Obesity in the Early Childhood Years: State of the Science and Implementation of Promising Solutions: Workshop Summary

DETAILS

114 pages | 6 x 9 | PAPERBACK
ISBN 978-0-309-43921-3 | DOI: 10.17226/23445

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Obesity in the Early Childhood Years

STATE OF THE SCIENCE AND IMPLEMENTATION OF PROMISING SOLUTIONS

Workshop Summary

Steve Olson, *Rapporteur*

Roundtable on Obesity Solutions

Food and Nutrition Board

Health and Medicine Division

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

THE NATIONAL ACADEMIES PRESS
Washington, DC
www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, NW Washington, DC 20001

This activity was supported by Contract No. 20132685 from The California Endowment, Contract No. 10002863 from Highmark, Inc., Contract No. 10001561 from The JPB Foundation, Contract No. 10001518 from Kaiser Permanente, Contract No. 10001539 from The Kresge Foundation, and Contract No. 10001565 from the Robert Wood Johnson Foundation, with additional support from the Academy of Nutrition and Dietetics; Alliance for a Healthier Generation; American Academy of Pediatrics; American College of Sports Medicine; American Council on Exercise; American Heart Association; American Society for Nutrition; Bipartisan Policy Center; Blue Cross Blue Shield of North Carolina; ChildObesity180/Tufts University; Edelman; General Mills, Inc.; Greater Rochester Health Foundation; HealthPartners, Inc.; Healthy Weight Commitment Foundation; Kellogg Company; Mars, Inc.; Nemours Foundation; Nestlé Nutrition, North America; Nestlé USA; The Obesity Society; Partnership for a Healthier America; President's Council on Fitness, Sports & Nutrition; Reebok, International; Salud America!; Sesame Workshop; and YMCA of the USA. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project.

International Standard Book Number-13: 978-0-309-43921-3
International Standard Book Number-10: 0-309-43921-3
Digital Object Identifier: 10.17226/23445

Additional copies of this report are available from the National Academies Press, 500 Fifth Street, NW, Keck 360, Washington, DC 20001; (800) 624-6242 or (202) 334-3313; http://www.nap.edu.

Printed in the United States of America

Cover credit: Design by Casey Weeks.

Suggested citation: National Academies of Sciences, Engineering, and Medicine. 2016. *Obesity in the early childhood years: State of the science and implementation of promising solutions: Workshop summary*. Washington, DC: The National Academies Press. doi: 10.17226/23445.

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PLANNING COMMITTEE ON OBESITY IN THE EARLY CHILDHOOD YEARS: STATE OF THE SCIENCE AND IMPLEMENTATION OF PROMISING SOLUTIONS—A WORKSHOP[1]

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[1] The National Academies of Sciences, Engineering, and Medicine's planning committees are solely responsible for organizing the workshop, identifying topics, and choosing speakers. The responsibility for the published workshop summary rests with the workshop rapporteur and the institution.

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This workshop summary has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published workshop summary as sound as possible and to ensure that the workshop summary meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We wish to thank the following individuals for their review of this workshop summary:

Anne M. Dattilo, Nestlé Infant Nutrition
Janet A. Phoenix, George Washington University
Maha Tahiri, General Mills Bell Institute of Health and Nutrition
Jennifer Weber, American Heart Association and American Stroke Association

Although the reviewers listed above provided many constructive comments and suggestions, they did not see the final draft of the workshop summary before its release. The review of this workshop summary was overseen by **Martin A. Philbert,** University of Michigan. He was responsible for making certain that an independent examination of this workshop summary was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this workshop summary rests entirely with the rapporteur and the institution.

Contents

1

Introduction and Overview[1]

Among the many troubling aspects of the rising prevalence of obesity in the United States and elsewhere in recent years, the growth of early childhood overweight and obesity stands out. As pointed out later in this workshop summary, the prevalence of obesity among U.S. children aged 2-5 years rose from approximately 5 percent in the early 1970s, the period used to establish a baseline for obesity, to 8.4 percent in 2012 (Ogden et al., 2014). As of 2012, approximately one in seven children in this age group was overweight (Fryar et al., 2012). The average 5-year-old girl in the United States weighed 43.2 pounds in 1976-1980 and 46.6 pounds in 2007-2010 (Fryar et al., 2012; Najjar and Rowland, 1987).

During the past decade, however, the prevalence of obesity among young children appears to have leveled off and may have begun to decline among some populations (Ogden et al., 2012). From 2003-2004 to 2011-2012, for example, the prevalence of obesity decreased from 13.9 percent to 8.4 percent among 2- to 5-year-olds (Ogden et al., 2014), although more data are needed to confirm this decline.

To explore what is known about effective and innovative interventions to counter obesity in young children, the National Academies of Sciences, Engineering, and Medicine's (the Academies') Roundtable on Obesity Solu-

[1] The planning committee's role was limited to planning the workshop, and this workshop summary has been prepared by the rapporteur with assistance from National Academies of Sciences, Engineering, and Medicine staff as a factual account of what occurred at the workshop. Statements, recommendations, and opinions expressed are those of individual presenters and participants, and are not necessarily endorsed or verified by the Academies, and they should not be construed as reflecting any group consensus.

tions held a workshop in Washington, DC, on October 6, 2015, titled "Obesity in the Early Childhood Years: Emerging Science and Implementation of Promising Solutions." (Box 1-1 briefly describes the Roundtable and its objectives.) The workshop brought together many of the leading researchers on obesity in young children to describe the state of the science and potential solutions based on that research. The workshop also explored sustainable collaborations and new insights into the implementation of interventions and policies, particularly those related to nutrition and physical activity, for the treatment and prevention of obesity in young children (see Box 1-2 for the workshop's complete statement of task). More

BOX 1-1
The Roundtable on Obesity Solutions

The Roundtable on Obesity Solutions was established in 2014. The Roundtable engages leaders from multiple sectors to help solve the obesity crisis in the United States. Through meetings, public workshops, background papers, and innovation collaboratives, the Roundtable fosters an ongoing dialogue on critical and emerging issues in obesity prevention and treatment and weight maintenance. It provides a trusted venue for enhancing and accelerating the discussion, development, and implementation of multisector collaborations and policy, environmental, and behavioral initiatives that can increase physical activity, reduce sedentary behavior, and improve the healthfulness of foods and beverages consumed to reduce the prevalence and adverse consequences of obesity and eliminate obesity-related health disparities.

BOX 1-2
Workshop Statement of Task

An ad hoc committee will plan and conduct a 1-day public workshop that will explore obesity during the early childhood years (birth to age 5). The workshop will highlight the science and recent developments in the understanding of emerging modifiable factors associated with the risk of early childhood obesity, including maternal health. The workshop agenda also will include presentations and discussion that address sustainable collaborations and new insights into implementing interventions and policies, particularly related to nutrition and physical activity, for the treatment and prevention of obesity in young children. Participants will discuss strategies that hold the greatest promise for progress in reducing obesity prevalence, especially in populations at greatest risk for obesity.

than 100 people attended in person, and 600 more registered to watch the webcast of the workshop.

After a brief welcome by Mary Story, professor of global health and community and family medicine at Duke University, vice-chair of the Roundtable on Obesity Solutions, and chair of the workshop planning committee, the workshop proceeded with four panels, each consisting of several presentations followed by a moderated discussion session.[2] (Appendix A contains the workshop agenda, and biographical sketches of the presenters appear in Appendix C.)

The first panel, which is summarized in Chapter 2, examined the prevalence of obesity in young children; trends over time; and the persistence of obesity into later childhood, adolescence, and adulthood. It also explored epigenetic factors related to the risk of early childhood obesity, as well as the development of taste and flavor preferences in the first few years of life.

The second panel, summarized in Chapter 3, addressed what is known about modifiable protective and risk factors associated with obesity through age 5. These factors include a mother's prepregnancy weight and weight gain during pregnancy; gestational diabetes; smoking during pregnancy; breastfeeding; complementary feeding; responsive parenting; and sleep, activity, and sedentary behavior in young children.

The third panel, summarized in Chapter 4, turned to interventions, practices, and policies that have demonstrated promise in the prevention and treatment of early childhood obesity. Specific topics included the role of pediatricians in obesity prevention and treatment, programs that take place in early care and education settings, and family-focused interventions.

The fourth and final panel, summarized in Chapter 5, looked at innovative cross-sector solutions, including multifaceted government programs at the national and local levels and partnerships involving health care systems.

Finally, Chapter 6 summarizes the brief closing remarks of Bill Purcell, attorney, Farmer Purcell White & Lassiter, and chair of the Roundtable on Obesity Solutions.

Boxes at the beginning of each chapter highlight important points made by the presenters, with the presenters' names shown in parentheses. It should be noted that these and other observations and conclusions described in this workshop summary represent the viewpoints of speakers and participants and should not be seen as conclusions or recommendations of the Academies or of the workshop as a whole.

[2] Other members of the planning committee were Anne Dattilo, Allison Gertel-Rosenberg, Jennifer MacDougall, Brent McBride, Rafael Pérez-Escamilla, Sonya Shin, Elsie Taveras, and Dianne Ward.

2

The State of the Science

Highlights from the Presentations of Individual Speakers

- Children in the United States on average have gained weight since the early 1970s, but the prevalence of obesity in all age groups appears to have stabilized since the early 2000s, and obesity may have become less prevalent among children aged 2 to 5. (Ogden)
- New understandings of epigenetic modifications in the expression of genes could point to factors in the environment that can be modified to reduce obesity. (Barkin)
- The flavors of the foods children experience beginning in utero and continuing during breastfeeding and complementary feeding establish flavor and food preferences that can persist throughout a lifetime. (Mennella)
- The birth of a child is an event that can motivate parents to change long-established behaviors. (Mennella)

The first of the workshop's four panels examined the state of the science in three key areas: the prevalence of overweight and obesity in early childhood and changes over time, the epigenetics of childhood obesity, and the role of flavor in establishing lifelong food preferences. These presentations were followed by a discussion session, summarized at the end of this chapter.

PREVALENCE AND TRENDS OF OVERWEIGHT AND OBESITY IN THE EARLY CHILDHOOD YEARS

According to data from the National Health and Nutrition Examination Survey (NHANES), 16.9 percent of children and teens in the United States between the ages of 2 and 19 were obese in 2011-2012 (Ogden et al., 2014). Among adults, aged 20 and older, 34.9 percent were obese. Together, these percentages translate into more than 90 million individuals—78.6 million adults and 12.7 million youth (see Figure 2-1), observed Cynthia Ogden, an epidemiologist at the National Center for Health Statistics at the Centers for Disease Control and Prevention (CDC), in her opening presentation at the workshop. "I know you all know this, but I think it is quite striking," she said.

The NHANES is a complex, multistage probability sample of the U.S. civilian noninstitutionalized population (Johnson et al., 2014). Because it is a sample rather than a census, all of its estimates have confidence intervals, Ogden noted. Starting in 1999, the NHANES became a continuous survey, with data being released every 2 years. About 5,000 people are surveyed each year and given standardized examinations.

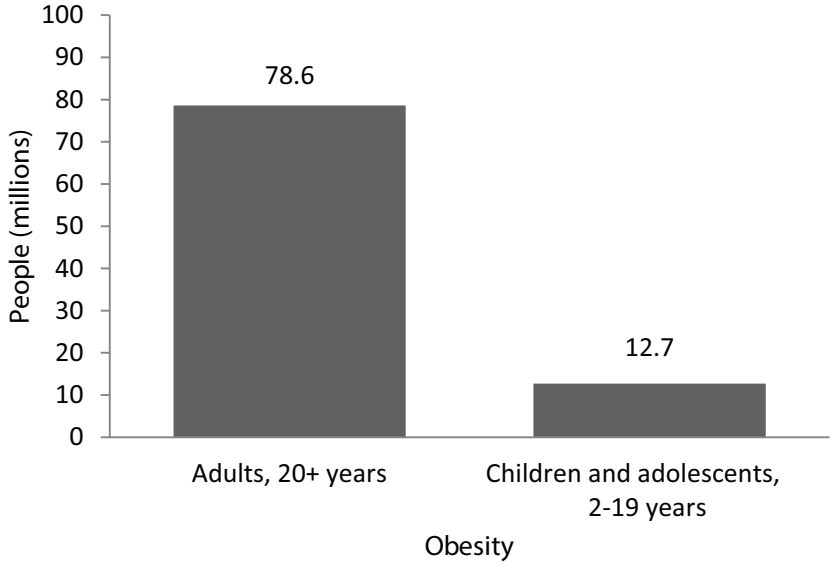

FIGURE 2-1 Obesity in adults and children and adolescents in the United States, 2011-2012.
SOURCES: Presented by Cynthia Ogden on October 6, 2015 (CDC, 2015a; Ogden et al., 2013).

Ogden noted that the precursor to the NHANES was the National Health Examination Survey. In 1971 nutrition was added, and the NHANES began (CDC, 2014). In that year, children aged 1 year and older were surveyed. The survey was extended to children aged 6 months and older in 1976 and to those aged 2 months and older in 1988 (CDC, 2014), and in 1999 it began encompassing all ages starting at birth. The survey includes measurements of weight and height, which are transmitted directly from the scale and stadiometer to a database to reduce the chances of recording errors. Ogden pointed out that the measured data from the NHANES are much more accurate than the proxy or self-reported data gathered in other surveys.

In children, obesity is not defined by a standard cut point as it is for adults, Ogden explained. Rather, anthropometric measures are compared with a reference population. For children less than 24 months of age, weight for recumbent body length is compared with the World Health Organization's (WHO's) growth standards (CDC, 2015b). Children are considered to have high weight-for-length if they are at or above the sex-specific 97.7th percentile on the WHO growth chart, which is 2 standard deviations from the mean (CDC, 2015b). Another definition sometimes used is weight-for-recumbent-length at or above the sex-specific 95th percentile on the CDC's growth charts (CDC, 2015b).

For children aged 2 to 5, body mass index (BMI)—defined as weight divided by the square of a person's height in metric measures—is compared with a reference population, which in the United States is generally the sex-specific 2000 CDC growth charts, said Ogden. Children are considered overweight if they have a BMI-for-age between the 85th and the 95th percentiles and obese if they are at or above the 95th percentile (CDC, 2015a). More recently, Ogden observed, some have defined severe or extreme obesity as a sex-specific BMI for age above 120 percent of the 95th percentile.

Current Prevalence of Overweight and Obesity

Ogden reported that, based on the WHO growth charts, the prevalence of high weight-for-recumbent-length (defined as greater than the 97.7th percentile) in children less than 2 years of age in the United States is 7.1 percent overall—3.5 percent for boys and 11.0 percent for girls. Using the CDC's growth charts (which define high weight-for-recumbant-length as greater than the 95th percentile), the corresponding percentages are 8.1 percent overall, 5 percent for boys, and 11.4 percent for girls (Ogden et al., 2014).

Based on 2012 data (the most recent data available), the percentages of 2- to 5-year-olds who are overweight are 14.4 percent for boys, 14.5 percent for girls, and 14.5 percent overall, while the corresponding percentages for obesity are 9.5 percent, 7.2 percent, and 8.4 percent (Ogden et al., 2014).

Among children less than 2 years of age, Ogden reported, there are no statistically significant differences in the prevalence of high weight-for-recumbent length by race/Hispanic origin (Ogden et al., 2014). By contrast, obesity prevalence differs significantly among non-Hispanic white, non-Hispanic black, non-Hispanic Asian, and Hispanic 2- to 5-year-olds (see Figure 2-2). For example, the prevalence of obesity among African Americans and Hispanics is significantly higher than that among non-Hispanic whites or non-Hispanic Asians in this age group. The reason for these differing patterns in the two age groups is unclear, Ogden said, but she suggested that it might be partially explained by differences in both the definition and measurement of excess weight in the two groups. The prevalence of obesity among young children also varies substantially by income in the United States. As of 2011, according to the Pediatric Nutrition Surveillance System, obesity among low-income, preschool-aged children ranged from less than 9.2 percent to 17.9 percent in different states, compared with an overall obesity rate in the general U.S. population of 8.4 percent (see Figure 2-2).

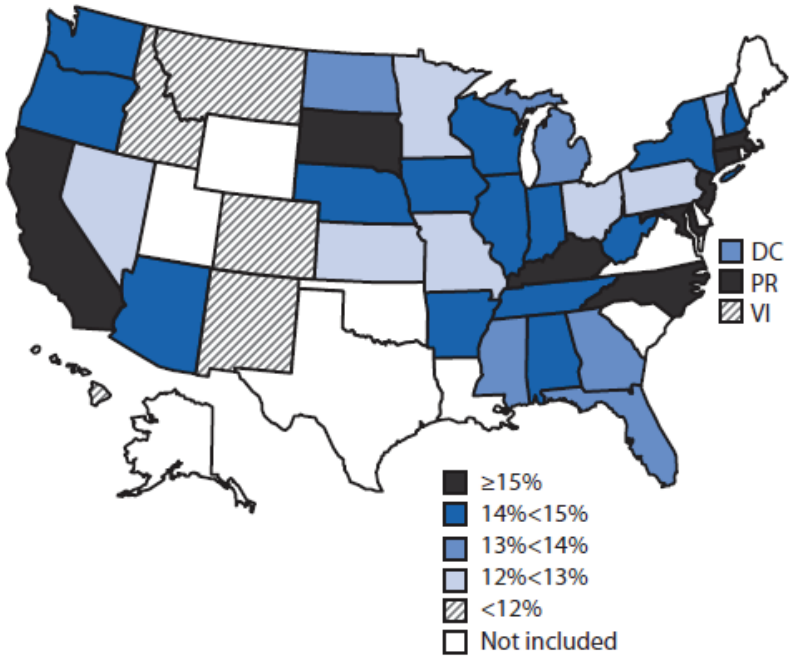

FIGURE 2-2 Prevalence of obesity among low-income, preschool-aged children, Pediatric Nutrition Surveillance System, United States, 2011.
NOTE: DC = District of Columbia; PR = Puerto Rico; VI = U.S. Virgin Islands.
SOURCES: Presented by Cynthia Ogden, October 6, 2015 (May et al., 2013).

Trends Over Time

Ogden reported that among 2- to 19-year-olds in the United States, the prevalence of obesity has more than tripled—from approximately 5 percent in the 1970s to 17 percent in the most recently available data, for 2011-2012 (Ogden et al., 2014) (see Figure 2-3). She noted that if children and adolescents aged 2-19 years are divided into three groups—ages 2-5, 6-11, and 12-19—one sees that obesity has risen more among the latter two groups than among the former (Ogden et al., 2014).

Still, the average weight of 2- to 5-year-olds has risen since the 1970s, Ogden stated. Average weight for 5-year-old girls was 46.6 pounds in 2007-2010, compared with 43.2 pounds in 1976-1980 (Fryar et al., 2012; Najjar and Rowland, 1987). For children less than 2 years of age, the prevalence of excess weight has not changed significantly since data on this age group were first collected in 1999-2000. The difference in trends between these youngest children and 2- to 5-year-olds is particularly interesting, said Ogden. More longitudinal data could help in understanding the difference, she suggested.

Childhood obesity trends were essentially flat over the decade before the most recently available data (Ogden et al., 2014), meaning that the increases occurred largely in the 1980s, the 1990s, and the first few years of the 2000s, said Ogden. Furthermore, for 2- to 5-year-olds, the prevalence of obesity decreased from 13.9 percent to 8.4 percent over the period 2003-

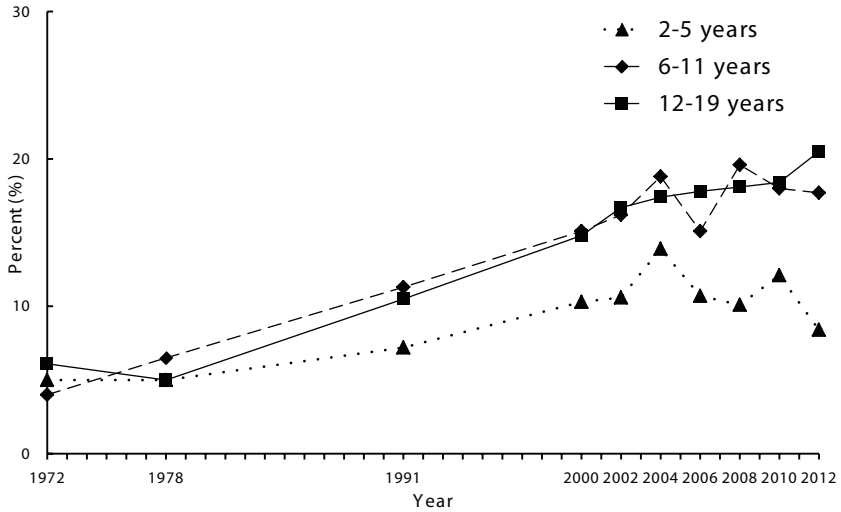

FIGURE 2-3 Prevalence of obesity among children and adolescents by age.
SOURCES: Presented by Cynthia Ogden on October 6, 2015 (Fryar et al., 2014).

