diets are adequate for micronutrients, with some deficiencies, particularly around iron. Dietary sources and bioavailability are not fully accounted for in RDA and similar guidance, reflecting the need to not over-generalise about population deficits or excesses.

Dietary Sugars: Not as Sour as They Are Made Out to Be

Dennis Bier (Baylor College of Medicine) examined associations between sugar intake and health.

Like any macronutrient, sugars should not be consumed in amounts that interfere with satisfying the requirements for adequacy of all other essential nutrients. No macronutrient (proteins, fats or sugars) should be consumed in amounts that lead to excess energy storage.

Sugars are essential human nutrients; we make every sugar that is required for life. It is hard to reconcile this with the idea that sugars are inherently toxic. There are other indicators that sugars are not inherently toxic. For example, the foetus' most important fuel in the womb is glucose. Infants are born with sweet taste receptors and a gut-to-brain sugar-sensing pathway that promotes a behavioural preference for sugar.

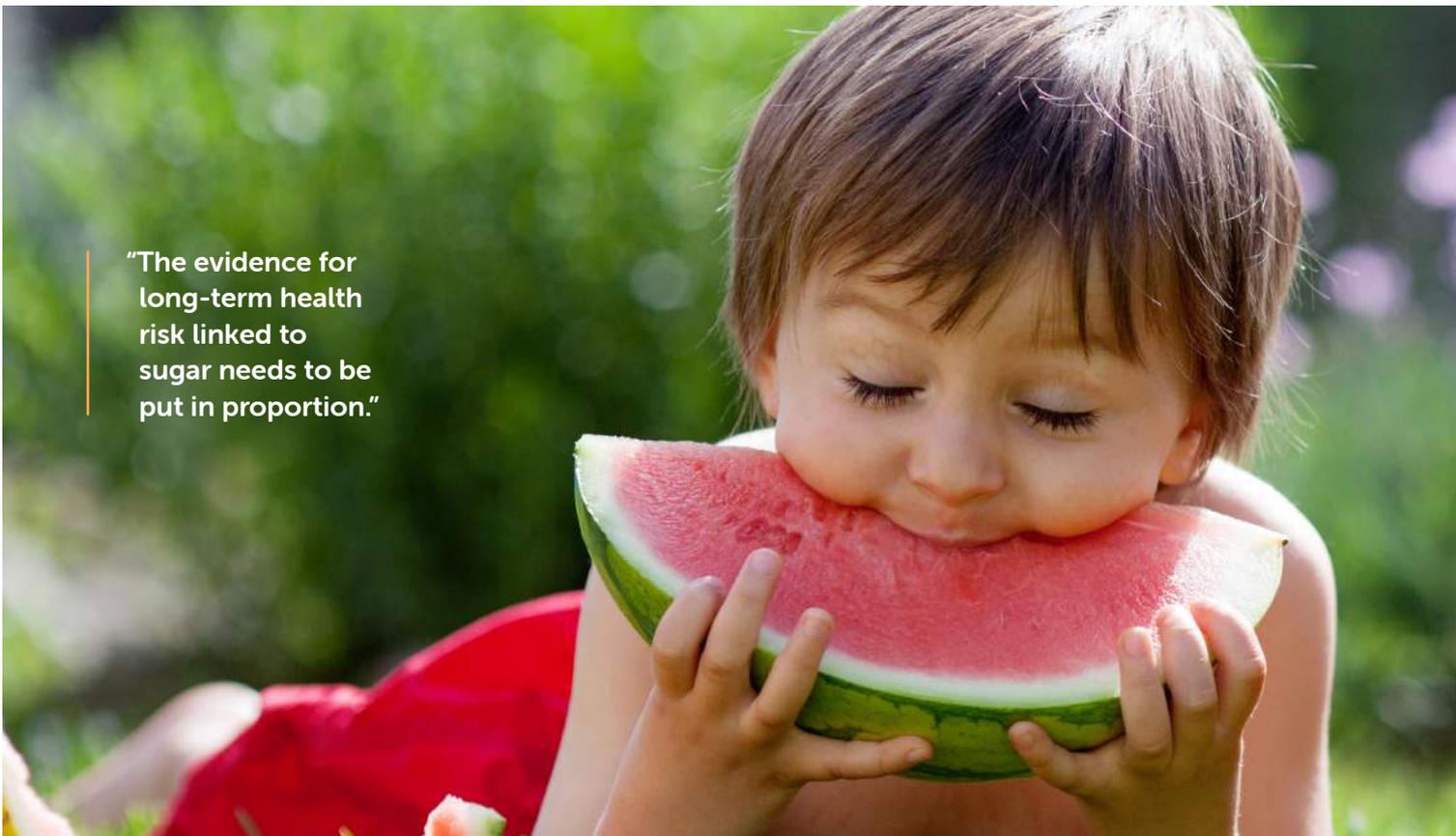
Children's capacity to metabolise sugar is significant. Lean children are very good at disposing of glucose they eat. Around 20 years ago a series of studies found that subjects given a week of 30% carbohydrate energy diet, then a break then a 60% carbohydrate diet, the diets provided 6-24% of energy as fructose. Energy expenditure matched energy intake. In lean children doubling the carb content of the diet, the children dealt with it by changing insulin sensitivity, not insulin supply. But obese children needed to increase insulin secretion.