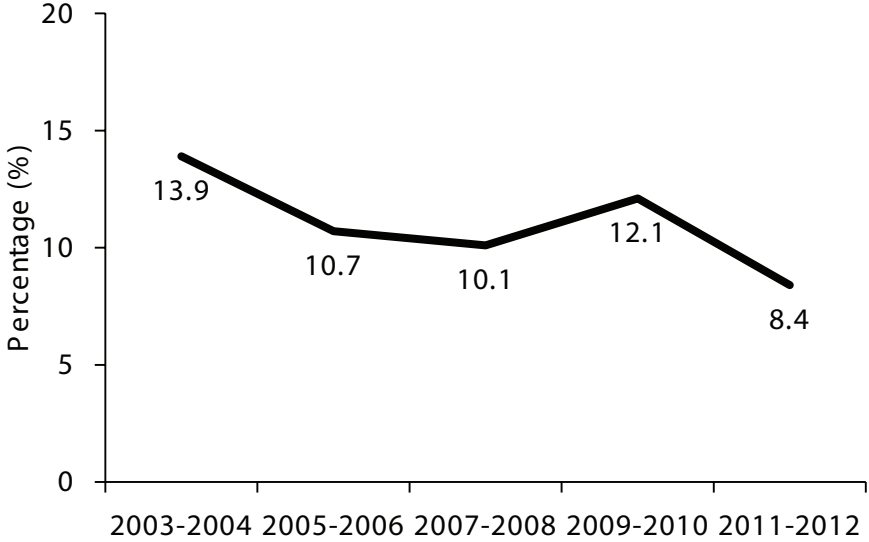

FIGURE 2-4 Prevalence of obesity among 2- to 5-year-olds from 2003 to 2012.
NOTE: 5.5 percentage point decrease (95 percent confidence interval of 1.4 to 9.6 percentage point decrease).
SOURCES: Presented by Cynthia Ogden on October 6, 2015 (Fryar et al., 2014).

2004 to 2011-2012 (see Figure 2-4). Ogden called attention to the need for more data to understand this drop. For example, were the 2011-2012 data an anomaly? Also, the numbers vary from each 2-year survey to the next, although averaging over a longer time period also shows a decline in obesity. "There may be a decrease in these young children," said Ogden. "We need to see the 2013-2014 [NHANES] data to confirm that."

Other data sources also show a drop in obesity among preschoolers, Ogden stated. For example, the Pediatric Nutrition Surveillance System found a slight but statistically significant decline in 18 states from 2008 to 2011 among low-income 2- to 4-year-olds participating in federal nutrition programs (May et al., 2013). Similarly, data from Southern California gathered by Kaiser Permanente researchers showed a decline in obesity among 2- to 5-year-olds—from 13.0 to 11.6 percent—between 2008 and 2013, although the change was insignificant (Koebnick et al., 2015).

Persistence of Obesity

A number of studies have found an association between childhood obesity and adult obesity, Ogden noted. For example, the Bogalusa Heart

Study found a moderate association (correlation of 0.3-0.4) between obesity in children when they were 2 to 5 years of age and obesity in those same individuals when they were adults. Compared with children with BMIs at or below the 50th percentile, children who were overweight were four times as likely to be obese as adults (Freedman et al., 2005).

Likewise, Ogden noted, data from the Fels Longitudinal study showed that children who were obese at 3-4 years old had a 15-25 percent chance of being obese in adulthood (Guo et al., 2002). The Early Childhood Longitudinal Study of kindergarteners in 1998-1999 found that children had a 47 percent probability of being obese in 8th grade if they had been obese in kindergarten (Cunningham et al., 2014). A study of data from a Washington State health maintenance organization found that obesity at ages 1 to 2 years was not a significant predictor of obesity during young adulthood, but that obesity between the ages of 3 and 5 years increased the odds of obesity in young adulthood to 4.1 (Whitaker et al., 1997). This study also found that the risk depended on whether the child had a parent with obesity. Finally, the longitudinal Cardiovascular Risk in Young Finns Study found a moderate association of 0.29 for girls and 0.36 for boys between obesity at age 3 and in adulthood (Juhola et al., 2011).

These studies still leave many questions unanswered about the persistence of obesity, noted Ogden, such as whether cohort differences are important. But, she said, they show that persistence occurs and is increasingly likely with older children.

In summary, said Ogden, 7-8 percent of children less than 5 years of age have excess weight, although the percentage depends on the age group in question and the measures used to quantify obesity. Finally, she noted, there are disparities in the prevalence of early childhood obesity along racial, ethnic, and economic lines.

THE EPIGENETICS OF CHILDHOOD OBESITY

The risk of obesity is impacted by the dynamic relationship among genetics, environment, and early childhood development, observed Shari Barkin, William K. Warren Foundation endowed chair and professor of pediatrics at the Vanderbilt University School of Medicine. Study of this relationship is still in its early stages, she noted. But enough is now known, she said, to "examine potential ideas for what might be modifiable or able to be mitigated as we examine innovative solutions for pediatric obesity prevention."

Human beings are 99.9 percent identical at the genetic level, noted Barkin, yet still have many differences (NHGRI, 2014). Part of the reason for these differences is epigenetics. Barkin defined the science of epigenetics as the study of changes in the expression of genes via post-translational and

post-transcriptional modifications. "Think of it this way," she said. "You can't change your genes, but you can change the way your genes behave."

Barkin explained that in all living species, the environment affects gene expression. Organisms receive cues from the environment that can change which genes are turned on and off (Lobo, 2008), a process that has been described as the social life of genes (Dobbs, 2013). For example, when the larvae of docile European bees are placed in the hives of the killer bee, the normally placid European bees acquire a phenotype identical to that of killer bees (Dobbs, 2013). "The genes didn't change, but the expression of the genes did," said Barkin.

Barkin noted that in February 2015, the Institute of Medicine held a workshop on the role of epigenetics in the origins of obesity in fetal development and early life and opportunities for intervention (IOM, 2015). The workshop examined gene expression across the lifetime and at multiple levels of environmental interaction (see Figure 2-5). From the many topics

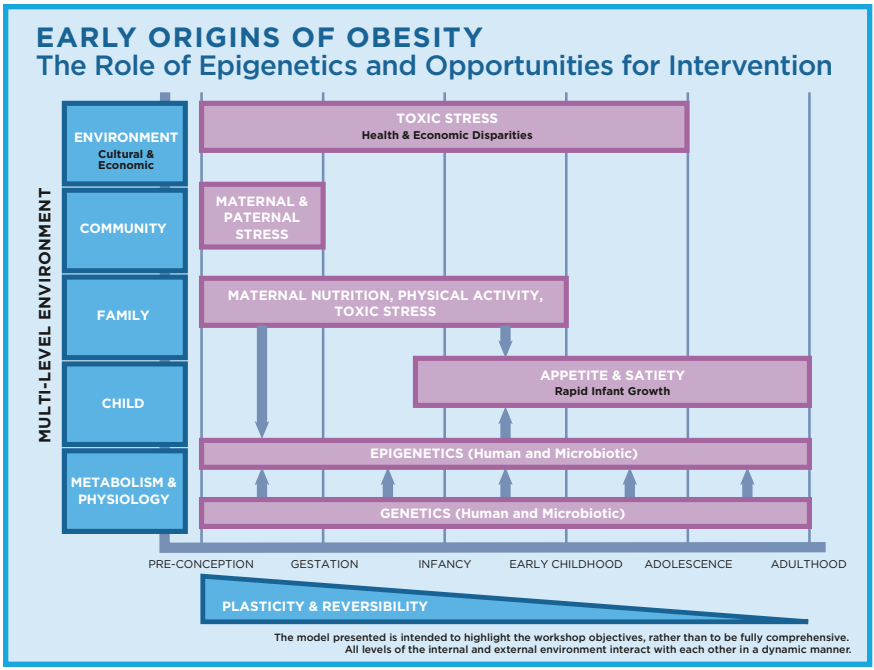

FIGURE 2-5 Epigenetic influences of obesity in a multilevel environment.
SOURCES: Presented by Shari Barkin on October 6, 2015. From Examining a Developmental Approach to Childhood Obesity: The Fetal and Early Childhood Years (IOM, 2015).

discussed at that workshop, Barkin focused specifically on maternal and paternal nutrition.

When genetically identical mice are exposed to different maternal diets in utero, said Barkin, they can have very different phenotypes, including different weights and different appearances (Waterland and Jirtle, 2003). In particular, mice that would normally be obese instead have a lean phenotype if their mothers are exposed to a diet supplemented with choline, folic acid, and vitamin B12, which affects the methylation of DNA at a genetic locus known as agouti (Waterland and Jirtle, 2003). "Clearly, maternal nutrition is important," said Barkin.

In animal models, high-fat diets during pregnancy similarly are associated with differential gene expression related to lipid metabolism, glucose metabolism, and appetite, Barkin reported. This altered gene expression can affect carbohydrate and lipid metabolism in offspring, in turn affecting the phenotypes of offspring (Lillycrop and Burdge, 2011). Some of these effects can be mitigated if postnatal nutrition has normal fat composition, Barkin added.

Barkin stated that maternal nutrition also affects the microbiome of mothers and their children—the community of single-celled organisms that live in close association with the body (Peterson et al., 2009). In a study of Japanese macaques, for example, mothers on a Western diet high in fats experienced a shift in microbiome species that affected lipid metabolism and inflammatory response (Friedman, 2015). Exposure to a maternal Western diet appears to pattern the microbiome and effect a pro-inflammatory state in infants (Friedman, 2015; Kumar et al., 2014). Although studies in the past have focused on correlations, many studies currently under way are looking at causation, Barkin reported.

Paternal nutrition also matters, said Barkin. Epigenetic modifications appear to act through the sperm that fertilize eggs (Lane et al., 2015). In rats, for example, a high-fat paternal diet increases beta cell dysfunction in female offspring (Ng et al., 2010). Paternal obesity also appears to affect the metabolic and reproductive health of the offspring for multiple generations (Lane et al., 2015). Barkin suggested that some of these effects could be addressed with improved paternal nutrition.

These findings have important implications for better understanding childhood obesity, Barkin pointed out. For example, Godfrey and colleagues (2011) examined longitudinal cohorts of children and epigenetic signatures of their umbilical cord tissue and then looked at fat distribution in the same children at age 9. Methylation patterns at several genes were associated with increased adiposity in an independent sample of children, although no causal mechanism was identified. The authors concluded that perinatal epigenetics could provide an opportunity to assess individual vulnerability to childhood obesity.

Barkin also described a 7-year randomized controlled trial of family-based community-centered interventions to prevent obesity in preschool-aged children that she and her colleagues are conducting. Using saliva to probe epigenetic signatures, they have found methylation patterns in children at risk of obesity that are associated with the BMI of their mothers.

To summarize this intriguing body of research, Barkin highlighted the field's potential "to identify at-risk [for obesity] children as well as understand mechanisms . . . [and] shed light on factors that could be potentially mitigated."

THE FLAVOR WORLD OF CHILDHOOD: BASIC BIOLOGY AND HEALTH IMPLICATIONS

Many chronic illnesses that plague society derive in large part from poor food choices that are dictated by people's taste preferences, stated Julie Mennella, a member at the Monell Chemical Senses Center in Philadelphia. "We don't have a problem of children over-consuming broccoli," she said. "They are over-consuming added sugars and salt, [with] too few fruits and vegetables. This pattern of food choice that is evident in the youngest members of our society mirrors that of our nation's adults."

What can account for patterns of food choice that appear to be antithetical to health and for the difficulty of changing those patterns? Mennella pointed to two factors that can predispose some children to consume obesogenic diets: inborn, evolutionarily driven taste preferences, and the detrimental consequences of not being exposed to the flavors of healthful foods early in life (Mennella and Ventura, 2011; Trabulsi and Mennella, 2012).

Evolution has shaped the taste of foods children initially prefer or reject, said Mennella. In an environment with limited nutrients and abundant poisonous plants, sensory systems evolved to detect and prefer the once rare energy (carbohydrate)-rich and sodium-rich foods that taste sweet and salty and to reject toxic foods that taste bitter (Forestell and Mennella, 2015).

Mennella went on to explain that the chemical senses that underlie the flavors of foods and beverages are functioning by at least the second trimester of pregnancy (Forestell and Mennella, 2015). Taste receptors are found not only in the oral cavity but also in the nasal cavity (Lee and Cohen, 2015) and in the gut (Egan and Margolskee, 2008), and activation of these receptors in the mouth can be a source of extreme pleasure or pain. While some responses are inborn (e.g., the liking of sweets), Mennella said, they can be shaped by learning.

Mennella focused first on sweet taste, which she contended is one of the most powerful taste signals for a baby and humans' oldest reward (Mennella, 2008). Babies are born attracted to sweet taste, the predominant taste quality of mother's milk. Within hours of birth, infants ingest more

of a sweetened solution than water and can differentiate varying degrees of sweetness (Desor et al., 1973). They suck more strongly on a nipple sweetened with sucrose than on an unsweetened nipple (Maone et al., 1990), and this potentiating of sucking is evident even in premature infants (Maone et al., 1990). Putting a drop of sugar in solution in a baby's oral cavity produces a smile, a calming effect, and a sucking effect (Steiner, 1979), and it blunts expressions of pain (Pepino and Mennella, 2005; Stevens et al., 2010). "Sugar is very powerful," said Mennella. "It is not just a preferred taste."

The preference for sweet taste—the taste signal for energy (e.g., fruits)—remains heightened during childhood and periods of maximal growth, Mennella continued (Coldwell et al., 2009; Mennella et al., 2014). It is evident among children around the world (Mennella, 2008). Relative to adults, children as a group prefer a more intense sweet sensation, Mennella noted, and the adult pattern of sweet taste preferences does not emerge until mid-adolescence (Mennella et al., 2011). "Even your teenager is living in a different world when it comes to sweet," she said.

"As much as children like the taste of sweet, they dislike the taste of bitter," Mennella continued. This dislike serves an important role, by "protecting the animal from consuming that which is toxic," she reiterated. Like sweet preferences, sensitivity to some bitter tastes also changes with age, attaining the adult pattern during mid-adolescence (Mennella et al., 2010, 2011).

In the current food environment, the elegant biology that attracts children to mother's milk and to sources of energy and protects them from poison makes them vulnerable to obesity, contended Mennella. "The biology hasn't changed," she said. "The environment has changed. [It is] rich in added sugars or salt." While the biological drive to avoid bitter and prefer salty and sweet foods may have served children well in a feast-or-famine setting, this biology explains why children are vulnerable to the current food environment abundant in highly processed and palatable foods and rich in added sugars, non-nutritive sweeteners, and salt. Understanding this vulnerability is key to developing evidence-based strategies for obesity prevention in children, said Mennella.

Mennella acknowledged that the ingrained biology of avoiding bitter tastes and liking sweet ones will not be changed easily. However, good news comes from research on how sensory experience beginning early in life can modify flavor and food preferences. "Our biology is not our destiny," said Mennella. "These senses can learn. We can get children off to a healthy start if they are provided with those experiences, and the earlier the better."

Mennella and her colleagues have focused on fruits and vegetables. A diet insufficient in fruit ranks as the leading dietary risk factor for the global burden of disease, with a diet low in vegetables ranking somewhat lower

(Ezzati and Riboli, 2013). The earliest information about these important sources of nutrients comes from the mother, both before birth and after (Neville et al., 2012). A variety of flavors are transmitted from the mother's diet to amniotic fluid (Mennella et al., 1995) and, if she breastfeeds, to breast milk (Mennella, 2007; Mennella and Beauchamp, 1991a,b, 1996, 1999). Infants detect these flavors, Mennella noted, and experience modifies their acceptance of similarly flavored foods. She and her colleagues found, for example, that the babies of mothers who ate carrots during pregnancy or lactation ate more carrots and made less negative faces while doing so than the babies of mothers who avoided carrots (Mennella et al., 2001). Similarly, the babies of mothers who had more fruits in their diet were more accepting of fruits upon first tasting them (Forestell and Mennella, 2007). The same phenomenon has been found in experimental results from other animals (Aigueperse et al., 2013; Mennella, 2007), Mennella noted. "It is a fundamental feature of how animals first learn about what foods are safe," she said. "The young learn from their mothers what foods she prefers, what foods she has access to, and what foods define their culture."

This learning about foods continues during complementary feeding, when solid foods are introduced into the infant's diet, Mennella continued. She pointed out that the presence of a food in a child's environment does not ensure that the child will learn to eat that food. Rather, the child must taste the food to learn to like it (Birch et al., 1987). With respect to fruits and vegetables, infants, whether breastfed or formula fed, continue to learn to like their flavor through repeated (8-10 days) exposure to a particular fruit or vegetable or to a variety of these healthy foods (Mennella et al., 2001; Sullivan and Birch, 1994). This learning is reinforced if the foods are part of the maternal diet (Sullivan and Birch, 1994), and is more efficient during infancy than in later childhood (Birch and Marlin, 1982). But the reality is that many children are deprived of learning to like the taste of fruits and vegetables, Mennella said. From the age of 2 years, children are more likely to consume a manufactured sweet than a fruit or vegetable on any given day (Saavedra et al., 2013). By age 4, 92 percent of children consume less than the minimum recommended amount of vegetables, while 99 percent of children exceed the recommended intake of added sugars (Krebs-Smith et al., 2010).

These dietary patterns, which are set before the age of 2 years (Saavedra et al., 2013), cannot be underestimated, Mennella stressed. Infrequent intake of fruits and vegetables during late infancy is associated with infrequent intake at 6 years (Grimm et al., 2014). The evidence suggests that the diets of children often mirror those of their parents, and consequently many are not having the experiences they need to learn to like fruits and vegetables, Mennella said.

Ending on a hopeful note, Mennella pointed to periods of life in which

old routines fall away and habits are suddenly in flux (Duhigg, 2012). One such period is around the birth of a child. For example, Mennella noted, many smoking cessation plans have been successful with pregnant women (Lumley et al., 2009). "Being pregnant and then a parent is probably one of the strongest motivators to change or modify behaviors," she said. For some women, simply knowing that their babies are learning about what they eat could make a difference, she suggested. She also recommended focusing on older adolescents as their taste and flavor preferences begin to change (Mennella et al., 2010, 2011). "They are the future parents of the next generation," she said. "It may be another opportune time for individuals who may be motivated to change to establish healthy eating habits that will be passed on to their children."

In conclusion, Mennella emphasized that basic research in both humans and animal models is critical to continued advances and applications in this area. Food is much more than taste or a source of calories, she said. "It gives us pleasure. It identifies who we are as a people, as a family, as a culture. It symbolizes our relationship to our environment."

DISCUSSION SESSION: OPPORTUNITIES FOR INTERVENTIONS

During the discussion session, the presenters turned their attention more directly to some of the kinds of interventions that could be supported by the science they had described. For example, Barkin emphasized the potential for further research to identify critical periods or populations in which interventions could be especially effective. "When we supplement appropriately, it might have greater benefits for certain ages or genders," she said. "We also have to manage the unintended consequences of who it might not be good for." Improved diets before and during pregnancy likely have an effect beyond any nutritional supplement. "There is no magical pill that seems to be associated with better outcomes; rather pre-pregnancy BMI and gestational weight gain seem to be potential points for intervention."

Mennella emphasized the importance of focusing on the family environment in investigations of how to improve diets. "You cannot feed babies separately than you feed a family," she said. "The baby is nourished by what the mother eats and that learning continues after birth, especially if the baby is breastfed." She noted that, while children often eat specially prepared foods during early complementary feeding, the goal is to have the child eat the foods of the family. For that reason, she suggested thinking about the diet of the family rather than the diet of only the child, a perspective that could help make healthy food habits more sustainable. Children can learn to like healthy foods, she reiterated, and the earlier they are exposed to them in the positive context of their families, the more successful the outcomes will be.

Barkin recommended looking at the framing of food and beverage consumption. If the default option with a fast food meal is fruit and milk rather than french fries and a soda, more people will eat these foods, she said. She also observed that discussion of healthy eating inevitably involves public policies, which again highlights the importance of both the evidence and family dynamics. "If we can consider how policies address families together as a unit, we could have the opportunity to shift normative behaviors," she suggested. For example, policies could help spread knowledge about what kinds of foods and what kinds of eating habits are best, such as not grazing on foods and beverages throughout the day. "Grazing overrides our homeostatic mechanism of saying, 'Hey, I'm full and I don't need to eat right now,'" she noted.

Finally, Barkin suggested that evidence needs to be presented to policy makers and the public in a way that tells a story. "Evidence, unfortunately, is not enough to change policy," she said. "It is the way in which you tell the story of the evidence."

3

Modifiable Risk and Protective Factors Associated with Overweight and Obesity Through Age 5

Highlights from the Presentations of Individual Speakers

- Mothers' prepregnancy body mass index (BMI), weight gain in pregnancy, and smoking in pregnancy all can affect the risk of obesity in children. (Bodnar)
- Although the effect size is small, breastfeeding is associated with prevention of childhood obesity in the general population, especially and even more so among children with a genetic predisposition to becoming obese. (Pérez-Escamilla)
- The dynamic eating patterns of the first few years of life offer many opportunities to change lifelong habits. (Saavedra)
- Responsive parenting, in which parents deliver prompt, developmentally appropriate responses that are contingent on a child's behavior and needs, can reduce the risk of obesity. (Birch)
- Insufficient sleep in infancy and early childhood and a lack of physical activity are modifiable risk factors for early childhood obesity, and these are among the many risk factors that account for higher rates of obesity in some ethnic and racial minority groups. (Taveras)

The second panel of the workshop included five presentations that progressed through the maternal–child life course to explore modifiable risk and protective factors for obesity. The first looked at pregnancy; the

second at breastfeeding; the third at complementary feeding; the fourth at responsive feeding; and the fifth at sleep, activity, and sedentary behavior. Together, these presentations described a wide range of opportunities for countering obesity in the first 5 years of life.

PREGNANCY FACTORS IN RELATION TO CHILDHOOD OBESITY

Lisa Bodnar, associate professor in the Departments of Epidemiology and Obstetrics and Gynecology at the University of Pittsburgh Graduate School of Public Health and School of Medicine, took as her point of departure the idea that, as pointed out in the previous chapter, pregnancy is an especially powerful opportunity for the promotion of healthy eating and physical activity behaviors among women (Phelan, 2010). Pregnant women are highly motivated to improve their health and the health of their infants, and this is a period of their lives when they are particularly likely to adopt new behaviors (Phelan, 2010). Pregnant women also have frequent contact with their health care providers. According to Bodnar, all of these features of pregnancy offer opportunities for intervention.

Bodnar discussed four factors that have a potentially causal relationship with childhood obesity: maternal prepregnancy body mass index (BMI), weight gain in pregnancy, gestational diabetes, and smoking in pregnancy.