Lean children do well irrespective of a wide variety of intake of carbohydrates and sugars.

The evidence for long-term health risk linked to sugar needs to be put in proportion. Smoking raises risks by a factor of 40, but all nutritional problems raise risk by a factor of 2 or less. Even this evidence is from observational studies, meaning causation has not been proven. Studies can be highly unreliable, especially if they rely on people self-reporting food intake. Studies also rarely reflect nutrient contents varying according to season, storage and cooking method or factor in personal and environmental variables. Many studies control for 5 or 10 variables but 575 interdependent variables have been identified.

In 2015, the UK Scientific Advisory Commission looked at carbohydrates in a comprehensive, wide-ranging review. It found insufficient evidence to link sugars and carbohydrates with many issues. The evidence that sugars are causally responsible for many of the detrimental outcomes attributed to them is weak. Instead of focusing on sugars, policy and intervention should look at the whole diet, energy balance and healthy lifestyles as a strategy for preventing obesity.

"The evidence for long-term health risk linked to sugar needs to be put in proportion."



Session III:

Health Behaviours and the Developing Brain



Chair:
**Charles Hillman -
Northeastern University**

The toddler years are a time of rapid cognitive and motor development. Children's brains and bodies undergo huge changes, supported by appropriate physical activities and the supply of nutrients.

Motor development is not a discrete area of development, according to Karen Adolph. Motor skills are the underpinning for a whole range of cognitive milestones as children become more able to move around and explore their environment. Traditional milestone charts do not allow for different practices around the world, but by 20 months all children reach a similar level of motor development that helps them enjoy the world.

Charles Hillman sets out the key findings of a fascinating study into physical activity and the activation of different

Physical Activity, Brain and Cognition

Charles Hillman (Northeastern University) examines the link between physical activity and brain activity in children who are normal weight, overweight and obese.

Children are becoming increasingly inactive. Across the world, many children do not achieve the recommended levels of 60 minutes per day of moderate to vigorous physical activity. The problem is worse in girls than boys. Childhood obesity is also an increasing problem; there are more than 124,000,000 obese children worldwide.

The preschool years are a crucial period for motor, mental and cognitive development. Brain health in children aged below 2 years is largely tied to behavioural milestones such as sitting, reacting to faces, and walking. It is thought that novel experiences that promote motor skills, movement and exploration promote neuroplasticity and cognitive growth. It is challenging to measure and study unstructured, natural play which is the main form of physical activity in children aged 3-5.

The FitKids2 study found that physical activity benefitted children's performance in tasks requiring executive control, such as memory tasks. Executive control is about deliberate, intentional actions requiring inhibition, working memory and cognitive flexibility. Children in

parts of the brain. After physical activity, children with a normal weight show improvement in tasks that require connection between the two hemispheres of the brain. The same is not true of overweight and obese children, whose performance in tasks requiring executive control may be worsened by physical activity.