Bodnar cited a study of approximately 8,500 low-income families in Ohio in which birth certificate data were linked to measured weights and heights obtained through the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) at 2, 3, and 4 years of age (Whitaker, 2004). The result was what she called an "elegant dose–response relationship" between a mother's prepregnancy BMI and the likelihood that her child would be obese at these ages. The children of mothers who were obese or severely obese before they became pregnant had a three- to fourfold increased risk of obesity. A number of subsequent studies have demonstrated this relationship, Bodnar noted. A meta-analysis by Yu and colleagues (2013) compared underweight, overweight, and obese women with normal-weight women and found that the children of overweight and obese women have about a twofold increased risk of becoming overweight or obese later in life.

The pathways through which maternal obesity may contribute to childhood obesity are complex, said Bodnar, involving both the metabolic programming of risk and the sharing of genes and behaviors. "We haven't really been able to tease apart which is more important," she said. "It is likely that they all play a role."

Bodnar also pointed out that prepregnancy BMI is difficult to modify because nearly half of pregnancies are unplanned or mistimed (Finer and Zolna, 2011), and most women who are planning a pregnancy do not seek

preconception care (Robbins et al., 2014). "Seeking preconception care may not even be on their radar," she said. Also, she noted, few women who are obese know that their weight can have immediate consequences for their children (Nitert et al., 2011).

After conception, Bodnar continued, the focus of research turns toward influences that occur during pregnancy, one of which is the amount of weight a woman gains during gestation. In 2009 the Institute of Medicine (IOM) and the National Research Council (NRC) published modified gestational weight gain recommendations that incorporate prepregnancy BMI (IOM and NRC, 2009). The recommended weight gain for a normal-weight woman is 25 to 35 pounds, whereas that for an obese woman is 11 to 20 pounds. Any gain above these upper ranges is generally considered excessive, Bodnar said.

Excessive gestational weight gain is common among U.S. women, Bodnar observed. Even among normal-weight women, 43 percent gain too much weight during their pregnancies (Truong et al., 2015) (see Figure 3-1). Among overweight and obese women, 65 to 70 percent exceed the IOM and NRC recommendations for weight gain during their pregnancies (Truong et al., 2015), Bodnar noted. When Oken and colleagues (2007) followed about 1,000 mother–child pairs for 3 years, they found positive relationships between total pregnancy weight gain and the children's BMI z-scores, triceps skinfold thicknesses, and systolic blood pressure at age 3 years.

Bodnar cited a meta-analysis of 12 different studies by Mamun and colleagues (2014), which found that children born to mothers who gained more than the recommended amount of weight during pregnancy had a 40 percent increased risk of developing obesity in their lifetime. The magnitude of this risk varied over time: children less than 5 years of age had about a 90 percent increase in the risk of childhood obesity when their mothers gained too much weight during pregnancy, while children aged 5-18 also showed this association, although it was less strong (only about a 30 percent increase in risk), and for adults (older than 18), the increase in risk was 47 percent.

Weight gain during pregnancy entails a unique balancing act, Bodnar noted. Women who gain too little weight during pregnancy have an increased risk of preterm birth and of having babies who are small for gestational age (IOM and NRC, 2009), she said, while those who gain too much weight have an increased risk of their children being obese (Mamun et al., 2014).

Another consideration, Bodnar noted, is that women who gain too much weight during pregnancy have a tendency to retain that weight postpartum (Viswanathan et al., 2008). If they have subsequent pregnancies, these women are more likely to start pregnancy overweight, which further increases their risk of gaining too much weight during pregnancy (IOM and NRC, 2009; Pérez-Escamilla and Kac, 2013). With each successive

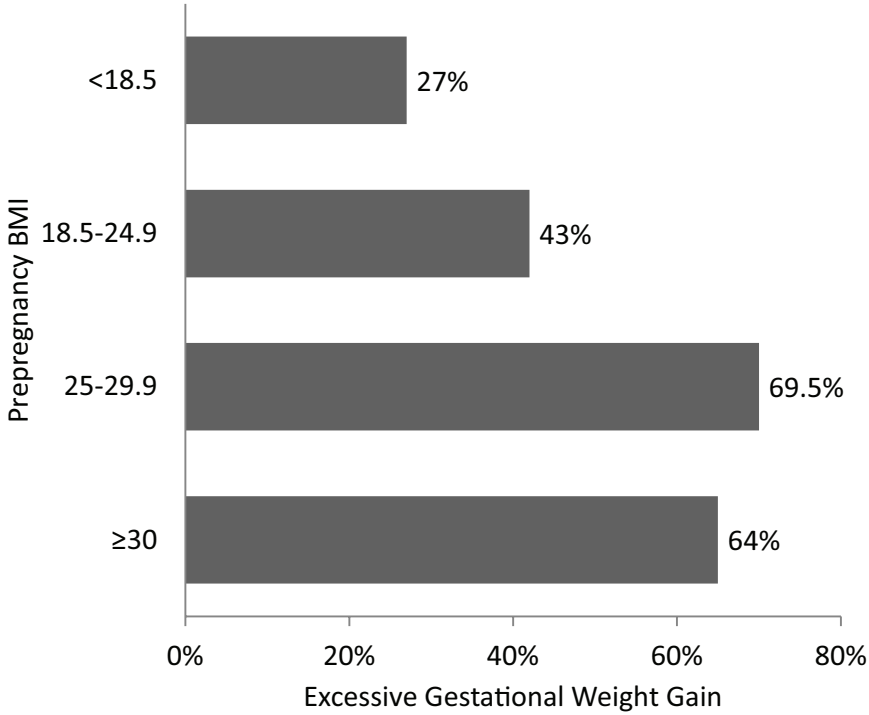

FIGURE 3-1 Prevalence of excessive gestational weight gain by prepregnancy body mass index (BMI), U.S. births.
SOURCES: Presented by Lisa Bodnar on October 6, 2015 (adapted and reprinted with permission from Truong et al., 2015).

pregnancy, the likelihood of this obesity cycle increases (Pérez-Escamilla and Kac, 2013).

Interventions to reduce gestational weight gain have shown mixed results, Bodnar reported. A recent meta-analysis reviewed 49 randomized controlled trials involving more than 11,000 pregnant women who engaged in interventions that included dieting, exercise, or some combination of the two (Muktabhant et al., 2015). Bodnar noted that these interventions reduced the risk of excessive weight gain during pregnancy by about 20 percent, but the effect on the risk of macrosomia (excessive birth weight for length of gestation) in the women's babies was smaller and not statistically significant, although the effect was stronger for women who were overweight, obese, or at risk of gestational diabetes. No studies have yet looked at the effects of interventions on childhood obesity, and "this is an important gap that needs to be addressed," Bodnar said.

Turning to the third factor introduced at the beginning of her presentation, Bodnar observed that gestational diabetes is related to fetal overnutrition, which may influence obesity in children (Catalano and Hauguel-de Mouzon, 2011). Mothers with gestational diabetes are more likely to have children with higher birth weights and greater fetal adiposity, although this relationship is significantly diminished when maternal prepregnancy BMI is accounted for (Kim et al., 2012). Bodnar noted that nearly half of gestational diabetes cases are thought to be attributable to overweight and obesity, and the incidence of gestational diabetes is strongly associated with prepregnancy BMI (Kim et al., 2010).

Bodnar cited a meta-analysis by Philipps and colleagues (2011) that found that mothers with all types of gestational diabetes (onset both before and during pregnancy) had children with higher BMI z-scores. When these results were adjusted for prepregnancy BMI, she noted, the association was significantly attenuated. Another meta-review (Kim et al., 2012) resulted in similar conclusions, although the sample sizes of individual studies have tended to be small, and few have used direct measures of adiposity in children. Maternal BMI appears to be a stronger factor than gestational diabetes in childhood obesity, Bodnar said, but "there is still work to be done in this area."

Moving to a fourth factor with a potentially causal relationship with childhood obesity, Bodnar stated that smoking in pregnancy is consistently associated with an increased risk of childhood obesity (Ino, 2010; Oken et al., 2008). She observed that there are two mechanisms thought to explain this association. The first is that children born to smoking mothers may experience a period of postnatal catch-up growth, following their slower growth in utero (Ong, 2006). The second is that maternal smoking may affect appetite regulation, food preferences, or nutrient metabolism in offspring (Ayres et al., 2011; Behl et al., 2013; Ino, 2010). Bodnar reported that Oken and colleagues (2008) summarized 14 studies of maternal smoking in children aged 3 to 33 years and found a 50 percent increase in the risk of childhood obesity among the children of mothers who smoked during their pregnancies, after adjusting for maternal BMI and other factors. Ino (2010) found similar results.

Bodnar highlighted a longitudinal study by Riedel and colleagues (2014) that followed about 1,000 children, some exposed to smoking in utero and some not, to see how their relative weights changed over time. The researchers found that, among girls born to smoking mothers, overall BMI z-scores were lower at birth compared with babies born to nonsmokers, but by 4 and 5 years of age, their BMI z-scores were higher than those of their unexposed peers (see Figure 3-2). Bodnar noted that related research has found that exposure to secondhand smoke during pregnancy increases the risk for childhood obesity (Griffiths et al., 2010; Raum et al., 2011).

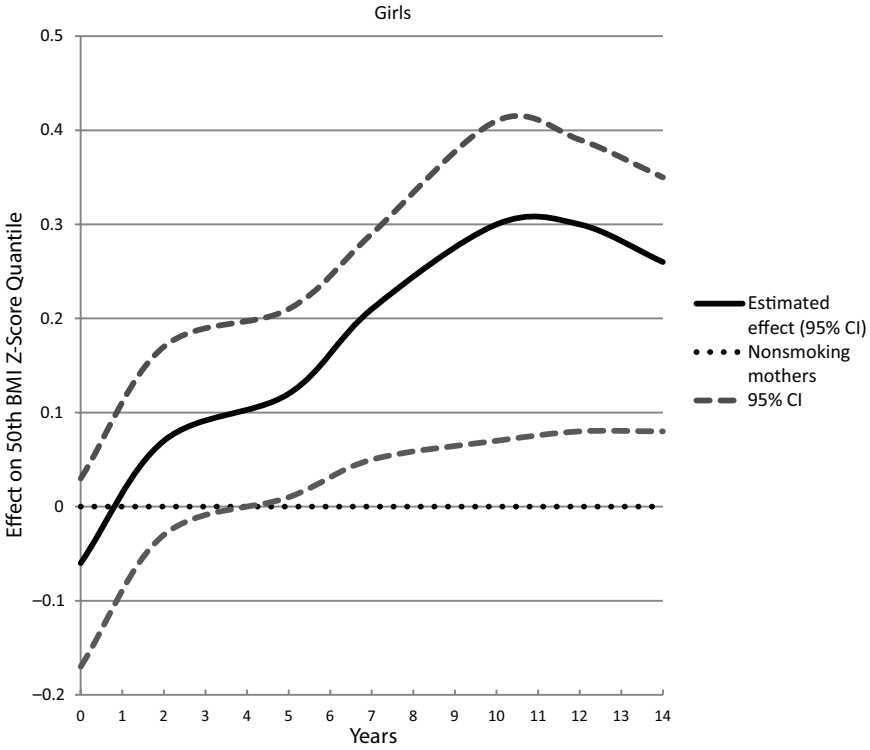

FIGURE 3-2 Body mass index (BMI) z-scores for girls with smoking and nonsmoking mothers.
NOTE: CI = confidence interval.
SOURCES: Presented by Lisa Bodnar on October 6, 2015 (reproduced with permission from Riedel et al., 2014).

Many important knowledge gaps exist in the understanding of maternal influences on childhood obesity operating during pregnancy, said Bodnar. She cited the need for specific markers, such as maternal body composition, fat distribution, diet, and metabolic changes in pregnancy. Another major question, she suggested, is how early-life nutrition and physical activity, as well as exposure to chemicals during pregnancy, may modify the long-term risk of obesity (Heindel and vom Saal, 2009; Symonds et al., 2013).

BREASTFEEDING AND THE RISK OF CHILDHOOD OBESITY

Breastfeeding may protect against childhood obesity for several possible reasons, observed Rafael Pérez-Escamilla, professor of epidemiology,

Yale School of Public Health. Breastfed babies may be better able to self-regulate their energy intake using cues related to changes in milk composition during feeding, he said, and mothers using formula may be more likely to overfeed their babies because they have more control over that process than is the case when a baby self-regulates intake (Pérez-Escamilla et al., 1995). He noted that breast milk has a lower protein content than infant formula, which may protect against higher insulin levels and greater obesity risk (Koletzko et al., 2009). Echoing a point made earlier by Mennella, moreover, he observed that, depending on maternal diet, breastfed babies are exposed to a greater diversity of flavors, which may positively affect their taste preferences for fruits, vegetables, and other foods lower in energy density if their mothers consume those foods (Mennella, 2014). Finally, he said, suboptimal infant feeding patterns using formula may lead to excessive weight gain during infancy, which is likely to increase the risk of childhood obesity (Dewey, 1998; Pérez-Escamilla and Kac, 2013).

Pérez-Escamilla reported on two recent meta-analyses assessing the epidemiological evidence behind the hypothesis that breastfeeding offers protection against the development of childhood obesity. In a meta-analysis of 105 studies, Horta and colleagues (2015) found a significant reduction—26 percent—in the odds of children becoming obese later in life if they were breastfed as infants. This systematic review covered evidence from low-, middle-, and high-income countries and did not impose restrictions on the experimental or observational designs allowed, and the studies varied widely on such attributes as breastfeeding modalities and comparison groups. The range of ages at which obesity was assessed was 1 to more than 20 years, with the effect varying by age. Also, the larger the sample size included in the study, the lower was the effect size detected, and there were differences between children born before and after 1980, perhaps related to differences in formula composition, contended Pérez-Escamilla. Cohort studies tended to show the smallest effect size (odds ratio [OR] = 0.79) relative to case-control (OR = 0.68) and cross-sectional studies (OR = 0.67), he noted. In addition, the greater the adjustment for confounding, the smaller was the effect size. Effect sizes were almost identical across high- and middle- to low-income countries, Pérez-Escamilla reported, and exclusive breastfeeding tended to produce the strongest protection. Looking only at the studies of the highest possible quality, the review found an effect size of just 13 percent reduction in risk.

In the second meta-analysis, Giugliani and colleagues (2015) looked at 35 studies, but only 12 of them reported BMI or weight-for-length (or -height). Of these, 10 were randomized controlled trials, and two were quasi-experimental. The studies covered high-, middle-, and low-income countries and a wide variety of interventions and ages. Although the evidence from these studies must be interpreted with caution, Pérez-

Escamilla said, the benefits appeared to be somewhat higher in high-income versus lower-income countries. Smaller sample sizes also tended to yield greater effects, he observed. The authors did find a modest reduction in the risk of childhood obesity as a function of maternal exposure to a breastfeeding promotion program in low- and middle-income countries. Pérez-Escamilla noted that although the effect size was small—a reduction of just 0.06 z-score mean difference in BMI or weight-for-length (or height)—it is statistically significant.

Beyerlein and von Kries (2011) found that only among children in the highest BMI percentiles was breastfeeding associated with a lower BMI compared with formula feeding, suggesting that children with a greater propensity for obesity may benefit the most from breastfeeding, contended Pérez-Escamilla. Subsequent studies (e.g., Dedoussis et al., 2011), he noted, have found that particular alleles in the fat mass and obesity-associated (*FTO*) gene may help explain why breastfeeding protection is stronger among babies with a genetic propensity to become obese. This genetic predisposition may indeed be impacted by breastfeeding, he suggested. Abarin and colleagues (2012) found that, among boys with the *FTO* gene propensity for obesity, there was a dose–response relationship between how long they received only breast milk and the degree of protection against childhood obesity they received by 14 years of age. Among the boys who had this genomic propensity, Pérez-Escamilla said, none were overweight if they had received only breast milk for 5 months, compared with half of the boys who received only breast milk for less than 2 months.

Pérez-Escamilla made several recommendations for additional research. He pointed to the need for prospective studies that would carefully measure the duration of exclusive breastfeeding. Genomic propensities are a promising area for future epidemiological and basic mechanistic research, he contended, along with the effects of breastfeeding as a function of other maternal–child life-course factors, including prepregnancy BMI, gestational weight gain, and the timing of the introduction and the type of complementary feeding (Daniels et al., 2015a; Pérez-Escamilla and Bermúdez, 2012). He also noted that researchers generally do not correct for the effects of diet and physical activity between the period of breastfeeding and the time of anthropometric measurement, which he characterized as a "huge gap that needs to be filled."

In conclusion, said Pérez-Escamilla, breastfeeding is associated with prevention of childhood obesity in the general population, with a stronger association among children with a genomic propensity to become obese. The effect size is small, but this is not surprising, he suggested, given the constellation of factors that influence obesity. "Breastfeeding protection, promotion, and support should form a part of childhood obesity prevention strategies," he asserted. "Thankfully, we have a fair number of

evidence-based strategies that work at both the facility and the community level, and some that work at the macro-environment [level], protecting the ability of moms who wish to breastfeed their babies." These include the Baby-Friendly Hospital Initiative (Pérez-Escamilla, 2007), peer counseling (Chapman et al., 2010), and breastfeeding protection policies (Hawkins et al., 2013; Smith-Gagen et al., 2014).

COMPLEMENTARY FEEDING

Gestation and the first 2 years of life shape metabolic, immunologic, sensory, behavioral, developmental, and growth parameters for the rest of a person's life, observed Jose Saavedra, global chief medical officer, Nestlé Nutrition, and associate professor of pediatrics, Johns Hopkins School of Medicine. He described the work of Dattilo and colleagues (2012), who sought to identify comprehensively those actionable, modifiable factors associated with overweight during this critical period. Modifiable factors were defined as feeding and related dietary, environmental, or behavioral practices that could potentially be modified by parents and caregivers, with interventions beginning at birth.

Surprisingly, the factors that are significantly subject to the direct influence of parents and caregivers, and have been associated with childhood obesity in the first 2 years of life are not numerous, Saavedra pointed out. Those related to food and diet include

- lack of breastfeeding,
- early introduction (before 4 months of age) of complementary foods,
- high intake of sweetened beverages, and
- low intake of fruits and vegetables.

Those related to feeding and behaviors include

- lack of breastfeeding;
- lack of responsive feeding practices by caregivers, including low attention to hunger and satiety cues and the use of overly restrictive, controlling, rewarding, or pressure feeding;
- low total and nocturnal sleep;
- lack of family meals;
- television/screen viewing time; and
- low active play.

Saavedra focused on the modifiable factors related to complementary feeding. Two large studies in the United States have looked at infant feed-

ing and care practices in the first year of life, he reported. One was the Infant Feeding Practices Study II (IFPS II), a longitudinal assessment conducted using food frequency questionnaires delivered by mail from 2005 to 2007 to examine infant feeding and feeding transitions during the first year of life (CDC, 2015c). The study started with a group of about 4,000 pregnant women and followed about 2,000 of them and their infants until they reached 12 months of age, with higher-risk groups underrepresented. The second large study was the Nestlé Feeding Infants and Toddlers Study (FITS), conducted in 2002 and 2008, which included nationally representative samples aged 0-4 years. Diet was assessed cross-sectionally in households using a 24-hour dietary recall survey carried out by phone (Nestlé, 2014). The IFPS II found extremely dynamic feeding patterns in the first few months of life, Saaverda said (Grummer-Strawn et al., 2008). The period between the end of 3 months of age and the beginning of 5 months of age, in particular, is extremely dynamic, he noted. At the beginning of this period, 20 percent of infants have already been exposed to complementary foods; by the end of the period, this figure rises to 40 percent (Fein et al., 2008; Grummer-Strom et al., 2008). The FITS reinforced the dynamic change in both the amount and the variety of solid foods introduced within a brief time period (Siega-Riz et al., 2010).

Drawing from these and other studies, Saavedra reported that the early introduction of solid foods, before age 4 months, is seen in children who are not initially breastfed; those who are not breastfed until 6 months of age; and those who are born of less educated, single, young mothers living in the eastern rather than the western United States and participating in WIC (Clayton et al., 2013; Fein et al., 2008; Grummer-Strawn et al., 2008). Drawing from IFPS II data (Clayton et al., 2013), Saavedra stated that the following reasons for the early introduction of solid food are most commonly cited:

- "My baby was old enough to begin to eat solid food." (88.9 percent)
- "My baby seemed hungry a lot of the time." (71.4 percent)
- "My baby wanted the food I ate or in other ways showed an interest in solid food." (66.8 percent)
- "I wanted to feed my baby something in addition to breast milk or formula." (64.8 percent)
- "It would help my baby sleep longer at night." (46.4 percent)
- "A doctor or health care professional said my baby should begin eating solid food." (55.5 percent).

Saavedra called particular attention to the final reason, related to inadequate advice from health care professionals. "We have some of ourselves to blame for the lack of understanding and poor education we provide with

regard to when complementary food introduction could or should be happening," he asserted.

Grains tend to be the first food introduced, noted Saavedra, with the gradual addition of vegetables; fruits and juices; meats; and sweets, sweetened beverages, and desserts (Siega-Riz et al., 2010) (see Figure 3-3). He added that the results of the FITS show that average energy intake in North America is higher than estimated requirements throughout the first 4 years of life. Average protein intake also is considerably higher than estimated requirements. So, too, is the intake of saturated fat, Saavedra said, with about three-quarters of children in the third and fourth years of life exceeding dietary guidelines for this nutrient. Moreover, more than 80 percent of children exceed the upper limit for sodium by the fourth year of life. At the same time, virtually no children reach the current recommendation for fiber intake during this period (Butte et al., 2010). "We probably need to modify our expectations with regard to fiber intake targets, as they seem unreachable even with adequate food choices," Saavedra suggested. He continued, "That said, fiber highly correlates with the energy density of the diets. The higher the fiber intake, particularly when fruits and vegetables are consumed as fruits and vegetables and not as extracts, juices, or beverages, the energy density of the diet significantly goes down, and the total energy intake by the child also goes down. Fiber intake may be important not for the purposes of meeting [the recommendation], per se, but for the

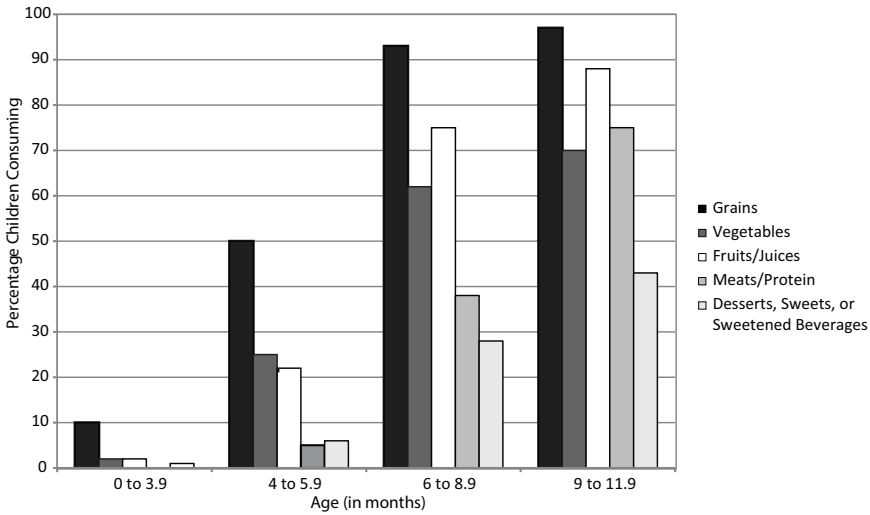

FIGURE 3-3 Percentage of children consuming any complementary foods by age groupings in the first year of life in the Feeding Infants and Toddlers Study 2008.
SOURCES: Presented by Jose Saavedra on October 6, 2015 (reprinted with permission, Siega-Riz et al., 2010).

purposes of decreasing the energy density [which] contributes to a lower energy intake."

On any given day, once complementary feeding has been initiated, Saavedra reported, 30 to 40 percent of children aged 6 months and older do not eat a vegetable, and 20 to 35 percent of children in this age group do not eat a fruit (Fox et al., 2010; Siega-Riz et al., 2010). Yet after their first birthdays, 70 to 90 percent of children are fed some type of sweet, with sweetened beverages constituting about a quarter of this intake. More than a third of the calorie increase from ages 6 to 48 months is attributable to sweets and sweetened beverages, including candy, ice cream, sweet rolls, pie, cake, and cookies (Fox et al., 2010), which "could potentially explain a huge part of the problem," said Saavedra. Consumption of sugar-sweetened beverages in infancy almost doubles the odds of consuming them at age 6, he noted (Pan et al., 2014). Also, by 4 years of age, the majority of toddlers eat at a fast food restaurant one to three times per week (Briefel et al., 2015). "Again, when you look at . . . the energy density, the nutrient density, and the density as it relates to saturated fat, we have, obviously, a problem," Saavedra asserted. He reported data from the FITS that on average, less than 10 percent of the energy for a 4-year-old comes from fruits and vegetables. Finally, with respect to the portion of total calories contributed by each food group, he noted that the pattern is clearly set before 2 years of age. Despite changes in total energy consumption and a growing number of food options with age, the relative energy contribution of each food group remains the same, he said, suggesting that this pattern will remain unchanged for life.

Saavedra finished by saying, "The most important messages are [we] need to start educational interventions much earlier than what we have been paying attention to." Echoing a point made in Mennella's presentation (see Chapter 2), he went on to say that it is important to take advantage of the fact that a child's first few months of life are the time when families are most receptive to education in adopting behaviors, particularly related to dietary patterns.

During the discussion period, Saavedra made an interesting point with regard to the food introduced to children during the first year of life. In North America relative to many other parts of the world, many more vegetables and fruits are commercially available for infants and children, and the majority of them no longer have added sugar and salt. However, the table food parents introduce to infants and toddlers tends to have much more added sugar and salt, Saavedra said, not only in the United States but elsewhere as well. Furthermore, these early food offerings can establish patterns of food intake that are difficult to change later in life.

Saavedra also suggested that parents need better education in bottle feeding. For example, infants receiving breast milk exclusively in a bottle may actually gain more weight than infants receiving formula in

a bottle. Compared with the natural maternal–child bidirectional feedback mechanisms of breastfeeding, bottle feeding can easily override infants' satiety signals if parents are not familiar with or educated in their infants' hunger and satiety cues.

Changing behaviors is difficult, Saavedra acknowledged, but again, the birth of a child is a receptive time for a mother to change her behaviors or induce a behavior in a child. The target messages are not numerous, and just a few could make a big difference, he asserted. They include breastfeeding, not introducing solids before 4 months of age, increasing the child's consumption of fruits and vegetables, and decreasing the consumption of sweets and sweetened beverages. Saavedra ended by saying, "The key messages are not many, [and] education on these messages is feasible. And it can be made accessible and scalable, particularly if we make full use of current technology. If we work together, a good part of the solution is within our reach."

RESPONSIVE PARENTING

For most of history, food scarcity was the context in which parenting behaviors developed, said Leann Birch, William P. Flatt professor, Department of Foods and Nutrition, University of Georgia. Food availability was unpredictable, food choice was limited, palatability was questionable, and energy and nutrient densities were low in the foods that were available. "There are still many people in the world who are living in this situation," Birch noted.

Many of the traditional parenting practices that developed in this context, Birch said, are still the default options today. These practices include feeding in response to infant crying regardless of the reason, trying to get children to eat large portions, requiring that they finish what is on their plate, having them eat even when they say they are not hungry, and believing that a big baby is a healthy baby. The problem, said Birch, is that in the current obesogenic environment, these practices may place children at increased risk for rapid weight gain and obesity.

One potential way to change these traditional feeding practices is to use what is called responsive parenting, Birch asserted. A long-established concept in the developmental literature, she explained, responsive parenting entails prompt, developmentally appropriate responses that are contingent on a child's behavior and needs. Mothers are encouraged to learn to recognize infant cues, whether their babies are hungry or distressed for some other reason, and then are taught alternative soothing strategies to use depending on the cues. For example, parents are encouraged to try minimal interventions first to see whether the baby will settle and go back to sleep. If the baby is still fussy, feeding is a reasonable response.

Responsive parenting is meant to foster the development of self-regulation and promote cognitive, social, and emotional development, Birch observed. "The infant begins to learn that the world is a predictable place in which their actions have an effect," she said.

Birch posed the question of whether responsive parenting can affect rapid weight gain and obesity risk early in life. The existing evidence is intriguing, she said, but still scant. First, evidence from randomized controlled trials shows that responsive parenting is modifiable. For example, Landry and colleagues (2006) showed that a parenting intervention known as the Play and Learning Strategies[1] increased mothers' contingent responsiveness compared with a control group. Birch noted that responsive parenting also has been positively associated with cognitive, social, and emotional growth in children (Eshel et al., 2006), particularly the development of self-regulatory skills. She explained that self-regulation involves a number of overlapping constructs, including self-control, willpower, effortful control, delay of gratification, emotion regulation, executive function, and inhibitory control (Anzman-Frasca et al., 2015). Multiple aspects of self-regulation could be important in avoiding excessive intake in the current food environment, she stated.

Birch and her colleagues have been studying whether responsive parenting can reduce obesity risk (Paul et al., 2011, 2014; Savage et al., 2015). In a randomized controlled trial known as SLIMTIME (SLeeping and Intake Methods Taught to Infants and Mothers Early in Life Trial), they followed 160 first-time mothers and infants to see whether responsive parenting can affect the primary outcome of infant weight gain and such secondary outcomes as sleep duration, night feedings, and the use of feeding to soothe. The study had a two-by-two intervention design. The three intervention groups received either a soothe or sleep intervention in which mothers were taught to discriminate between hunger and other sources of infant distress and to use soothing strategies in response to fussiness, particularly at night; a feeding intervention in which mothers were instructed to delay complementary foods until 4 months, avoid putting infant cereal into bottles, and pay attention to hunger and satiety cues; or both. A fourth group did not receive either intervention.

One observation, Birch reported, was that mothers in the SLIMTIME intervention groups were less likely than those in the control group to report encouraging their infants to finish the bottle, although even in the intervention groups, half the mothers were still doing so. The researchers also saw differences in early emotion regulation, which emerges around the end of the first year of life. Compared with the control group, the responsive parenting infants were better able to regulate their negative emotions

[1] See https://www.childrenslearninginstitute.org/programs/play-and-learning-strategies-pals (accessed April 20, 2016).

to recover from being upset, fussing, and crying during a toy removal task (Anzman-Frasca et al., 2013). Babies in the intervention groups also were fed less in the middle of the night and were sleeping a bit longer than those in the control group (Paul et al., 2011). "They are learning to self-soothe, to calm themselves down, to settle, and not elicit the parent to give them a feeding," said Birch.

The SLIMTIME trial produced differences in weight-for-length percentiles at 1 year, when the intervention ended (Paul et al., 2011), with the greatest effects being among children who received the intervention focused both on the introduction of solids into the diet and on soothing and sleeping. "It took both of those things to move the needle on weight-for-length percentiles at 1 year," said Birch.

Birch described an ongoing trial known as INSIGHT (Intervention Nurses Starting Infants Growing on Healthy Trajectories), in which the responsive parenting intervention has been expanded to include helping babies sleep longer, dealing with fussy babies, interacting with babies when they are awake and alert, and other parenting practices (Paul et al., 2014). According to preliminary data from this trial, she said, on average (based on a Kolmogorov Smirnov two-sample test, $p < 0.01$), infants in the parenting intervention have less rapid weight gain from birth to 28 weeks and have lower weight-for-length percentiles at 1 year of age (Savage et al., 2015). Based on these results, "responsive parenting can make a noticeable difference in early rapid weight gain," Birch asserted, although "whether we will have longer-term effects still remains to be seen."

Many questions still surround this work, Birch noted. Does responsive parenting have collateral benefits for other aspects of child development? Are the results generalizable to higher-risk samples? Can designs be more resource-efficient and effective? Does the dose, timing, or mode of intervention delivery have powerful effects? What are the long-term effects?

In both the SLIMTIME and INSIGHT trials, Birch explained, the interventions were delivered very early in life by research nurses, an expensive approach that is unlikely to be scalable. Also, she noted, the trials involved first-time parents, who may be more open to new behaviors than mothers who already have children. In response to a question, she responded that her study has gathered data on the mothers' employment and use of day care, as well as on their weights and diets, but these data have not yet been analyzed.

SLEEP, ACTIVITY, AND SEDENTARY BEHAVIOR

> "There was never a child so lovely . . . but his mother was glad to get him to sleep."
>
> —Ralph Waldo Emerson

Despite Emerson's timeless description of the pleasures of an infant sleeping, the rising prevalence of childhood obesity has been paralleled by secular trends of shorter sleep durations in children, observed Elsie Taveras, division chief of general academic pediatrics and director of pediatric population health management, Massachusetts General Hospital for Children; associate professor of pediatrics and population medicine, Harvard Medical School; and associate professor of nutrition, Harvard School of Public Health. She cited a meta-analysis of almost 700,000 children from 20 countries, encompassing more than 100 years of data, in which Matricciani and colleagues (2012) found that, on average, children today sleep about 20-25 minutes less each day than their parents did when they were the same age. Across childhood, she noted, evidence suggests a decrease in sleep duration over the past 20 years, due in part to later bedtimes (Dollman et al., 2007; Iglowstein et al., 2003). "As some of us who are on call and leave the hospital late at night can attest to, there are very young children who are awake way too late at night," said Taveras. Similar secular trends of insufficient sleep are occurring among adults, she noted.

Taveras observed that infants and toddlers in the lowest quartile of sleep are more likely to be put to bed asleep versus drowsy or awake (National Sleep Foundation, 2004). As was also noted by Birch, these children may not be learning to self-regulate their own sleep as effectively as others. Older children in the lower quartile of sleep are more likely to share a room or bed, are more likely to drink one or more caffeinated beverages during the day, and are more likely to have a television in the room where they sleep (National Sleep Foundation, 2004).

Evidence from the adult literature has shown a strong correlation between obesity in the United States and the increasing prevalence of adults who report insufficient sleep, said Taveras. According to data from the Centers for Disease Control and Prevention's (CDC's) Behavioral Risk Factor Surveillance System, the same states that have the highest prevalence of obesity[2] also have the highest prevalence of adults who perceive themselves as sleeping too little,[3] and the pooled odds ratio for short sleep duration and obesity in adults is 1.55 (Cappuccio et al., 2008). Furthermore, Taveras noted, insufficient sleep duration in adults is associated with many adverse health conditions, including cancer, obesity, diabetes, and coronary heart disease, as well as all-cause mortality and lower life expectancy (Ayas et al., 2003; Gangwisch et al., 2006; King et al., 2008; Kripke et al., 2002; Patel and Hu, 2008; Patel et al., 2006; Williams et al., 2007).

[2] Behavioral Risk Factor Surveillance System, 2014 data: www.cdc.gov/obesity/data/prevalence-maps.html (accessed April 20, 2016).

[3] Behavioral Risk Factor Surveillance System, 2008 data: www.cdc.gov/sleep/data_statistics.html (accessed April 20, 2016).

Taveras reported that a systematic review of 29 studies by Hart and colleagues (2011) suggested that both short sleep and later bedtimes in infants and children were associated with an increased risk for becoming or being overweight or obese. Some debate still surrounds this issue, she noted. Some studies have found an inverse association between sleep duration and adiposity in infancy, others have had null findings, and at least one randomized controlled trial of an infant sleep intervention showed no effect on future overweight (Klingenberg et al., 2013); however, other studies have found an inverse association between sleep duration and weight in children (Hart et al., 2011; Patel and Hu, 2008).

Taveras's own work with a large cohort of infants and toddlers has found a relationship between sleeping less than 12 hours per day in infancy and higher BMI z-scores and increased odds of obesity at 3 to 5 years of age (Taveras et al., 2008). In follow-up studies of these same children, the highest prevalence of obesity in mid-childhood—when the children were 7 to 9 years of age—was seen among those who had the most exposure to insufficient sleep across infancy and early childhood (Taveras et al., 2014). According to Taveras, "It might not just be insufficient sleep in infancy but insufficient sleep in infancy and throughout early childhood that persists to affect BMI and potentially metabolic syndrome in mid-childhood."

Most findings on the potential mechanisms underlying sleep and obesity relate to older children, but Taveras explained that among the possibilities are alterations in metabolic functioning, alterations in appetite hormones, and fatigue that affects the ability to participate in physical activity (see Figure 3-4) (also see Hart et al., 2011). Yet much remains unknown about the mechanisms relating too little sleep in infancy to rapid weight gain and obesity, she noted. Most studies have focused on sleep duration and have not examined other features of sleep, such as quality, timing, consolidation, regularity, ecology, and circadian alignment. Validated and objective measures of sleep characteristics are needed, Taveras asserted, rather than sole reliance on parental reports. Although good evidence exists for the efficacy of behavioral interventions in improving features of sleep in infancy, she observed, randomized controlled trials testing the effects of these interventions on future adiposity are lacking.

Shifting her attention to physical activity and sedentary behavior, Taveras pointed out that children are programmed to enjoy physical activity, but many environments and policies discourage such activity. Little is known about the normal range of physical activity and sedentary behavior in infancy and its association with energy balance, she noted. For example, only one study has quantified an association between infant screen time and childhood overweight. This study, involving 3,610 preschool children, found no association between television viewing in infancy and child obesity (Heppe et al., 2013), despite the robust literature on older children and

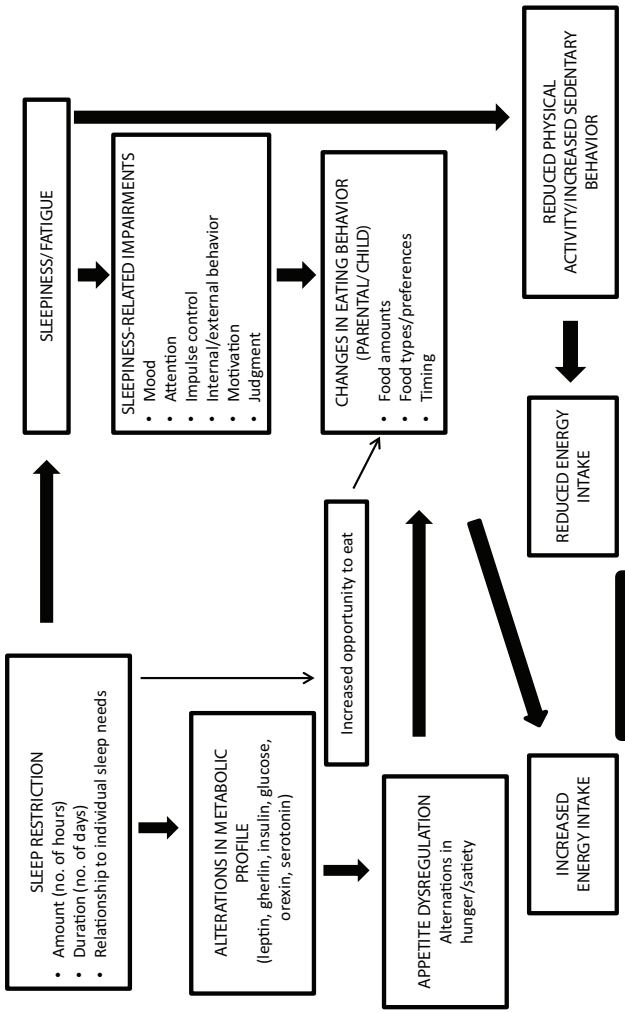

FIGURE 3-4 Hypothesized pathways through which sleep restriction may increase obesity risk.
NOTE: BMI = body mass index.
SOURCES: Presented by Elsie Taveras on October 6, 2015 (with permission from Judith Owens, M.D., M.P.H., Boston Children's Hospital, Harvard Medical School).

adolescents relating television viewing and obesity. In addition, accurate measurement of infant activity remains a major challenge, Taveras suggested, although some work has successfully used accelerometry for this purpose (van Cauwenberghe et al., 2011).

According to Taveras, the evidence linking motor behaviors in infancy with adiposity is limited and observational. A longitudinal study of 741 mother–infant dyads found that none of the milestones of rolling over, sitting up, crawling, or walking were associated with BMI z-scores, though later age at walking was associated with greater overall adiposity at age 3 (Benjamin Neelon et al., 2012). A longitudinal study of low-income African American mother–infant dyads assessed from 3 to 18 months found that delayed infant motor development was associated with overweight and high subcutaneous fat (Slining et al., 2010). However, Taveras noted, no published randomized controlled trials have evaluated the effect of a physical activity intervention in infancy on increasing accelerometry-measured physical activity or preventing obesity, although the evidence on the inverse relationship between television viewing and physical activity among children 2 to 5 years of age is strong.

Among children aged 2 years and older, Taveras observed, studies that have tracked activity and sedentary behavior using accelerometers have demonstrated a consistent protective relationship of greater physical activity levels and less television viewing with decreased risk of obesity and other measures of adiposity (Monasta et al., 2010). "The robust association later in childhood means we really should be focusing on these behaviors early in life," she suggested.

Finally, Taveras talked briefly about the early-life origins of racial and ethnic disparities in childhood obesity. Although, as noted in Chapter 1, some promising signs have appeared in the latest data, obesity remains at historically high levels among children, and some population groups are much more affected than others. As discussed in Chapter 2, among children 2 to 5 years old in the United States, 18 percent of Hispanic boys and 15 percent of Hispanic girls are obese, compared with a population average of 8.4 percent (Ogden et al., 2014). Among children aged 6 to 11, the corresponding percentages are 28.6 percent, 23.4 percent, and 17.7 percent (Ogden et al., 2014). Disparities also may exist before age 2 but may be partly disguised by methodological issues, Taveras suggested, such as the difficulty of obtaining accurate measurements. "If already, by 2 to 5 years of age, we have Hispanic children having five times the prevalence of obesity as their white counterparts, it means that those disparities are emerging early in life," she said.

Taveras reported that childhood obesity has a number of determinants, many discussed by previous speakers, including

- gestational weight gain and gestational diabetes;
- maternal smoking during pregnancy;
- accelerated infant weight gain;
- breastfeeding;
- sleep duration and quality;
- television viewing and television sets in bedrooms;
- responsiveness to infant hunger and satiety cues;
- parental feeding practices;
- eating in the absence of hunger;
- portion sizes;
- fast food intake;
- ingestion of sugar-sweetened beverages;
- physical activity; and
- sociocultural factors, including the availability of opportunities for recreation.

With respect to almost every single one of these early-life risk factors, Taveras noted, black and Hispanic children have a higher prevalence of behaviors in early life that pose a risk for obesity (Taveras et al., 2010). In fact, when these risk factors are accounted for epidemiologically, they explain all of the disparities observed among population groups, she said. Based on some of that evidence, the report of a White House Task Force on Childhood Obesity suggests that racial and ethnic disparities in obesity may be explained in part by differences in risk factors during the prenatal period and early life (White House Taskforce on Childhood Obesity, 2010).

DISCUSSION SESSION: GUIDELINES FOR YOUNG CHILDREN

The discussion session addressed the development of dietary and other guidelines for young children. Saavedra pointed out that guidelines currently under development by the U.S. Department of Agriculture will go well beyond diet to encompass other indicators of healthy growth, such as physical activity and other behaviors. Although food is a critical factor, he said, "it is important to take a much more holistic approach as it relates to the guidelines, especially from zero to 2, if not from zero to 4." The development of such guidelines will be a "huge step forward," suggested Pérez-Escamilla. The dietary and physical activity guidelines for infants and toddlers, which should be completed by 2020, will fill "a huge gap that we know exists based on the maternal–child life course obesity cycle," he said.