Physical activity is also the core theme of Darla Castelli's talk, which looks at how health behaviours can be built into the school day, requiring input from all school staff as well as families and the wider community.

Naiman Khan looks at the importance of micronutrients on cognitive development in children, and how carotenoids support healthy brain development and cognitive function in the early years.

the study intervention group improved performance in inhibition and cognitive flexibility tasks by almost twice the amount of those in the control group. MRI scans showed fitter participants had more activation in major brain networks involved in higher control processes.

A 20-minute walk on a treadmill caused children to have greater activation of brain function, with better achievement in reading, spelling and arithmetic compared to a control group. The results differed in normal weight and overweight children; obese children showed reduced brain activity and a performance deficit after exercise.

"Single bouts of physical activity provide temporary benefits to brain function and cognition."

These results held across different tasks; overweight and obese children showed a deficit in performance in reading and maths activities after exercise. This means that consideration must be given to how overweight and obese children can exercise without this impacting their academic performance. Researchers found that increases in abdominal fat mass correlated with deficit in performance on working memory and inhibition and reduced academic performance in reading, spelling and arithmetic.

The study indicated that single bouts of physical activity provide temporary benefits to brain function and cognition, and adiposity may serve as a marker for decreased cognitive performance. Early school-based intervention to help promote healthy behaviours is crucial for lifespan health and effective functioning of brain, health and achievement.

Nutrition Effects on Brain and Cognition in Children

Naiman Khan (University of Illinois) spoke about his work examining the link between the micronutrient lutein and cognitive function in children.

Childhood is an important period of brain and physical development. Several key processes occur, often simultaneously, until the third decade of life. This long trajectory means health and lifestyle factors such as physical activity contribute to optimal development.

The brain only accounts for 2% of total body weight but is responsible for 20% of the body's energy expenditure. This means the brain is an organ with a high metabolic rate, and high nutrient requirement. Nutrients play important roles in cognitive function through impacting energy utilisation, neurosynthesis, neurotransmitter synthesis and physiological health that in turn impacts cognitive health.

“Nutrition plays an important role in the brain and cognition through a variety of mechanisms.”

Many nutrients are involved in brain health, such as lutein, water and dietary fibre. Let's look at lutein in more detail. Lutein is a carotenoid found in green leafy vegetables. Carotenoids can accumulate in adipose tissue, the brain, the retina and the skin and they provide protection from oxidative stress.

Lutein represents 12% of carotenoids in the diet but 60% of carotenoids in the brain. It is particularly found in the prefrontal cortex hippocampus, suggesting a role in executive function and relational memory. Humans are unable to synthesise carotenoids, so we are reliant on dietary intake. Children typically consume 0.5mg/day of lutein and zeaxanthin (another carotenoid). If they were to eat half a cup of leafy vegetables per day, the level would be around 10 mg/day, indicating nutritionally poor diets.

Increased consumption of lutein in adults through dietary intake and supplementation provides cognitive benefits and benefits for macular pigmentation. There is a correlation between lutein status and academic achievement between children aged 8-10, in all measures of academic achievement (maths, written language and achievement composite).

A recent randomised control trial looked at the impact of lutein and DHA on children aged 8-10. A previous trial had found that the combination of DHA and lutein was important for brain structure and function in older women. Benefits for relational memory and macular MPOD were observed. Lutein could have implications for cognitive health across the human lifespan, but more evidence is needed to determine whether a food-based approach is appropriate and to confirm the factors that contribute to intraindividual variability.



Importance of Motor Skills Development

Karen Adolph (New York University) proposed that motor development underpins all development in young children.

Motor development is traditionally thought about in terms of physical milestones such as beginning to crawl and walk, but in reality all behaviour is motor behaviour, from communication to using tools, eating or playing with toys. Motor skills are therefore important for all development. They can reveal a window into development. Early motor development is age-related, as anomalies are correlated with development disability.