4

Effective Interventions: What Works?

Highlights from the Presentations of Individual Speakers

- Interventions that begin in pregnancy and the first 2 years of life and continue over time have the potential to reduce childhood overweight and obesity. (Taveras)
- There are opportunities and challenges for early life obesity prevention in the clinical setting. (Paul)
- Efforts at the levels of public policy, the community, the organization, interpersonal relations, and the child can promote healthy eating and regular physical activity in early care and education facilities. (Ward)
- Family-focused interventions to promote healthy lifestyles, improve parenting skills, and target broader family life have had significant effects on childhood obesity. (Davison)

In the third panel of the workshop, four presenters provided an overview of what is known about effective interventions in the early childhood years. The topics covered included interventions in pregnancy and the first 2 years of life to prevent childhood overweight and obesity, the role of pediatricians in obesity prevention, the potential of early care and education to stem obesity, and family-focused interventions in the home setting.

EFFECTIVE INTERVENTIONS IN PREGNANCY AND THE FIRST 2 YEARS OF LIFE

Elsie Taveras of Massachusetts General Hospital for Children and Harvard Medical School, who gave the final presentation of the second panel, opened the third panel by reviewing interventions in pregnancy and the first 2 years of life that work to prevent childhood overweight and obesity. She and her colleagues conducted a systematic review of 34 completed studies of 26 such interventions (Blake-Lamb et al., 2016). Nine of these interventions, she reported, were found to be effective in improving childhood weight status. She and her colleagues also examined ongoing studies of such interventions summarized in the ClinicalTrials.gov database, noting a substantial increase in the number that were based in clinics and that were targeted at the individual level.

The interventions that worked were focused primarily on individual- or family-level behavior changes, Taveras observed. Interventions in homes, clinical settings, or group sessions held in community-based settings were equally effective. Taveras described four examples, one of which was the SLeeping and Intake Methods Taught to Infants and Mothers Early in Life Trial, described by Leann Birch during the workshop's second panel (see Chapter 3).

The second example was the Healthy Beginnings Trial, which looked at 667 first-time mothers and their infants in socially and economically disadvantaged areas of Sydney, Australia (Wen et al., 2012, 2015). Taveras reported that community nurses conducted eight home visits lasting 1 to 2 hours, one occurring prenatally and the other seven in the first 2 years of life. The targets of the interventions were breastfeeding, infant feeding and activity, family nutrition, and activity. At 2 years of age, body mass index (BMI) was 0.29 kg/m^2 lower on average in the intervention group compared with controls. By 5 years of age, however, there were no sustained effects on BMI or on dietary behaviors, quality of life, physical activity, or television viewing time. This was one of several interventions that worked in the short term but were not sustained in the long term after they ended, said Taveras.

The NOURISH randomized controlled trials recruited 698 first-time mothers and their healthy-term infants (Daniels et al., 2012a,b). As described by Taveras, two 3-month group education modules starting at ages 4-6 months and 13-16 months delivered a skills-based program focused on parenting practices that mediate children's early feeding experiences and that include protective complementary feeding. When the interventions ended at 13-16 months, the intervention group had an average BMI z-score that was lower by 0.23 to 0.42 compared with the controls. At 2 to 5 years, the researchers found increased use of protective feeding practices but no difference in BMI z-score or prevalence of overweight or obesity. "Do we

define that as working?" asked Taveras. "I think so, with the caveat that I will mention later, which is maybe we need to think about this in a life-course approach, and as some intervention activities end, others need to be picked up to sustain those effects."

Finally, Taveras described the Special Turku Coronary Risk Factor Intervention Project for Babies (STRIP), a longitudinal randomized controlled trial in which more than 1,000 infants and their families were randomized at 7 months of age to intervention and control groups (Simell et al., 2000). The intervention group received individualized dietary and lifestyle counseling at clinic visits every 1 to 3 months until the children were 2 years of age, twice per year until they turned 7, and yearly until they were 10, with a focus on diet and physical activity. At the outcome period of age 10 years, 10.2 percent of the intervention girls and 18.8 percent of the control girls were overweight; the boys showed no difference in percentages overweight.

Taveras also described several interventions that did not work. For example, protein-enriched formulas actually increased the risk of childhood obesity in the studies that she and her colleagues reviewed (Blake-Lamb et al., 2016). Also, none of the interventions focused only on pregnancy resulted in improved childhood obesity outcomes (Blake-Lamb et al., 2016).

Taveras cited several lessons learned from her review. First, obesity prevention programs need to be continued or maintained during the early childhood years and beyond, she said. This observation highlights the importance of a life-course approach, she suggested, with risk-reducing interventions being conducted over time in the settings where children spend their time.

The second lesson Taveras cited has to do with the role of eco (particularly environmental)-social (particularly family) contexts in the planning and sustainability of some interventions. "The most effective interventions were those that focused on the family and that attempted to change the environment," she said.

The existing literature has a number of gaps, Taveras pointed out. None of the studies intervened on maternal prepregnancy BMI or prenatal tobacco exposure. "We need to try to find a way to reach women who are intending to become pregnant," Taveras suggested, which is difficult since so many pregnancies are unplanned.

Taveras also mentioned that many infant feeding interventions have focused solely on breastfeeding, few have assisted women who were formula feeding, and none have focused on infants' intake of sugar-sweetened beverages. She said, "We do a disservice to those women who have chosen to not breastfeed, to not be able to counsel them on responsiveness, or even how they can prevent obesity among their children who are being bottle or formula fed."

Taveras pointed out further that systems-level and community-based interventions are underrepresented in the literature, although ongoing trials entail more of these kinds of interventions. In addition, null results tend not to be published, she observed, which limits the ability to generalize about what does not work.

Finally, Taveras mentioned that few interventions are attempting to change the social context or upstream influences on obesity, such as government policies (for example, food subsidies) and private-sector practices (for example, fast food marketing). Moreover, she asserted that, in general, most interventions are of suboptimal quality.

Taveras concluded her presentation by decrying the siloing of work on early childhood development, obesity prevention, and health promotion. As a pediatrician, she sees obesity prevention and child development as completely intertwined. "Focusing on obesity prevention shouldn't mean that we don't take the opportunity to also work on healthy child development when we have the opportunity in this critical period of life," she argued. Accumulating evidence is showing that adverse early childhood experiences have effects on children's development not just in the short term but in the long term as well. Initiatives focused on child development could take advantage of critical periods to lay a foundation for good nutrition, physical activity, sleep, and other important health behaviors. For example, Taveras is involved in an intervention in community health centers in the Boston area designed to change how families interface with all the different programs and settings—such as obstetrics and gynecology clinics, pediatric clinics, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), fatherhood programs, early child care and education, worksites, home visiting programs, and community centers—that affect not only obesity but also social, emotional, and physical development (see Figure 4-1). "Novel interventions that operate at systems levels hold promise for improving early life obesity prevention efforts," she observed.

A CLINICIAN'S PERSPECTIVE ON INTERVENTIONS EFFECTIVE IN EARLY CHILDHOOD

As with interventions focused on the first 2 years of life, few interventions have focused on the *prevention* of obesity for children aged 2 to 5 years, observed Ian Paul, professor of pediatrics and public health sciences, Pennsylvania State University College of Medicine; and chief of the Division of Academic General Pediatrics and vice chair of clinical affairs in the Department of Pediatrics, Penn State Hershey Children's Hospital. However, interventions with motivational interviewing as a key component have had some success in the *treatment* of overweight, he observed. For example, Resnicow and colleagues (2015) used a Pediatric Research in Office

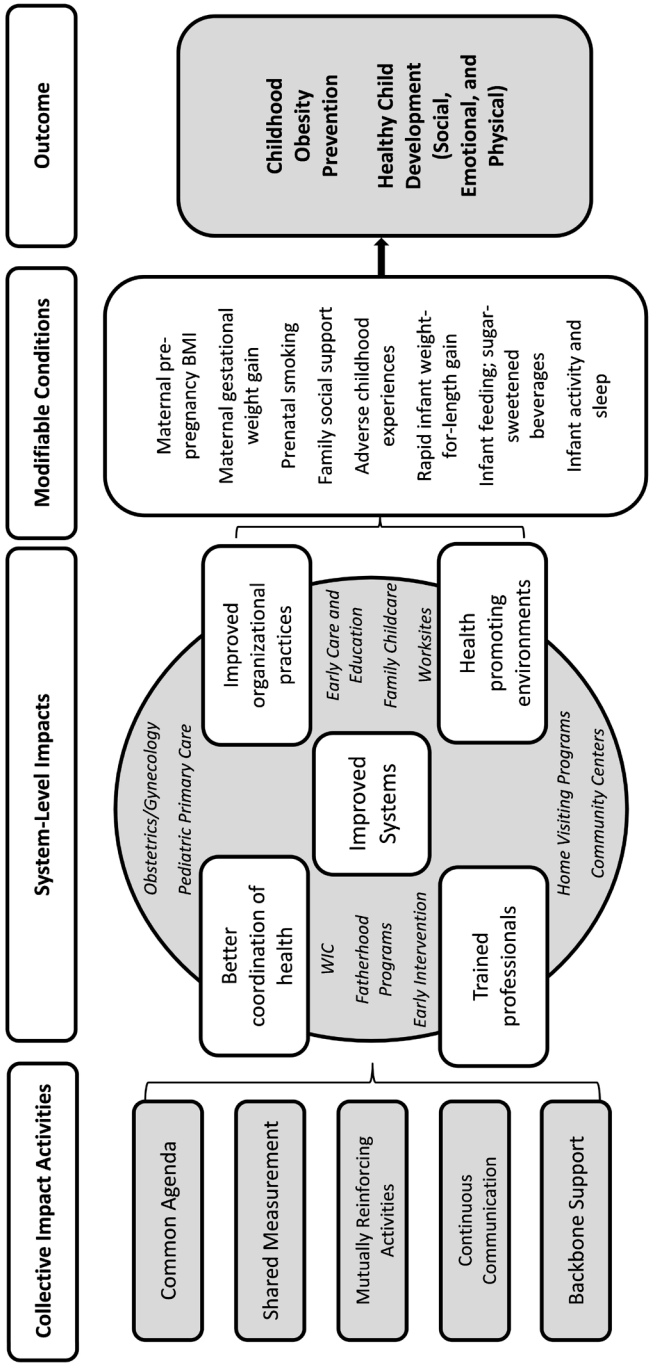

FIGURE 4-1 A systems-level approach to obesity prevention in early childhood.
NOTE: BMI = body mass index; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.
SOURCES: Presented by Elsie Taveras on October 6, 2015 (Blake-Lamb et al., 2016).

Settings network to conduct a 2-year trial of three groups of children 2 to 8 years old who were overweight or obese: one group that received usual care, one that received a motivational interviewing intervention, and a third that received a motivational interviewing intervention plus the attention of a registered dietitian. BMI improved in all three groups, with the members of the group that received both interventions showing the greatest improvement over 2 years.

"My talk would have been pretty short," noted Paul, if not for the release of a recent report from the American Academy of Pediatrics. According to that report, "Pediatricians should use a longitudinal, developmentally appropriate life-course approach to help identify children early on the path to obesity and base prevention efforts on family dynamics and reduction in high-risk dietary and activity behaviors" (Daniels et al., 2015b, p. e275). "That sounds great," said Paul. "Fortunately, they did also give us some specifics." He then broke the report's recommendations down into several categories (Daniels et al., 2015b).

First, pediatricians should identify children at risk, Paul said. For this purpose, they should use growth charts, prenatal risk factors, behavioral risk factors, and other measures.

Second, Paul said, pediatricians should educate. They should screen for knowledge about healthy diets and portion sizes; the risks of sedentary behavior; the role of WIC and the Supplemental Nutrition Assistance Program (SNAP); and online resources, such as choosemyplate.gov.

Third, suggested Paul, pediatricians should help manage the food and activity environment by, for example, screening for risky behaviors. Examples of such behaviors include the consumption of sugar-sweetened beverages. If that behavior is identified, Paul said, pediatricians should suggest zero-calorie beverage alternatives.

Finally, Paul observed that the American Academy of Pediatrics has suggested that pediatricians should encourage self-monitoring (Daniels et al., 2015b). For example, families can keep diaries showing what behaviors are contributing to an obesogenic environment rather than a healthy environment. As with many issues in pediatrics, Paul suggested, "We want it to be a family-focused intervention. As we have heard before, obesity is not just a child problem. It is often a family problem."

Pediatricians have a number of advantages in reaching out to children and families, Paul noted. They have good access to children and their parents or guardians, they are a trusted source of health information, and they can link families to community resources. However, Paul also listed the many barriers pediatricians face. They have time and space constraints, such as limited availability of clinic rooms. Appointments are short, typically just 15 to 20 minutes. Families must spend extra time to make more visits to pediatricians, and travel is difficult for some families. Physician

care is relatively expensive, and reimbursement for obesity-related care has been poor. Pediatricians do not always feel equipped to handle issues involving obesity prevention or even obesity treatment. They often lack knowledge or experience in preventing obesity for young children, and especially from birth to age 5, it can be difficult to convince families that there is a problem. As Paul noted, "We have heard about the chubby baby is a healthy baby. A lot of that goes on. Even for myself, when I look at a child that is 3 or 4 years old as the BMI curve hits its nadir [and] a child is at the 95th percentile, it is hard for me to . . . tell the parents that the child has a problem."

The difficulty for pediatricians becomes clear, Paul suggested, if one examines the third edition of *Bright Futures*, which lists several priorities for a 2-year well child visit, including assessment of language development, temperament and behavior, toilet training, television viewing, and safety (Hagan et al., 2008). But none of the visits in years 2 through 4[1] lists diet or nutrition as a priority, he observed. Similarly, the questionnaire for parents from *Bright Futures* includes one question about food insecurity and whether a child is eating iron-rich foods, but no others related to nutrition or obesity prevention guidance. According to Paul, this omission suggests there is only so much pediatricians can cover in a single, annual office visit.

Paul stated that pediatricians use weight-for-length and BMI growth charts for every patient. Although many pediatricians have not used BMI growth charts in the past, some evidence indicates that this situation is changing. "However," he said, "I can assure you that the weight-for-length chart for children under age 2 is almost never being used by pediatricians." He noted that the American Academy of Pediatrics has set a clear criterion for infant overweight: weight-for-length equal to or greater than the 95th percentile (Daniels et al., 2015b). "Maybe that will cause [pediatricians] to pay some attention to [weight-for-length]," Paul suggested.

Paul closed by pointing to several hopeful signs. Quality improvement is becoming pervasive across U.S. hospitals, he noted, and it is moving from the inpatient to the outpatient setting. He suggested that the use of electronic health records could be leveraged to improve the delivery of primary care related to obesity—for example, by displaying high BMI or rapid weight gain as an alarm value. Previsit or waiting room surveys could be automatically loaded into the electronic record so that risky behaviors would be highlighted when the physician entered a visiting room.

New models of care could deliver primary care more efficiently and give pediatricians more face time with families, Paul noted. For example,

[1] Early childhood tools: https://brightfutures.aap.org/materials-and-tools/tool-and-resource-kit/Pages/Early-Childhood-Tools.aspx (accessed April 20, 2016).

centering care[2]—a model of group health care entailing the three main components of assessment, education, and support—is starting to move from prenatal care into pediatric well child care, especially during the first year or two after birth (e.g., Mittal, 2011; Page et al., 2010). Pediatricians and dietitians also could partner with community programs such as WIC and farmers markets, Paul suggested. Communications between pediatricians and obstetricians could improve to encourage breastfeeding and smoking cessation during pregnancy, he added. Both groups also could communicate better with child care providers, which almost never happens today, Paul noted.

As a final example of partnering, Paul mentioned NET-Works (Now Everybody Together for Amazing and Healthful Kids Study), a randomized controlled trial involving an intervention that integrates home, community, primary care, and neighborhood strategies (Sherwood et al., 2013). The goal is to promote healthy behaviors, healthful eating, and activity and to prevent overweight and obesity among preschool-aged children. "I like this model because the primary care provider has a very defined role," said Paul. "It is respectful of the lots of other things that a pediatrician has to do during a visit."

EFFECTIVE INTERVENTIONS IN EARLY CARE AND EDUCATION

More than 60 percent of U.S. children are in some kind of regular child care arrangement (Laughlin, 2013), stated Dianne Ward, professor of nutrition, Gillings School of Global Public Health, University of North Carolina. Collectively referred to as early care and education (ECE), these arrangements may be child care centers, family homes, Head Start programs, or prekindergarten programs. Children also may be in unlicensed or license-exempt care provided by neighbors, relatives, or friends.

"The ECE area has been identified as a missed opportunity" for obesity prevention, said Ward (Story et al., 2006). She noted that the experiences children have in these settings can affect health outcomes, diet, and physical activity. As reported by Reynolds and colleagues (2013), the ECE setting provides a spectrum of opportunities and multiple levels for the promotion of healthy practices (see Figure 4-2). At the most upstream level, Ward noted that public policies can affect the quality of young children's experience in the ECE setting in many ways (Kakietek et al., 2014; Stephens et al., 2014; Wright et al., 2015). Licensure and standards for licensed facilities are one example, she said. Another is quality rating and improvement systems, including nutrition and physical activity standards. Block grant funding provided by the federal government to states can be tied to higher

[2] See https://www.centeringhealthcare.org (accessed April 20, 2016).

(a)

(b)

FIGURE 4-2 A spectrum of opportunities (a) and levels of influence and contexts (b) to promote healthy practices in early care and education settings.
SOURCES: (a) CDC, n.d.; (b) as presented by Dianne Ward on October 6, 2015 (Sallis et al., 2008).

quality and enhanced standards. And individual states have learning standards for ECE settings. "If we could include specific nutrition and physical activity standards," Ward suggested, "this is another way that we might be able to affect what children experience."

At the organizational level, policies and practices within facilities could influence the foods and beverages served, the amount of physical activity provided, and the amount of time spent in sedentary activities, Ward said (Alkon et al., 2014; Bonis et al., 2014; Drummond et al., 2009; Finch et al., 2012; Natale et al., 2014; Ward et al., 2008). Efforts to achieve an external ECE certification or rating also can enhance the experiences children have (Dowda et al., 2009).

Ward noted that a number of existing curricula used in ECE facilities focus on nutrition or physical activity. Although the data in this area are somewhat weaker, she argued that they cumulatively reveal an important impact. Also, she observed, providing structured physical activity lessons increases overall physical activity and fundamental motor skills, and training and technical assistance contribute to teachers' ability to provide physical activity lessons (Alhassan et al., 2012; Annesi et al., 2013; Fitzgibbon et al., 2011; Parish et al., 2007; Reilly et al., 2006; Specker et al., 2004). Improvements in the quality of the outdoor play environment can include open areas, looping cycle pathways, grass hills, portable play equipment, and more space per child (Bower et al., 2008; Cosco et al., 2010; Nicaise et al., 2012). Other physical activity modifications with potential include providing more vigorous activity (Collings et al., 2013); reducing sedentary time (for example, having no chairs at some tables and taking regular breaks from sitting) (Hinkley et al., 2015); providing energizers during lessons (such as activity breaks) (Webster et al., 2015); and embedding physical activities within circle time, centers, and transitions (Kirk et al., 2013). Also at the organizational level, eating-related modifications with potential, Ward observed, include providing fruits or vegetables prior to main offerings; offering regular food tasting and cooking opportunities; creating a garden at an ECE program; instituting firm policies on foods brought from home, including food for celebrations; and using family-style dining (Mikkelsen et al., 2014; Ward and Erinosho, 2014).

Several research gaps in these areas need to be filled, Ward stated. The role of vigorous physical activity and its impact on the body composition of preschool-aged children needs to be explored, she said, as do the issues of reducing sedentary time and using energizers to provide elementary school children with more activity. Space limitations are a problem in most facilities, she noted, especially in urban facilities or in inclement weather, which may make it impossible to go outside. The role of teachers and the health of staff in developing healthy feeding and activity practices is still uncertain, she added, as is how best to engage parents.

At the interpersonal level, Ward noted, staff can promote healthy eating through role modeling, praising, providing informal education, prompting, using responsive feeding practices, and not using food as a treat or bribe. Although some evidence indicates that the way ECE professionals interact with children is directly associated with how children eat and what they consume, research gaps still exist in this area, she said. She added that even less is known about the role of ECE professionals in physical activity, with some evidence indicating that joining in play and being a role model are associated with more activity among children. "We need to do more research in this area," she asserted, "particularly about providing informal education, prompting, and not punishing children for being active."

Ward stated that an important issue that has not been well explored is how to engage parents in supporting the role of the ECE setting in the development of healthy eating patterns and regular physical activity. Some interventions have involved attempting to achieve parent engagement in a passive way by sending home newsletters or other notices, but Ward noted that a more effective approach is to incite some sort of response from parents. She suggested that good examples include the Hip Hop to Health, Jr. program (Fitzgibbon et al., 2011) and the Healthy Caregivers–Healthy Children (HC2) program (Natale et al., 2014).

Another area that needs additional consideration and research, Ward argued, is the health of child care providers, although the impact of their behaviors and health on children is largely unknown. Most ECE staff are low-income wage earners, she observed, garnering about minimum wage in many states. She noted that the few studies of their health that exist present a poor picture marked by obesity, poor diets, inactivity, stress, sleep irregularities, smoking, and other negative health behaviors and outcomes. "Yet these are the same people we ask to be role models, to be leaders, and to be educators with our children," she observed.

Efforts are needed at all five levels—public policy, community, organizational, interpersonal, and the child—said Ward. Although opportunities exist at each level, she suggested that interventions that target multiple levels may be more successful. The Hip Hop to Health, Jr. program, for example, includes both an educational component focused on healthy eating and regular physical activity and a parent component. Over its 10 years of operation, it has shown a number of positive outcomes, Ward noted (Fitzgibbon et al., 2005, 2011).

Partnering between ECE settings and public health professionals through the use of licensure, ECE standards, and professional organizations provides many opportunities for progress, Ward said. Other opportunities include creating and distributing training opportunities in healthy eating and physical activity for ECE teachers; developing partnerships with

parents to support ECE; and offering comprehensive wellness programs for children, ECE staff, and families.

Ward concluded by pointing to several additional research gaps. Little is known about how to promote healthy eating and regular physical activity in family child care settings, she observed. Although some trials in this area are currently in progress, little of this work is looking at infant and toddler programs. And the effects of vigorous physical activity need to be explored to see whether that emphasis should be reintroduced to the ECE setting, Ward suggested.

EFFECTIVE INTERVENTIONS IN THE HOME SETTING

Since 2012 at least 16 randomized controlled trials of family-focused interventions for reducing obesity in children 5 years old or less have been completed, and another 9 are currently in progress or have results pending, noted Kirsten Davison, associate professor of nutrition, Harvard School of Public Health. These interventions involve repeated interactions with parents to modify parenting approaches and change child outcomes. "This research is increasing rapidly," Davison said. She divided this research into three categories: promotion of healthy lifestyles, the combination of healthy lifestyles and parenting skills, and interventions targeting broader family life (reviewed by Sung-Chan et al., 2013).

In the first category, Davison said, are interventions focused on the family food environment, media rules, parents' own diets, physical activity, and other components of a healthy lifestyle. Interventions target the timing of the introduction of solids, limits on sugar-sweetened beverages, having the television off during meals, meal-time routines, parental diet and modeling of physical activity, repeated exposure to vegetables, and the promotion of child motor development. Completed studies involving such interventions include Barkin et al. (2012), Campbell et al. (2013), Daniels et al. (2012b), Fitzgibbon et al. (2011), Schroeder et al. (2015), and Skouteris et al. (2010), while those with results pending include de Vries et al. (2015), Delisle et al. (2015), Eneli et al. (2015), Horodynski et al. (2011), and Sobko et al. (2011). Interestingly, said Davison, most studies conducted outside the United States fall into this category, while the other two categories consist mainly of U.S. studies.

The second category, said Davison, extends these interventions to include, for example, responsive parenting, child sleep routines, parenting style, child emotional regulation, and co-parenting. Completed studies in this area include Haines et al. (2013), Østbye et al. (2012), Paul et al. (2011), and Wen et al. (2012), while those with results pending include Paul and Birch (2012) and Ward et al. (2011).

The third category of interventions does not target obesity, Davison

observed, but could have effects on weight. For example, Brotman and colleagues (2012) focused on the prevention of conduct disorder among children in high-risk families, but one long-term outcome of this intervention was reductions in weight gain over time. Similarly, in studies discussed at conferences of the Society of Prevention Research on such topics as conduct disorder and antisocial behavior, changes in child BMI often have occurred, even when the researchers were not expecting such an outcome. "We are going to find multiple examples of this," said Davison, although she characterized them as "harder to find."

Davison drew several general conclusions from the studies of family-focused interventions. Six of the studies showed significant effects on child BMI, she noted, which is consistent with results of a meta-analysis by Yavuz and colleagues (2015). Similarly, a majority of the studies found significant effects on the mediator of interest. All four that involved a home setting showed significant effects on BMI, whereas the studies that involved a community setting had more mixed results. Also, the studies that involved low-income populations and racial and ethnic minorities were more successful than those that involved other populations. The length of the intervention did not have a noteworthy effect on the results, Davison said, and the studies with short-term follow-ups tended to show a greater effect than those with longer-term follow-ups. In fact, she observed, most of the studies that followed participants for more than 1 year found little long-term effect on weight.

One clear research gap noted by Davison is the development of sustainable family interventions whose effects are maintained. "Most programs focus on a specific cluster of behaviors and tend to be quite narrowly focused, in general, on diet and physical activity," she said. "There may be real opportunities in partnering with people looking at different outcomes, whether it be oral health, child developmental disorders, and so forth." In addition, she observed, most programs work with highly selected samples and are limited to a single setting. Family retention is a challenge, with dropout rates ranging from 32 percent to 73 percent (Skelton et al., 2011). Also, "what about dads?" Davison asked. "If we counted the number of times we have mentioned the word *mother* today and the times we have mentioned *father*, this is going to be a very disproportionate characterization. There is a great need for research in this particular area," she argued. Davison described a preliminary content analysis of approximately 500 papers on parenting and childhood obesity published over the past 5 years, for example, only 9 percent of which present any results for fathers.

Davison concluded by describing a cluster of opportunities for further study of family-focused interventions. The first is an increased emphasis on translational research and the value of pragmatic trials, she suggested, which could lead to sustainable interventions. Likewise, she sees great

potential for integrating interventions into systems of care such as Head Start or school-based health centers to reduce selection bias and sustain intervention effects. Multisetting family-focused interventions are in progress, she noted, and there is increasing interest in engaging in fathers. "A real marker of this would be the release of an RFA [request for applications] focused on fathers," she said. Finally, the integration of social media and web applications into family interventions could be considered to increase family engagement and reduce attrition.

DISCUSSION SESSION

Integrating Across Levels

During the discussion period, the panelists turned their attention to how to connect different interventions across settings, age levels, and institutions.

Taveras cited an approach she and her team have taken to initiate an intervention in a clinical setting and then continue it outside the clinic through community health workers, health coaches, and others (Taveras et al., 2015a,b). "We are also using quite a bit of social media and mobile technology to reach families outside of the clinical setting where, frankly, behavior change happens," she said. "It doesn't happen when they are seeing me in the clinic." She argued that the designers of interventions need to think more creatively about reaching families in the settings where they spend much of their time.

Davison in turn cited the care demonstration projects, which have the objective of linking interventions across community sectors, including health care and community public health (Davison et al., 2015; Taveras et al., 2015a). Linking these sectors is a tremendous challenge, she said. Up-front planning and consistent messaging and materials across sectors are important, she added, along with heavy reliance on media. Community coalitions and regular opportunities for champions in different sectors to connect have potential in this area, she suggested.

Paul reiterated that "there is only so much that can be done in the pediatric office." If pediatricians have a defined role, he suggested, community partnerships can reinforce the messages and behaviors they convey. He also mentioned the importance of the dose of an intervention. "A couple of exposures to messages over a short period of time are unlikely to have a sustained effect," he said; rather, having a sustained effect requires multiple exposures over a longer time period.

Ward noted that professionals have opportunities to communicate with families, but they also need support from others, such as Child and Adult Care Food Program (CACFP) consultants. Taveras, too, cited "missed opportunities to work within existing structures." For example, she noted,

none of the systems-level interventions from pregnancy to age 2 have included the WIC program. "WIC is such a huge opportunity for children at high risk," she said. "We are not working on childhood obesity in home visiting curricula. We are not engaging fatherhood programs. . . . We have to work at a systems level. We are really not doing that currently."

In addition, Paul pointed to poor communication among sectors. Primary care physicians and child care professionals rarely interact. The WIC program "is giving messages that may be the same or different from what the parents are hearing from pediatricians," Paul said. "For a lot of families, that can be very confusing. Who do I accept the information from? It would seem that the different aspects of early child health would have some way to communicate with each other, but we don't."

Ward observed that ECE professionals are receptive to wellness promotion opportunities, both for children and for themselves. A supportive environment and reinforcement of the efforts they make can help staff promote healthy nutrition and physical activity, she asserted.

Messaging and Empowerment

In response to a question about the messages that need to be sent, Paul said, "There is not a single silver bullet here as far as the message. There are various messages." The message may need to be different for different communities and different racial or ethnic groups based on the norms of their culture, he added, and repeated messages from diverse stakeholders from different sectors of the environment across the life course may be needed to make a difference.

Paul also cited the effectiveness of a health literacy approach with very simple messages that use pictures. But he pointed out as well that different families have different issues: in one a child might drink soda all day, while in another a child might drink water but have four Pop-Tarts for breakfast. "There is not a one-size-fits-all intervention," he argued.

Taveras observed that when parents and children are asked about the messages that would be most effective in changing their behaviors, the answers received are surprising. In a study of children with obesity who managed to return to a healthy weight, for example, the children said some of the things that motivated them were teasing about social stigmatization and peer relationships (Sharifi et al., 2015). Children want to fit into the clothing that other children their age fit into, Taveras observed. They do not want to shop for clothing at plus-size stores. They do not want to have to swim with a shirt on to hide their gynecomastia. "We sometimes fail to see that the answer to how to get families and children to change is by engaging those parents and children in helping us with the solution," Taveras suggested.

Davison urged the leading public health organizations to develop a set of messages they all endorse. "If we have multiple organizations really pushing that, we will start to see those messages permeate consistently," she asserted.

Ward mentioned efforts to get parents and ECE professionals to talk with each other. "The vast majority of parents are trying and want the best for their children, [but] they are a bit conflicted about how to get there," she observed. She suggested that perhaps messages that relate to brain promotion through better food and physical activity could motivate parents in ways that current messages, such as having smaller portion sizes, do not.

Paul pointed to what he called stealth interventions. "Every new parent wants their baby to sleep as long as they can, myself included," he said. "If we know that short sleep duration or poor sleep hygiene is a risk factor for childhood obesity and later obesity, and if we focus on the thing that is desirable to parents such as prolonging sleep duration, parents want that. . . . That is going to be better received than talking about obesity prevention [for] a 2-month-old."

Roundtable member Shiriki Kumanyika of the University of Pennsylvania pointed to the onslaught of messaging that runs counter to efforts to control obesity. Messaging is needed that enables parents to "push back, to push the demand curve the other way [and] ultimately change the environment and then the dose," she suggested.

Davison mentioned a pilot intervention in which she and her colleagues focused not on traditional diet and physical activity behaviors but on, for example, conflict resolution skills, media literacy, and parent resource empowerment (the ability to identify resources in the community that could benefit the family and then advocate for access to those resources) (Davison et al., 2013). "That is one example of how [parents] can push back and explicitly seek out those things," she said.

5

Promising and Innovative Cross-Sector Solutions

Highlights from the Presentations of Individual Speakers

- Food, Nutrition, and Consumer Services in the U.S. Department of Agriculture is working with a wide range of partners to address challenges in food security and nutrition. (Concannon)
- Evidence-based, scalable, and sustainable interventions in New York City have contributed to a reduction in obesity among low-income preschool children. (Clapp)
- Health systems can serve as integrators that work intentionally and systematically across sectors to improve health and well-being. (Gertel-Rosenberg)
- Building trust, forging partnerships, and continually reassessing and resetting system goals can advance cross-sectoral work on obesity prevention. (Huang)

During the workshop's final panel, four presenters and the workshop participants in general looked across sectors to identify promising solutions to the problem of obesity in young children.

PROGRAMS AT THE U.S. DEPARTMENT OF AGRICULTURE

Diet-related disease and obesity have largely replaced malnutrition as the clinical consequence of food insecurity and hunger in the United States,

observed Kevin Concannon, under secretary for food, nutrition, and consumer services, U.S. Department of Agriculture (USDA). USDA addresses both diet-related disease and food insecurity through 15 different programs, including the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); the Supplemental Nutrition Assistance Program (SNAP); the Child and Adult Care Food Program (CACFP); and the *Dietary Guidelines for Americans*.

WIC, which began in Pineville, Kentucky, in 1974, is designed to safeguard the health of low-income, nutritionally at-risk women who are pregnant and postpartum, as well as the health of infants and young children. Today, WIC operates through 1,900 local agencies and 10,000 clinic sites nationwide, providing evidence-based supplemental food packages to more than 8 million participants monthly. About half of the infants born in the United States now participate in the program, Concannon observed. "The public health significance of WIC cannot be overstated," he asserted.

Concannon explained that the WIC food packages, which were updated in 2009 to align with recommendations of the Institute of Medicine (IOM) and the *Dietary Guidelines for Americans*, emphasize fruits, vegetables, whole grains, lean proteins, and low-fat or nonfat milk and milk alternatives. In addition to the monthly food packages, WIC participants receive tailored nutrition education, breastfeeding education and support, counseling, and health promotion.

WIC has demonstrated a long-standing positive impact on breastfeeding rates, dietary intake, health outcomes, and health care costs, Concannon said. Since the food package was revised, WIC participants have been consuming more fruits, vegetables, whole grains, and low-fat dairy products and less whole milk—diets with increased fiber and decreased saturated fat (Chiasson et al., 2013). According to Concannon, low-income communities have greater access to whole grains, fruits, and vegetables as a result of the changes. In 2013, the Centers for Disease Control and Prevention (CDC) stated that the program has likely played an important role in the recent leveling off or decline in obesity rates among low-income preschoolers in 19 of the 43 states and territories that were studied (May et al., 2013). More robust information on WIC's impact on early childhood obesity also is being gathered, Concannon noted. For example, USDA is in the midst of the longitudinal WIC Infant and Toddler Feeding Practices Study II (discussed by Jose Saavedra during the workshop's second panel; see Chapter 3), which is following a nationally representative sample of infants who began WIC participation at birth through their fifth birthday.

Concannon particularly emphasized the potential to link WIC more closely to federally qualified health centers and other health care centers. At the local level, he said, many WIC clinics are collocated with public health care centers and health departments to facilitate integrated services. The

National Association of Community Health Centers reports that more than 1,200 health centers are operating through more than 9,000 delivery sites and are serving more than 22 million people each year, 10 percent of whom are children under age 5 (National Association of Community Health Centers, 2014). Additionally, Concannon reported that WIC has collaborated with the Arkansas Children's Medical Center on a variety of research projects; has worked with pediatricians in Pennsylvania to optimize primary prevention of obesity; and has established clinics in four hospitals in the Southwest, including an Indian Health Service hospital.

Turning to the *Dietary Guidelines for Americans*, Concannon explained that the current guidelines, which are published jointly by USDA and the U.S. Department of Health and Human Services every 5 years, apply to children aged 3 years and older. At the time of the workshop, the next iteration of guidelines was about to be released. However, Concannon observed, work was under way to make recommendations for the period of pregnancy through 24 months of age as input for the committee working on the 2020 guidelines. "The current process is not one of developing but of beginning to assess the science," he said. "The work on incorporating tailored advice for infants, toddlers, and women during pregnancy and the *Dietary Guidelines for Americans* is a separate process and will begin once the 2020 committee is in place." Also under way at the time of the workshop was an update to the meal requirements for CACFP, which Concannon called "another important step forward."

Two recent changes in law are driving efforts to strengthen USDA programs in health care settings, Concannon noted. The first is the SNAP nutrition education program, which includes $400 million in nutrition education grants to states spent annually under SNAP. The law now allows USDA grantees to promote policy systems and environmental change strategies and interventions to prevent obesity, Concannon observed, which will strengthen obesity prevention efforts in many feeding programs. The second change in law is the Patient Protection and Affordable Care Act (ACA), which requires nonprofit hospitals to undertake community benefit programs based on community needs assessments. "Nutrition initiatives and assistance programs are ripe for inclusion," said Concannon. "When I am on the road meeting with not-for-profit groups, I invariably bring this up as an area of opportunity."

Even before the ACA community benefits requirement, Concannon noted, many health care organizations were partnering with USDA programs through SNAP. For example, since 2010 Blue Cross Minnesota has offered Market Bucks, a dollar-for-dollar match for each dollar SNAP participants spend on fresh produce using Electronic Benefits Transfer (EBT) cards. As another example, Concannon explained that some hospitals and health care complexes, such as Our Lady of the Lake Children's Hospital in Baton

Rouge, Louisiana, and the Children's Hospital in Arkansas, have established summer meal sites for all local children 18 and younger. In addition, major health care systems in the country, including the Cleveland Clinic, the Mayo Clinic, and ProMedica, have, he said, "taken the issue of food insecurity and obesity to heart and are engaging across several of our program fronts with community-based agencies, schools, child care centers, and food banks."

Concannon also touched briefly on the importance of leadership. Drawing on his previous experience as a state director, he noted that some states take less advantage of the food and nutrition programs at USDA than others, even though they have the same opportunities to do so. "I am urging my colleagues within Food and Nutrition Consumer Services to, first and foremost, give state governments the opportunity to engage to participate," he said. "If states are not engaged to participate, go looking for the health care systems, for the partnerships with counties, for other colleagues and other federal agencies to reach in to pursue some of these goals. The needs are severe that are out there. Strong leadership (and experience) can be successful even in challenging political environments."

The United States still faces many challenges in food security and nutrition, Concannon concluded. For its part, he said, USDA is working "diligently to cross-sector our partnerships in an effort to leverage resources and enhance our public health impact."

OBESITY PREVENTION IN NEW YORK CITY

According to Jeni Clapp, director of Healthy Eating Initiatives, New York City Department of Health and Mental Hygiene, obesity is responsible for more than 5,000 deaths annually in New York City, second only to tobacco as a cause of preventable deaths (according to a 2012 internal analysis by the New York City Department of Health and Mental Hygiene, Bureau of Epidemiology Services, and Bureau of Vital Statistics). Hospitalizations among adults with diabetes accounted for 24 percent of all hospitalizations in 2011 (Chamany et al., 2013), she reported, and the financial cost of obesity to New York City taxpayers is estimated to be about $1,500 per household per year (calculated based on Trogdon et al., 2012). "Needless to say, for a local health department, there are a lot of reasons why we want to address obesity," she said.

Clapp noted that obesity among K-8 students in New York City public schools is high but, as with the national trends cited in Chapter 1, has plateaued or slightly declined in recent years (see Figure 5-1). Efforts to reduce obesity in New York City have shown "promising results" among individuals with severe obesity (Day et al., 2014), she said, with the decline in severe obesity outpacing the decline in obesity generally. The reasons for the decline are not clear, said Clapp.

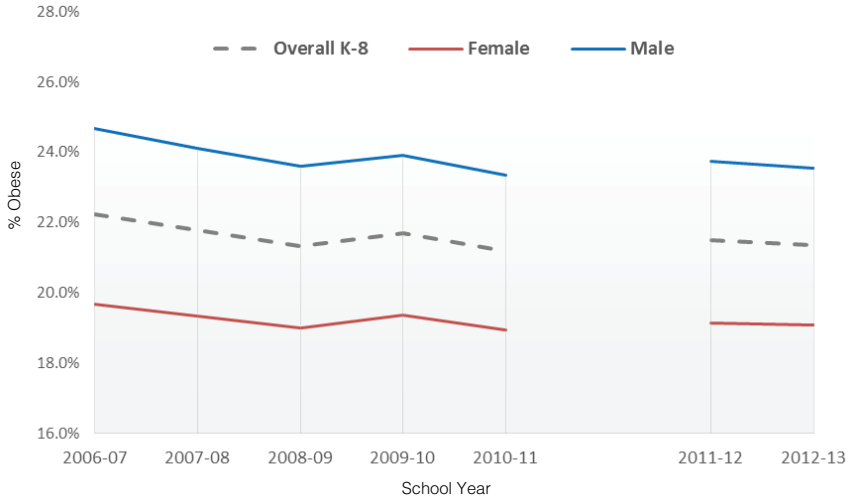

FIGURE 5-1 Rates of obesity in New York City public schools (kindergarten through grade 8 and by sex) between 2006-2007 and 2012-2013. (The gap represents the implementation of a new measuring program.)
SOURCES: Presented by Jeni Clapp on October 6, 2015 (reprinted with permission, The New York City Department of Health and Mental Hygiene, 2014).

In 2005 the New York Department of Education implemented New York City FITNESSGRAM®, Clapp reported, and a partnership with the New York City Department of Health and Mental Hygiene has yielded a database in which the height and weight of individual students can be tracked over time. This database, which Clapp noted contains more than 2.5 million records for nearly 950,000 unique students, has revealed greater reductions in obesity among non-Hispanic white and Asian-Pacific Islander children than among Hispanic and non-Hispanic black children, and greater reductions in low-poverty than in high-poverty neighborhoods (Berger et al., 2011). As a result, she explained, the obesity epidemic is continuing to affect disproportionately communities that are already experiencing health and economic disparities. "We still have a lot of work to do," she asserted.

The health department in New York City is charged with improving the public's health, Clapp noted. To this end, it focuses on meeting individuals where they are, improving their knowledge, augmenting their skills, and boosting the amount of money they have to spend on improving their health. It also tries to improve the environment in which people live, including stores, restaurants, marketing, and other factors that affect food decisions. "If you want an apple and you know that an apple is a

healthy snack, but the store nearby doesn't sell it or the cost is relatively expensive or the quality is poor, you are a lot less likely to get that apple," said Clapp. "Same thing with exercise. If there is not a gym or park nearby or it is expensive or your street doesn't feel safe to you, you are much less likely to get that exercise. . . . We can't control what happens everywhere, but we have a bit of control over public spaces and spaces that we regulate. We want to make those spaces the gold standard of health."

Clapp described one such example of how New York City is addressing early childhood obesity. Approximately 2,000 public and private group child care centers in New York City care for about 130,000 children aged 0 to 5. The New York City Board of Health has long held independent regulatory authority over these centers, Clapp explained. In 2006 the Department of Health proposed to the Board of Health that it amend Article 47 of the city's health code to establish requirements for healthful beverages, to strengthen requirements for physical activity, and to limit children's screen time. An evaluation of the 2007 changes to Article 47 indicated that compliance was high, Clapp said.

In 2015, Clapp noted, Article 47 was amended again to update the screen time, nutrition, and physical activity requirements. She explained that the 2015 update reduced the amount of screen time allowed for children aged 2 years and older from 60 minutes per day to no more than 30 minutes per week, which is consistent with research findings; changed to 2 years the age at which 100 percent juice is permitted and reduced the amount to 4 ounces, which is consistent with CACFP recommendations; and decreased the amount of continuous sedentary time allowed for children from 60 minutes to 30 minutes except during scheduled rest, which is consistent with the IOM recommendations.