However, age norms can be deceptive. Experience can be a better predictor of skill than age, so motor skill acquisition does not necessarily give a clear indicator of neuromuscular maturation. The longer a child has been walking, the faster they walk. Infants have immense variability in when skills develop. Some babies may be walking at ten months, others will not walk until 16 months. There is also wide variability in skills, such as crawling technique.

“Motor skills instigate cascades of development.”

Motor skills instigate cascades of development. When learning to crawl or to walk, with experience infants can move faster and further. They are able to explore their surroundings more easily, which promotes development. Walkers are more likely to carry objects and can visit more distant objects. Motor skills enable children to capitalise on opportunities in the environment. Movement helps children discover the world, socialise and take part in a full range of activity.

Importance of Providing Opportunities for Health Behaviours During the School Day

Darla Castelli (University of Texas at Austin) says that physical activity should be built into children’s daily routines.

Today’s children are less active than previous generations. Physical inactivity is associated with increased morbidity. Children aged under 5 are recommended to have three hours of playtime each day, but only 33% of children aged 5-17 participate in the recommended 60 minutes of moderate-to-vigorous activity each time. In Brazil, children aged around 10 years were found to spend 56% of their waking hours in sedentary activity.

Healthy eating is also recognised as vital for children’s health, to provide the micronutrients they need for brain development. Fewer than 1 in 10 adolescents eat the recommended amount of fruit and vegetables each day, and unhealthy eating is further compounded by consumption of sugar-sweetened beverages.

Childhood obesity is an increasing problem, particularly among minority groups, which are affected more than white, non-hispanic children. It is critical to establish healthy eating patterns in children aged 3-4 years in order to improve health throughout life. Children are spending more time outside the home in early life, as full-day preschool becomes the norm. This means the home environment influences eating patterns less, but it does offer an opportunity for caregivers to influence eating habits.

Often, well-meaning school policies such as extending teaching in subjects come at the expense of physical activity. Teachers should help model good behaviours such as physical activity at break time, signalling when it’s time to play or exercise and incentives can be offered such as allowing a class to choose their physical activity. A whole-school health-first comprehensive approach can be effective.

On healthy eating, a whole-school approach will encourage nutrient-dense, well-balanced meals. This affects not only staff who prepare meals, but all school employers.

“A whole-school health-first comprehensive approach can be effective.”

For example, teachers can take a healthy approach to classroom birthday celebrations. Eating patterns as a whole should be considered, looking at optimum times for eating, provision of fruits and vegetables, portion sizes and encouraging children to try new things.

In both eating and physical activity, competence, autonomy and relatedness should be emphasised. This means increasing children’s skills and understanding, allowing them to make choices and encouraging a social aspect to healthy living.

Conclusions

There is still a great deal to be discovered about how infants transition into toddlers, and the role of nutrition and physical activity in optimising development. This area is a challenging one to research, for ethical reasons and because of the nature of toddlers; as one conference participant noted, measuring the activity levels of a toddler is no easy task.

The world has made progress in tackling problems of undernutrition but it still remains a real problem, both in developing countries and economically disadvantaged groups in the developed world. Researchers are finding ways to measure and monitor the micronutrients that support healthy growth, which should help to point to ways stunting and wasting can be addressed in future.

Increasingly, obesity among young people is a problem and it is clear that preventing excess weight gain in very young children is a vital part of the solution. The basic message is that children should not consume more energy than they expend, but identifying strategies to bring this about is not simple because of the complex social, economic and cultural factors involved. However, given the toll of obesity on young people's health, happiness and educational achievement, as well as the associated health costs, this is not a problem that can be ignored.

Physical activity is undoubtedly an important part of ensuring toddlers live healthy lives. Movement is essential to enable children to develop cognitively, explore the world and relate to other people. Changing sedentary lifestyles into healthier, more active ones takes a whole community. Embedding physical activity throughout children's daily routines from the earliest days right through to adulthood is likely to be the best way to establish good habits for later life