The Article 47 updates had champions at multiple levels of government, Clapp noted, and the changes could be made through regulation rather than through new legislation. Child care staff received education and training on structured physical activity and healthy eating to support the changes, particularly in low-income neighborhoods, she noted. In addition, food procurement standards for all city agencies that purchase and serve food or beverages, which cover about 250 million meals served by the city annually, were established to encompass nutrition criteria that include sodium limits, calorie limits, and fiber guidelines. "What this meant is that the message we were conveying wasn't just to child care centers," Clapp said. "It was a change that was happening across the city." Complementary initiatives could help change the environment and shift social norms, she argued. "Incremental change is okay," she stated. "We may not have all of the answers, but that doesn't mean we can't tackle some."

Clapp reported that an evaluation looking at obesity prevalence among 3- and 4-year-old children enrolled in WIC, comparing high- and low-risk neighborhoods in the Bronx, Brooklyn, and Manhattan, found a reduction

in prevalence after the 2007 Article 47 amendments were implemented, as well as a narrowing of disparities between high- and low-risk neighborhoods in the Bronx and Manhattan (Sekhobo et al., 2014). The relationship of these trends to compliance with Article 47 is unknown, Clapp noted, but research suggests that the trends may be due to the intensive assistance offered in high-poverty neighborhoods. "City-wide policies may be working in tandem with policies at other levels of government to change the food and physical activity environment for low-income preschool children," she observed.

The policies affecting child care centers are part of a broader movement, Clapp noted. For example, policies to reduce the consumption of sugary drinks in New York City include not only the child care provisions but also the food procurement standards for city agencies, day camp regulations, and the city's unsuccessful 2013 attempt to cap portion sizes. These local efforts have been supported by federal policies, changes in other jurisdictions, and hard-hitting media campaigns, Clapp said. As an example of the latter, she pointed to portion caps being featured on the television program *Parks and Recreation*, which drew a great deal of attention across the country and raised the visibility of the issue.

Clapp outlined several takeaway messages from the experience in New York City. First, she said, innovations are prioritized based on evidence, scalability, and sustainability—although she noted that the city also has taken some risks to innovate. Second, having supportive mayors who are committed to public health and poverty reduction has given city officials the freedom and support to pursue these initiatives. Third, efforts have been focused on neighborhoods where health outcomes are worst, with messages being reinforced through a combination of policies, programming, education, and media. Policies can set a benchmark, Clapp noted, with each new policy change raising the bar for the next set of changes. Finally, she suggested, the layering of policies and initiatives at different levels has bolstered the message of making the healthier choice the easier choice. "It continues to be the North Star for us," she said.

In response to a question about how compliance with wellness policies is measured and enforced, Clapp said the approach in New York City is an extension of the public health model with respect to health and safety. It extends inspection, violation, and enforcement mechanisms to obesity and chronic disease, she said. Inspectors go into child care centers at least once a year, providing data for evaluation and further refinement of the approach.

OBESITY PREVENTION THROUGH HEALTH CARE PARTNERSHIPS

As a nonprofit pediatric health system, the Nemours Children's Health System has a vested interest in the health of children, said Allison

Gertel-Rosenberg, the system's director of national prevention and practice. Nemours offers pediatric clinical care, research, education, advocacy, and prevention programs, with the goals of improving child health and well-being and leveraging its own clinical and population health expertise.

In recent years, Nemours has been focusing on child health promotion and disease prevention to address the root causes of health, said Gertel-Rosenberg, with preventing childhood obesity and emotional and behavioral health problems being the first initiatives. In part, it has pursued this goal by complementing and expanding the reach of clinicians using a community-based approach. This approach reflects the fact that messages regarding healthy eating and physical activity need to extend across the life cycle, Gertel-Rosenberg observed, with consistent messaging from all of the key influencers in children's lives, including parents, early care and education (ECE) providers, and physicians. "It is not this one thing or this one place that is going to do it," she said. "It is the multitude of actions and how we work with our partners across those sectors [and] across that life span for the child."

Key elements of Nemours' strategy, explained Gertel-Rosenberg, are to define geographic populations and a shared outcome; establish multisector partnerships where children live, learn, and play; pursue policy and practice changes; develop social marketing campaigns; leverage technology; and serve as an integrator that works intentionally and systematically across sectors to improve health and well-being. She pointed out that many people at the workshop were fortunate to work in positions in which they could help think across sectors and break down silos. "Making the connections that need to happen and thinking through what synergistic effects can occur when we aren't focused on one place or one time is an optimal role for us to play," she said.

Gertel-Rosenberg reported that Nemours has undertaken a wide variety of programs to spread and scale healthy eating and active living in ECE settings. Through these programs, she noted, it can affect the lives of 800,000 children representing multiple populations. Nemours also has worked with many partners, such as the Sesame Workshop, with which it developed a toolkit using the *Sesame Street* characters to influence children in ECE settings. Most important, Gertel-Rosenberg asserted, ECE providers need turnkey solutions that are easy to implement so they do not need to struggle to figure out how to make something work.

Gertel-Rosenberg also suggested that efforts in formal ECE settings need to be coordinated with family providers, which typically do not have large enough staffs to spare people to attend a learning session. "We are thinking about how we can support these changes, how we can support these providers, and [how the] lessons we have learned can be taken forward and put into place in other initiatives that are going on around the country," she said.

Nemours also has established learning collaboratives to enable peers to learn from each other, Gertel-Rosenberg noted. The system worked with the CDC to spread these collaboratives to 10 sites in nine states so as to leverage its investments. "This is a great example of initiatives that may start small and may look different as we spread and scale them," Gertel-Rosenberg observed. "If you look at what we implemented in Delaware, it probably looks very different than what we have implemented in, say, California or in New Jersey, but it has the flavor."

Changes in both policy and practice are stronger than either alone, Gertel-Rosenberg asserted. Federal levers, state levers, and local context all provide opportunities to achieve change. Furthermore, the changes accomplished benefit not just the current cohort of children but future cohorts as well, and staff become empowered to serve as role models. "For a lot of folks, it might be the first time that they are gardening. It might be the first time that they are talking about getting down on the floor, or going outside to play with the kids in their care," Gertel-Rosenberg explained. "But when they are doing it, they are learning what it means, how to do it, and taking that to heart and figuring out what the next point of implementation is."

Gertel-Rosenberg drew several lessons from her experiences:

- These programs represent an investment of time. "This is not something that we have gone into lightly," she noted. "We thought a lot about how we can leverage their investments."
- State organizations need more organizational capacity and bandwidth to manage and implement large projects.
- State organizations do not naturally think about weaving projects into existing initiatives (such as the CDC's Spectrum of Opportunity). "The more that we can do to weave, make those connections happen, and figure out where the push buttons are, the better we are," she argued.
- Asking center staff to become leaders and train their entire center is innovative, and it requires time and coaching to develop peer leaders and leadership teams.
- Buy-in and sustainability typically require balancing fidelity to a national model with state and local customization. "Figuring out what the key components are that need to be replicated is important, and then figuring out where key concepts can be tweaked, if you will, to fit the context of the local communities or states," she explained.
- There are no perfect trainers; those strong in ECE tend to be weak in health and vice versa, which argues for pairing trainers that have strengths in each. The most important skill is relationship building and coaching with center teams.

- Technology can be a barrier. "We should be pushing on technology, but we should also be recognizing that technology may be a barrier," she said. "We don't want to turn people off to participation by putting high barriers into place."
- Programs are often overwhelmed by the number of "quality improvement" efforts.
- Programs find it difficult to participate because of competing time demands (to attend sessions and do homework, for example). Many programs do not even have regular staff meetings.
- "Lunch box" programs in which children bring their food with them entail unique challenges, since they require that parents be more directly involved.
- Efforts to involve parents and support changes at home need to be more intentional.

THREE LESSONS FOR OBESITY PREVENTION

In the last formal presentation of the workshop, Terry Huang, professor at City University of New York School of Public Health, shared three lessons he has learned through his cross-sectoral work on obesity prevention.

The first is that building trust is "absolutely key." This lesson "seems so simple, yet in practice is so hard," Huang noted. Building trust takes time, resources, effort, and strategy, he said, yet this area "gets the least amount of attention by the biomedical and public health enterprise."

For several years, Huang has been involved with a project focused on renovating and rebuilding a school that uses an innovative design to promote health. Many sectors have been involved in the project, including education, public health, design, and architecture. Evidence and theories related to healthy eating and physical activity have been translated into design strategies and language that designers and architects can use. Design thinking also has been extracted and adapted for a range of public health applications beyond this school building project. "Through this ongoing collaborative example, I have come to appreciate how much it takes to work across sectors," Huang said. He also has been involved with an initiative at the National Institutes of Health involving a series of forums focused on building trust that have brought together sectors including the food and beverage industry, the media, public health, government, and academia to develop an environment in which the parties can devise innovative solutions for moving forward. "Again, that process taught me so much about how hard it is to actually do this work, but yet how important it is if we [are] to embark on a multistakeholder approach toward obesity," Huang explained. Such forums, of which the roundtable that convened this workshop is an

example, can align the capacity of stakeholders with the complexity of the task, he argued.

The second lesson, Huang said, is the importance of partnerships, which, he asserted, can effectively leverage both collaboration and competition. Collaboration and competition may appear to be incompatible, he noted, but in the business world they can be structured on different levels to create a virtuous circle that leads to great innovation. In the ECE settings, for example, collaboration can occur at the local level while friendly competition at the state or regional level spurs widespread improvement, he suggested. "As teams become better at getting collaborative people to join them, they become more competitive over time," he said. For example, teams with diverse and collaborative players allow their members to be creative and to innovate while they compete for resources tied to particular public health goals. Teams that lose out in a competition then can be reconfigured to sustain coordinated distribution of work, Huang explained.

The final lesson Huang cited is the need to continually reassess and reset the goals of the system. In the school design project he described, for example, the original goal of promoting healthy eating and active living has evolved to the larger goal of fostering a culture that is imbued simultaneously with the values of learning, sustainability, and well-being. "We have these low-income children who are now going home during summer recess and saying how much they miss school," Huang noted. "If I can keep these kids all in school throughout the academic year and get them involved in the summer, there are all sorts of great things that will happen for [them] down the road apart from health impacts."

These lessons derive in part from what Huang called "translational systems science"—the idea that insights from diverse fields and disciplines about complex systems can inform innovative public health solutions. This idea, he argued, provides alternative ways of organizing the roadmap going forward beyond traditional biomedical thinking. For example, he has been working with the health department in Victoria, Australia, to launch a systems-oriented change initiative designed to transform the prevention system. This initiative has scaled up the systems thinking capacity of the department's prevention workforce, he asserted, while also creating a network of distributed actions and functionalities throughout the components of the prevention system, both at the local level and vertically between the local and state levels. The most important issue may not be the dose of a particular program delivered, suggested Huang, but the strategy behind the dose, as evidenced by the importance of aligning the capacity of the actors and the complexity of the task.

As another example of translational systems science, Huang called attention to the work that needs to be done to shift social norms and create a demand for obesity prevention, healthy places, healthy products, and

healthy policies. Such shifts in demand make it more likely that advantageous policies will be adopted and prove beneficial, he argued. In turn, resetting the goals of the system leads to new research questions, new strategies, and new ways to understand and affect complex systems. "Many of those are very different than what we are dedicating our time and resources to right now," Huang noted.

DISCUSSION SESSION

Creating Systems Change Across Sectors

In the discussion session, the panelists and the panel moderator discussed an issue at the heart of the Roundtable on Obesity Solutions: transcending place-based success stories to create the kinds of systems change needed for a sustainable solution. As was observed by moderator Lisel Loy, director of the Nutrition and Physical Activity Initiative at the Bipartisan Policy Center, bringing together talent from all of the sectors involved poses many challenges. "We are talking about building personal relationships," she said. "We are talking about investing the time it takes to build trust across sectors, among people who don't work together very often. We are talking about patience for incremental change. It is not all going to come at once. We are talking about site-specific and local changes, because that is the nature of the beast. There is no one size fits all. There is no off-the-shelf answer."

Gertel-Rosenberg observed that leadership is key to moving forward. Leaders exist in different places in different communities, she noted. If change is to be systemic rather than episodic, leaders need a "bookshelf" of options from which people, organizations, and communities can select. By using a combination of the best options and by incorporating feedback loops to change or strengthen those options, Gertel-Rosenberg asserted, different parts of interconnected complex systems can move forward coherently.

Huang offered three options for synthesis of efforts. First, he suggested that public health education should train people not just for academia or city health departments but for a much wider variety of roles, "to create agents of change across sectors." Preparing students to assume leadership roles in all industries and all sectors calls fundamental aspects of pedagogy into question, Huang argued.

Huang's second suggestion was that leadership needs to be part of community readiness. To address obesity, he argued, communities need to be ready to address health as an issue. "If we actually spent more time and effort on building up community readiness, that [would] go a long way in changing the leadership landscape locally and nationally," he said.

Finally, Huang suggested the need to create demand-side strategies that can help integrate bottom-up pressure and top-down strategies. A parallel, he believes, comes from the gay marriage movement in the United States. "If you look into the literature and the archives of how the U.S. gay marriage movement came about," he said, "there are clear lessons for how we can get better organized. So much of the outcome of a social movement like the gay marriage movement in the U.S. is a shift in leadership, with a coordinated and distributed action plan."

Fostering Sustainability

Related to the discussion of systems change was an exchange regarding how to create "business plans" that make initiatives sustainable and therefore impactful. Loy pointed out that a systems approach can engage the sectors that have a stake in the outcome of an initiative so that they make up-front investments in both changing systems and delivering outcomes, because change is in their interest. In particular, where health and wellness interventions intersect with the health care delivery system, she suggested, great potential exists to create sustainable financing models. In the context of the shift toward more value-based and integrated systems of care, she asserted, prevention can be embedded within coordinated systems that are based in the outcomes public health advocates share with business to bring new funding streams to the table.

Added Huang, "There can be no sustainable business model if our definition of a multistakeholder approach is limited only to the public sector or the academic sector." The private sector must be involved in crafting long-term solutions, he argued. Business initiatives geared toward health can be profitable, he noted, even for the food and beverage companies, but "a strategic, coordinated, and managed effort with clear accountability mechanisms built in" is required. As an example, he cited the need for a cohesive effort across the public, private, and academic sectors to shift social norms, whether around portion sizes, the value of healthy products, or the pleasure of wellness.

Gertel-Rosenberg pointed to a dual strategy that, unfortunately, may require a double payment at the beginning, when resources are needed both for the current reality and for what will happen in the future. The challenge is to combine current investments with thinking about the potential long-term roles for organizations, whether in the health care or education sector. "We have devised a system where, if one sector gains, another loses," Gertel-Rosenberg noted. "There is going to have to be a shifting of the norms, a broadening of the pie, if you will, where a redistribution is not a loss but rather a gain across shared goals and expectations."

Finally, Concannon observed that the ACA is helping to create a sus-

tainable set of strategies for communities based on the reality that prevention saves money in the acute care system. "That is a plus on the health care side," he said, "but it is also a plus for the industries and businesses that are paying [insurance] premiums." Similarly, he noted, the Healthy, Hunger-Free Kids Act is creating systemic change in school meals, partly as a result of government's engaging other organizations at the state and local levels. "We are trying to see what else can we do at the state level," he said. "You can't solve the hunger problem in this country with food programs. You need a much fuller commitment to engaging people in constructive ways so they have incomes."

6

Closing Comments

The United States and other nations have reasons to fear the obesity epidemic, and especially its effects on children, said Bill Purcell,[1] former mayor of Nashville, Tennessee, and chair of the Roundtable on Obesity Solutions, in his closing remarks at the workshop. But the workshop, he asserted, had revealed why "there is great hope and reason to believe that, together in the ways that have been described here, we will indeed do exactly what members of this roundtable have hoped we could accomplish." For almost 15 years, he noted, the Institute of Medicine and the National Academies of Sciences, Engineering, and Medicine have worked hard to understand the epidemic and do something about it, and have been committed to serving as the lead in that effort.

Purcell quoted Ecclesiastes, fourth chapter, 13th verse: "Better is a poor and a wise child than an old but foolish king, who will no more be admonished." Many poor children "need our help right now," he said. All those who have authority over the lives of children have a clear responsibility, he stated. "We leave this room understanding that charge and understanding that the future can and will be brighter," he concluded.

[1] Currently with Farmer Purcell White & Lassiter, PLLC.

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A

Workshop Agenda

Obesity in the Early Childhood Years:
State of the Science and Implementation of Promising Solutions

Workshop
Roundtable on Obesity Solutions

October 6, 2015
National Academy of Sciences Building
2101 Constitution Avenue, NW, Washington, DC
Auditorium

Purpose: Explore the state of the science and implementation of promising solutions for obesity during the early childhood years (birth to age 5).

Goals:

1. Explore what is known about overweight/obesity in the early childhood years (birth to age 5)
2. Identify modifiable risk factors
3. Identify effective interventions
4. Explore innovative solutions

8:30 AM **Welcome**
Mary Story, Duke University; Vice-Chair, Roundtable on Obesity Solutions; Chair, Workshop Planning Committee

8:40 AM **SESSION 1:**
Moderator: William Dietz, George Washington University

Prevalence and Trends of Overweight/Obesity in the Early Childhood Years and Persistence into Later Childhood, Adolescence, and Adulthood
Cynthia Ogden, Centers for Disease Control and Prevention

The Epigenetics of Childhood Obesity
Shari Barkin, Vanderbilt University

The Flavor World of Childhood: Basic Biology and Health Implications
Julie A. Mennella, Monell Chemical Senses Center

30-MINUTE MODERATED DISCUSSION

10:15 AM BREAK

10:45 AM **SESSION 2: Modifiable Protective and Risk Factors Associated with Overweight and Obesity Birth Through Age 5: State of the Science**
Moderator: Brent McBride, University of Illinois, Urbana-Champaign

Leann Birch, University of Georgia (responsive feeding)
Lisa M. Bodnar, University of Pittsburgh (pregnancy)
Rafael Pérez-Escamilla, Yale School of Public Health (infant feeding)
Jose (Pepe) Saavedra, Nestlé Nutrition (complementary feeding)
Elsie Taveras, Massachusetts General Hospital (sleep, activity, sedentary behavior, and disparities)

30-MINUTE MODERATED DISCUSSION

12:30 PM LUNCH BREAK

1:30 PM **SESSION 3: Overview of Effective Interventions: What Do We Know Works?**
Moderator: Jennifer MacDougall, Blue Cross and Blue Shield of North Carolina Foundation

Kirsten Davison, Harvard University (2-5 years of age, home and parenting)
Ian Paul, Pennsylvania State University (clinician perspective)
Elsie Taveras, Massachusetts General Hospital (pregnancy, 0-2 years of age)
Dianne Ward, University of North Carolina (2-5 years of age, early care and education)

30-MINUTE MODERATED DISCUSSION

3:00 PM BREAK

3:30 PM **SESSION 4: Promising and Innovative Cross-Sector Solutions**
Moderator: Lisel Loy, Bipartisan Policy Center

Jeni Clapp, New York City Department of Health and Mental Hygiene
Under Secretary Kevin W. Concannon, United States Department of Agriculture, Food, Nutrition, and Consumer Services
Terry Huang, City University of New York
Allison Gertel-Rosenberg, Nemours

30-MINUTE MODERATED DISCUSSION

5:00 PM **Closing Comments**
Bill Purcell, Farmer Purcell White & Lassiter, PLLC; Chair, Roundtable on Obesity Solutions

5:05 PM End of Workshop

B

Acronyms and Abbreviations

ACA	Patient Protection and Affordable Care Act
BMI	body mass index
CACFP	Child and Adult Care Food Program
CDC	Centers for Disease Control and Prevention
EBT	Electronic Benefits Transfer
ECE	early care and education
FITS	Nestlé Feeding Infants and Toddlers Study
HC2	Healthy Caregivers–Healthy Children program
IFPS II	Infant Feeding Practices Study II
INSIGHT	Intervention Nurses Starting Infants Growing on Healthy Trajectories
IOM	Institute of Medicine
NET-Works	Now Everybody Together for Amazing and Healthful Kids Study
NHANES	National Health and Nutrition Examination Survey
NRC	National Research Council

SLIMTIME	SLeeping and Intake Methods Taught to Infants and Mothers Early in Life Trial
SNAP	Supplemental Nutrition Assistance Program
STRIP	Special Turku Coronary Risk Factor Intervention Project for Babies
USDA	U.S. Department of Agriculture
WHO	World Health Organization
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children

C

Speaker and Moderator Biographies

Shari Barkin, M.D., M.S.H.S., received her medical degree from the University of Cincinnati Medical College and completed a Robert Wood Johnson Clinical Scholars fellowship at the University of California, Los Angeles. Her laboratory studies family-based, community-centered clinical interventions designed to improve health behaviors, such as physical activity and nutrition, in parent–young child dyads. Its work is focused on changing early body mass index trajectories in childhood so as to prevent childhood obesity and later related adult chronic conditions. The interventions developed and tested in the laboratory apply the ecologic model, which considers the child in the context of the family and the family in the context of the community, and how to apply scientific discovery pragmatically in potentially sustainable interventions that can improve the public's health. A theme of this work is the dynamic interaction among genetics, behavior, and environment at sensitive periods of childhood development. Dr. Barkin serves as principal investigator for the Growing Right Onto Wellness Trial, a 7-year randomized controlled trial focused on prevention of childhood obesity, funded by the National Heart, Lung, and Blood Institute and the National Institute of Child Health and Human Development. She also serves on the steering committee for the Childhood Obesity Prevention and Treatment Research National Institutes of Health Consortium. Dr. Barkin is serving her second term on the National Academies of Sciences, Engineering, and Medicine's Board on Children, Youth, and Families and is president-elect of the Society for Pediatric Research.

Leann Birch, Ph.D., is William P. "Bill" Flatt professor in the Department of Foods and Nutrition, University of Georgia. In her research as a developmental psychologist, she has focused on individual and contextual factors that influence the developing controls of food intake and obesity risk among infants, children, and adolescents. Early research from her laboratory on factors affecting the developing controls of food intake, including food preferences and responsiveness to portion size and energy density, has contributed to the evidence base on behavioral factors implicated in the development of childhood obesity. These findings laid the groundwork for exploring individual, familial, and contextual factors that shape the development of differences in eating behavior and obesity. Dr. Birch's current research focuses on primary prevention of obesity in infancy and early childhood. Author of more than 200 publications, she is internationally recognized for her research. She currently serves as co-leader of the University of Georgia Obesity Initiative's Maternal and Childhood Obesity Team, focusing on obesity as it relates to prenatal, postnatal, infant, and childhood obesity.

Lisa M. Bodnar, Ph.D., M.P.H., R.D., is an associate professor in the Departments of Epidemiology and Obstetrics/Gynecology, University of Pittsburgh Graduate School of Public Health and School of Medicine. She received her Ph.D. and M.P.H. in nutrition from the University of North Carolina at Chapel Hill, and is a licensed nutritionist and registered dietitian. Dr. Bodnar's research as a nutritional epidemiologist in the field of reproductive health is focused on elucidating the role of maternal nutritional status in maternal and child outcomes. She was a member of the 2009 Institute of Medicine Committee to Reevaluate Pregnancy Weight Gain Guidelines, as well as the U.K. Royal College of Obstetricians and Gynaecologists working group studying obesity and reproductive health. Dr. Bodnar's work on the contribution of maternal obesity and gestational weight gain to adverse pregnancy and birth outcomes is funded by the National Institutes of Health. She also is funded to study the role of maternal vitamin D status in preterm birth and preeclampsia. Recently, Dr. Bodnar was the recipient of the Young Professional Achievement Award from the Coalition for Excellence in Maternal and Child Health Epidemiology; she also received a Chancellor's Distinguished Research Award from the University of Pittsburgh.

Jeni Clapp, M.P.A., is director of healthy eating initiatives at the New York City Department of Health and Mental Hygiene, where she oversees strategies for preventing and reducing the prevalence of chronic disease among New Yorkers. During her tenure at the department, she has managed the National Salt Reduction Initiative, a national partnership to reduce sodium

in the U.S. food supply, as well as implementation of the New York City Food Standards, which apply to approximately 250 million meals and snacks served annually by city agencies. Ms. Clapp led the Healthy Hospital Food Initiative, which has been recognized nationally as a model for improving the food environment in hospital settings, and oversaw the design of MenuStat.org, an online tool used to track the nutritional content of restaurant foods and beverages nationally. She oversees nutrition education programming provided by the Department of Health and Mental Hygiene, including Eat Well Play Hard in Early Childcare Settings and the Health Bucks program. Ms. Clapp holds a B.A. degree from Wellesley College and a master's degree in public administration from New York University.

Kevin W. Concannon was nominated by President Obama and Secretary Vilsack and confirmed by the U.S. Senate in July 2009 to serve as under secretary for food, nutrition, and consumer services in the U.S. Department of Agriculture. Food, Nutrition, and Consumer Services includes the Food and Nutrition Service (FNS) and the Center for Nutrition Policy and Promotion (CNPP). Working in partnership with state and local organizations, FNS oversees nutrition programs that collectively serve one in four Americans, including the Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program; child nutrition programs, including the National School Lunch, School Breakfast, and Summer Food Service Programs; the Child and Adult Care Food Program; the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); and others. CNPP is responsible for developing and promoting the Dietary Guidelines for Americans, MyPlate, and a number of dietary and economic reports influencing nutrition policy. Under Secretary Concannon has had a lengthy and distinguished career in public service. He has served as director of state health and human services departments in Iowa, Maine, and Oregon. He also has served in a number of national organizations, including as president of the American Public Welfare Association, president of the National Association of State Mental Health Program Directors, trustee of the American Public Human Services Association, and board member of the American Humane Association. He has received a number of awards, including the Lifetime Human Services Award from the American Public Human Services Association (2007), the Catholic Charities USA Keep the Dream Alive Award (2012), and the National WIC Association Leadership award (2012). He received both B.A. and M.S.W. degrees from Saint Francis Xavier University, which also awarded him a doctor of laws degree honoris causa in 2013.

Kirsten Davison, Ph.D., is an associate professor of nutrition and director of the public health nutrition concentration at the Harvard School of

Public Health. She completed her Ph.D. in child and family development at the Pennsylvania State University. Her research focuses on family and community contributions to child obesity. Most recently, her research has focused on family-centered interventions to prevent child obesity in low-income populations. These interventions, which have been implemented in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and Head Start settings, are based on the principles of community-based participatory research and were developed, implemented, and evaluated in collaboration with parents. Current projects focus on parenting around children's snack food intake, strategies to engage fathers in obesity prevention programs and research, and a large-scale community intervention integrating evidence-based programs in multiple sectors (WIC, child care, schools, after-school programs, and community health centers).

William (Bill) Dietz, M.D., Ph.D., is a consultant to the Roundtable on Obesity Solutions of the Academies and director of the Sumner M. Redstone Global Center on Prevention and Wellness at the Milken Institute School of Public Health, George Washington University. He was director of the Division of Nutrition, Physical Activity, and Obesity in the Center for Chronic Disease Prevention and Health Promotion at the Centers for Disease Control and Prevention (CDC) from 1997 to 2012. Prior to his appointment to the CDC, he was a professor of pediatrics at the Tufts University School of Medicine and director of clinical nutrition at the Floating Hospital of New England Medical Center Hospitals. Dr. Dietz has been a counselor and is past president of the American Society for Clinical Nutrition, and is past president of the North American Association for the Study of Obesity. From 2001 to 2003 he served as a member of the Advisory Board to the Institute of Nutrition, Metabolism, and Diabetes of the Canadian Institutes for Health Research. In 2000, Dr. Dietz received the William G. Anderson Award from the American Alliance for Health, Physical Education, Recreation and Dance, and was recognized for excellence in his work and advocacy by the Association of State and Territorial Public Health Nutrition Directors. In 2002, he was made an honorary member of the American Dietetic Association and received the Holroyd-Sherry award for his outstanding contributions to the field of children, adolescents, and the media. He received the George Bray Founders Award from the North American Association for the Study of Obesity in 2005, the Nutrition Award from the American Academy of Pediatrics for outstanding research related to nutrition of infants and children in 2006, the Oded Bar-Or award from the Obesity Society for excellence in pediatric obesity research in 2008, and a Special Recognition Award from the American Academy of Pediatrics Provisional Section on Obesity and the Outstanding Achievement Award from the Georgia Chapter of the American Academy of

Pediatrics in 2012. Dr. Dietz is the author of more than 200 publications in the scientific literature and the editor of 5 books, including *Clinical Obesity in Adults and Children* and *Nutrition: What Every Parent Needs to Know*. He received his B.A. from Wesleyan University in 1966 and his M.D. from the University of Pennsylvania in 1970. After completing his residency at Upstate Medical Center, he received a Ph.D. in nutritional biochemistry from the Massachusetts Institute of Technology. Dr. Dietz is a member of the National Academy of Medicine.

Allison Gertel-Rosenberg, M.S., has spent her career addressing some of the most important and challenging issues in public health. As director of national prevention and practice for Nemours' National Office of Policy and Prevention, she is responsible for leading the office's efforts to spread and scale promising practices and strategic prevention initiatives designed to curb childhood obesity on a national scale, as well as for initiatives that involve the intersection of population health and clinical care. These efforts have included the highly successful Let's Move! Child Care; Healthy Kids, Healthy Future; and the National Early Care and Education Learning Collaborative initiative with the Centers for Disease Control and Prevention. Ms. Gertel-Rosenberg's involvement has run the gamut from securing funding for these collaborations, leveraging $47 million in grants, to playing a critical role in planning and implementing the strategic and operational measures necessary to make them successful. She is widely recognized as an expert on public health and population health and has presented at numerous national conferences on the value of investment in childhood health and the efficacy of prevention programs. In addition, she has published a number of articles on children's health issues. Ms. Gertel-Rosenberg received her M.S. in health policy and management from the Harvard School of Public Health and her B.S. in public health from Rutgers College.

Terry Huang, Ph.D., M.P.H., C.P.H., is a professor at the City University of New York School of Public Health. He chaired the Department of Health Promotion at the University of Nebraska Medical Center (UNMC) from 2010 to 2014. In addition, he is co-founder and senior advisor of the National Collaborative on Childhood Obesity Research (NCCOR), which coordinates activities across the National Institutes of Health (NIH), the Centers for Disease Control and Prevention, the U.S. Department of Agriculture, and the Robert Wood Johnson Foundation. Before returning to academia, Dr. Huang was director of the Obesity Research Strategic Core at the Eunice Kennedy Shriver National Institute of Child Health and Human Development, where he played a leading role in developing new national research directions and funding priorities. He is a global leader in creative solutions for obesity and chronic disease, systems-oriented preven-

tion strategies, cross-sectoral partnerships, and the translation of science to policy. He has lectured extensively and published more than 100 articles on these topics. He has also served as a consultant or expert for the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine; the Robert Wood Johnson Foundation; the Global Alliance for Improved Nutrition; the Access to Nutrition Foundation; and the EPODE International Network, among other notable organizations. For his work with NCCOR, Dr. Huang received the U.S. Department of Health and Human Services Secretary's Innovation Award in 2010 and the NIH Director's Award in 2011. In addition, he received the National Cancer Institute Award of Merit in 2012 and was named UNMC Distinguished Scientist in 2013. He is an alumnus of the American Swiss Foundation Young Leaders Program. Dr. Huang holds a Ph.D. in preventive medicine and an M.P.H. from the University of Southern California, and a B.A. in psychology from McGill University. He is board certified in public health and is fellow, immediate past program chair, and councilor of The Obesity Society. He is also vice president of North America, World Obesity Federation.

Lisel Loy, J.D., L.L.M., is director of the Nutrition and Physical Activity Initiative at the Bipartisan Policy Center. An attorney with more than 20 years of experience in policy and politics, she helped establish the Bipartisan Policy Center's first project, the National Commission on Energy Policy, and served as the commission's deputy director from 2002 to 2006. Prior to that, she served in the Clinton administration, where she was assistant to the president and staff secretary, responsible for overseeing the flow of information to and from the Oval Office. From 1997 to 1999, she was special counsel to the deputy secretary, U.S. Department of the Interior, where she worked on Indian treaty rights, water, and endangered species issues. Prior to her government service, Ms. Loy was a staff attorney in the clinical program at the Georgetown University Law Center. At Georgetown, she represented individuals, nonprofit groups, and the Mattaponi Indian tribe in a range of environmental and civil rights claims. She began her career working on nutrition education, community gardens, and land use issues in New York City. She currently serves on the Board of American Rivers, a national, nonprofit river conservation group. She is admitted to the bar in Washington, DC, and New York. She received her B.A. from Yale University and her J.D. from Stanford Law School.

Jennifer MacDougall, M.S., is the healthy living senior program officer at Blue Cross and Blue Shield of North Carolina Foundation. She oversees the foundation's investments as they relate to achieving the vision of North Carolinians of all ages having access to the key components of healthy living through integrated initiatives that create environments for physi-

cal activity and healthy eating. Previously, Ms. MacDougall worked with North Carolina State University's Recreation Resources Service, where she assisted municipal and county parks and recreation departments in the development and management of both the Parks and Recreation Trust Fund and Land and Water Conservation Fund projects. In addition, she worked collaboratively with parks and recreation agencies across the state to help develop partnerships between parks and recreation and public health agencies for the benefit of community health. Ms. MacDougall received both her B.S. and M.S. degrees in parks, recreation, and tourism management from North Carolina State University.

Brent A. McBride, Ph.D., M.A., is a professor of human development in the Department of Human Development and Family Studies and in the Division of Nutritional Sciences at the University of Illinois, Urbana-Champaign (UIUC), where he also serves as director of the Child Development Laboratory (CDL) program. As director of the CDL for the past 26 years, he has been actively engaged in working with investigators from a variety of disciplines on the UIUC campus as they explore protocols and approaches for studying young children's development in the context of classroom environments, as well as in laboratory settings. For the past 8 years, Mr. McBride has drawn on his expertise in child development and emphasis on translational research in early childhood settings in serving as one of the senior investigators on the STRONG Kids I & II projects, an interdisciplinary team of nine investigators from across the UIUC campus that is conducting longitudinal research to explore how genetic, family, community, child care, and cultural factors impact inappropriate weight gain and obesity during the early childhood years. A focus of his work with the STRONG Kids team has been on exploring the role of child care contexts in influencing obesity and inappropriate weight gain during the early childhood years.

Julie A. Mennella, Ph.D., obtained her doctorate from the Department of Behavioral Sciences, University of Chicago. She did postdoctoral work on the transfer of volatiles from maternal diet to amniotic fluid and human milk at the Monell Chemical Senses Center in Philadelphia. She joined the faculty there in 1990, and is now a full member. Her major research interests include investigating the timing of sensitive periods in human flavor learning during breastfeeding and formula feeding; uncovering the different taste worlds of children and adults and children's vulnerabilities to the current food environment; and understanding the role of genetics, culture, and experience in food choices and habits. In addition to her research, Dr. Mennella founded a program at Monell Center that encourages underrepresented minority high school and undergraduate students to

pursue careers in science and medicine. She has held a number of leadership positions in professional scientific societies and working groups at the National Institutes of Health and other international scientific and health organizations. She is the recipient of grants from the National Institute of Deafness and Other Communication Disorders and the Eunice Kennedy Shriver National Institute of Child Health and Human Development; the author or co-author of numerous peer-reviewed research papers; and an internationally recognized speaker on the ontogeny of flavor preferences and its implications for health and nutritional programming.

Cynthia Ogden, Ph.D., is an epidemiologist at the National Center for Health Statistics, Centers for Disease Control and Prevention (CDC), overseeing the analysis group for the National Health and Nutrition Examination Survey. Her research interests relate to nutrition, and in particular, growth and obesity. She worked on the revision of the 2000 CDC growth charts for children that are used to define obesity in U.S. children. Dr. Ogden has published extensively and given numerous presentations on obesity and dietary intake in the United States. She joined the CDC as a member of the Epidemic Intelligence Service. Previously, she worked in the Nutrition Division at the New York State Department of Health, where she researched obesity among schoolchildren in New York counties. She also has worked on nutrition-related projects for the Food and Agriculture Organization of the United Nations and currently is a lecturer at the George Washington University Milken Institute School of Public Health. Dr. Ogden earned her Ph.D. and master's degrees from Cornell University, where her research focused on social contributions to malnutrition among young children in Kigali, Rwanda.

Ian Paul, M.D., is a professor of pediatrics and public health sciences at the Pennsylvania State University College of Medicine, chief of the Division of Academic General Pediatrics, and vice chair of clinical affairs in the Department of Pediatrics at Penn State Hershey Children's Hospital. Dr. Paul is a general pediatrician and clinical and health services researcher with principal interests in primary preventive interventions for newborns, infants, and families. His major research focus is on the prevention of childhood obesity through home-based interventions delivered to parents of infants.

Rafael Pérez-Escamilla, Ph.D., is professor of epidemiology and public health and director of the global health concentration and of the Office of Public Health Practice at the Yale School of Public Health. His research has led to improvements in breastfeeding protection, promotion, and support worldwide through health facility and community-based initiatives, including breastfeeding peer counseling. He has also made major contributions

to the development, implementation, and evaluation of maternal, infant, and young child community nutrition programs globally. He is a member of the National Academies of Sciences, Engineering, and Medicine's Food and Nutrition Board, for which he chaired the Academies' workshop on "Updating the USDA National Breastfeeding Campaign," and is currently a member of the WIC Food Packages committee. He served on both the 2010 and 2015 USA Dietary Guidelines Advisory Committee and is currently serving on the USDA/Department of Health and Human Services "Birth to 24/Pregnancy" Dietary Guidelines Technical Expert Consultation Group. He is the recipient of the 2015 (*Journal of Human Lactation*) Patricia Martens Annual Award for Excellence in Breastfeeding Research. Dr. Pérez-Escamilla obtained his master's degree in food science and his Ph.D. in nutrition from the University of California, Davis.

Bill Purcell, J.D., is an attorney in Nashville, Tennessee, and an adjunct professor of public policy at Vanderbilt University. While he was serving as mayor of Nashville (1999 to 2007), his accomplishments as a civic leader earned him Public Official of the Year honors in 2006 from *Governing Magazine*. Elected to five terms in the Tennessee House, he held the positions of majority leader and chair of the Select Committee on Children and Youth. After retiring from the General Assembly, Mr. Purcell founded and became director of the Child and Family Policy Center at the Vanderbilt Institute of Public Policy Studies. From 2008 to 2010, he served as director of the Institute of Politics at the Harvard Kennedy School of Government. He was then appointed special advisor and co-chair of the Work Team for Allston in the Office of the President at Harvard University. He previously served in various capacities for the National Academies of Sciences, Engineering, and Medicine on obesity-related committees, including as a member of the Committee on an Evidence-based Framework for Obesity Prevention Decision Making, vice chair of the Committee on Accelerating Progress in Obesity Prevention, and member of the Standing Committee on Childhood Obesity Prevention. Mr. Purcell graduated from Hamilton College and Vanderbilt University School of Law.

Jose (Pepe) M. Saavedra, M.D., is a pediatric gastroenterologist, clinical investigator, and educator. He holds appointments in the Johns Hopkins School of Medicine and the Johns Hopkins Bloomberg School of Public Health, where he developed the Johns Hopkins Children's Nutrition Center. Dr. Saavedra carried out seminal work in the area of probiotics in pediatric populations, and has an extensive record of publications in nutrition and in the area of intestinal microbiota, immunity, and preventive nutritional strategies. He also is global chief medical officer for Nestlé Nutrition. Over the past several years, he has expanded Nestlé Nutrition's scientific innova-

tion and enhanced Nestlé's educational and research activities focused on infant health. Dr. Saavedra has spearheaded a number of creative collaborative initiatives designed to help educate and disseminate nutrition information, including work with the North American and European Societies of Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN, ESPGHAN) and the American Academy of Pediatrics (AAP). This latter collaborative led to the creation of the AAP's Institute for Healthy Childhood Weight—a special example of the leveraging of common interests, knowledge, and expertise to create shared value for both the collaborators and parents, consumers, and children. Dr. Saavedra is chairman of the board of the Nestlé Nutrition Institute.

Mary T. Story, Ph.D., R.D., is professor of global health and community and family medicine and associate director, education and training, Duke Global Health Institute, Duke University. She started in this position in January 2014. Prior to that she was senior associate dean for academic and student affairs and professor in the Division of Epidemiology and Community Health in the School of Public Health, University of Minnesota, where she was also adjunct professor in the Department of Pediatrics, School of Medicine. Dr. Story's interests are in the areas of child and adolescent nutrition, obesity prevention, and environmental and policy approaches to improving healthy eating. She is director of the National Program Office for the Robert Wood Johnson Foundation Healthy Eating Research program. Her own research focuses on understanding the multiple factors related to eating behaviors of youth and environmental, community, and school-based interventions for obesity prevention and healthy eating. She has produced more than 400 scientific publications in the area of child and adolescent nutrition and obesity. Dr. Story is a member of the National Academies of Sciences, Engineering, and Medicine's Food and Nutrition Board. She was previously a member of numerous Academies committees on school food, nutrition, food marketing, and obesity-related topics. She currently serves on the 2015 Dietary Guidelines Advisory Committee. Dr. Story received a Ph.D. in human nutrition science from Florida State University and is credentialed as a registered dietitian. She is a member of the National Academy of Medicine.

Elsie M. Taveras, M.D., M.P.H., is a pediatrician and a childhood obesity researcher. The main focus of her research is understanding determinants of obesity in women and children and developing interventions across the life course to prevent obesity, especially in underserved populations. Her work spans the spectrum of observational studies and interventions, with an emphasis on identifying and quantifying risk factors so they can be modified for health promotion and disease prevention. Dr. Taveras has published

more than 100 research studies examining early-life origins of obesity and interventions in home, clinical, and community settings to prevent and manage obesity among mothers and children. She is chief of the Division of General Academic Pediatrics and director of pediatric population health management at Massachusetts General Hospital, and is also an associate professor of population medicine at Harvard Medical School. She supports the academic activities of faculty of the Division of General Academic Pediatrics as they develop and test innovations in primary care delivery and in the conduct of research that leverages clinical and community partnerships. She also leads the Division in research and teaching on improving the health of individuals and populations across the life course, prevention of chronic diseases among children, and reduction and elimination of disparities in children's health and health care.

Dianne Ward, Ed.D., has been engaged in research to prevent childhood obesity through home, school, and community interventions that promote healthy eating and regular physical activity in children and families. She led the team that developed the highly regarded policy and environmental intervention for child care, NAP SACC (the Nutrition and Physical Activity Self-Assessment for Child Care). The second generation of NAP SACC, called GoNAPSACC, includes an updated self-assessment for centers and family child care homes and an online interactive version of the original program. Dr. Ward is co-directing a National Institutes of Health (NIH)-funded project to test a three-component intervention designed to increase healthy nutrition and regular physical activity in children enrolled in family child care homes (KEYS to a Healthy Family Child Care Home). Her other NIH projects include Caring and Reaching for Health, a worksite intervention for child care workers, and a social marketing intervention linking child care providers to parents (Healthy Me, Healthy We). Dr. Ward is very active in leadership positions among early care and education (ECE) researchers, including the ECE workgroup sponsored by the Robert Wood Johnson Foundation and the ECE Special Interest Group of the International Society for Behavioral Nutrition and Physical Activity.