Physical Activity: Moving Toward Obesity Solutions: Workshop Summary

DETAILS

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PHYSICAL ACTIVITY: MOVING TOWARD OBESITY SOLUTIONS

Workshop Summary

Leslie Pray, *Rapporteur*

Roundtable on Obesity Solutions

Food and Nutrition Board

INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

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"Knowing is not enough; we must apply.
Willing is not enough; we must do."
—Goethe

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This workshop summary has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. 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:

Joseph E. Donnelly, University of Kansas, Lawrence
Janet Fulton, Centers for Disease Control and Prevention
E. Paul Roetert, SHAPE America
Jennifer Sacheck, Tufts University

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 **Hugh Tilson,** University of North Carolina. Appointed by the Institute of Medicine, 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.

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1

Introduction

On April 14-15, 2015, the Institute of Medicine's (IOM's) Roundtable on Obesity Solutions held a 2-day workshop[1] titled "Physical Activity: Moving Toward Obesity Solutions." While the idea that physical activity impacts health can be traced as far back as Hippocrates, Russell Pate stated in his opening remarks that the scientific study of physical activity did not begin until the 20th century. By the 1990s, he said, researchers had collected enough evidence on the health implications of physical activity that the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine were able to collaborate on the first of what would become many public health statements on the importance of exercise (Pate et al., 1995). In 2008, the U.S. federal government for the first time issued fully approved physical activity guidelines.

The science around the linkages between physical activity and health has continued to accumulate, Pate said. The April 14-15 workshop was held to provide an expert summary of the state of the science regarding the impact of physical activity in the prevention and treatment of overweight and obesity and to highlight innovative strategies for promoting physical activity across different segments of the population (Box 1-1 summarizes the workshop goals).

[1] The planning committee's role was limited to planning the workshop. This workshop summary was prepared by the rapporteur 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 IOM. They should not be construed as reflecting any group consensus.

BOX 1-1
Workshop Goals

The workshop will explore the role of physical activity in the prevention and treatment of obesity and will feature expert speakers and discussion on the scientific basis for a focus on physical activity in obesity prevention and treatment. The workshop will include presenters and discussants on the subject of primary prevention of overweight and obesity in adults and children, as well as physical activity in overweight and obese populations. The workshop will also provide a space for speakers and attendees to share innovative strategies for promoting physical activity and preventing obesity in diverse settings and through various channels.

ORGANIZATION OF THE WORKSHOP AND THIS SUMMARY

The organization of this summary parallels that of the workshop itself (see Appendix A for the workshop agenda). This first chapter summarizes the welcoming remarks of Victor Dzau, president of the IOM at the time of the workshop and currently president of the newly formed National Academy of Medicine; Russell Pate's introductory presentation, which provided historical context for understanding the current state of the science regarding the impact of physical activity on the prevention and treatment of obesity; keynote speaker James Hill's presentation on the clarity of the evidence indicating that physical activity plays a significant role in reducing obesity; and Aviva Must's overview of sociodemographic disparities in obesity and physical activity as one of its determinants.

Following these introductory overviews, the remainder of the first day of the workshop was dedicated to exploring in more detail what scientists have learned about the role of physical activity in preventing obesity in youth (summarized in Chapter 2); what is known about the role of physical activity in preventing obesity in adults (Chapter 3); and the health effects of physical activity in youth and adults who are overweight or obese (Chapter 4).

The second day of the workshop focused on ways to promote physical activity across different segments of the population. Speakers and participants considered policy strategies (summarized in Chapter 5), community strategies (Chapter 6), and institutional strategies (Chapter 7).

In the final session of the workshop, representatives from three community programs in different parts of the country, working with varying age,

socioeconomic, and racial/ethnic segments of the U.S. population, discussed how their programs promote physical activity (summarized in Chapter 8).

Each session ended with a panel discussion with the speakers. Summaries of those discussions are provided at the end of the respective chapters, organized by topic.

WELCOMING REMARKS[2]

The Roundtable on Obesity Solutions was established in 2004 to engage leaders from multiple sectors and, through workshops such as this, to provide a venue for collaborations and policy initiatives designed to prevent and treat obesity and eliminate obesity-related disparities. In his welcoming remarks, Victor Dzau elaborated on the origins and goals of the roundtable and on the purpose of the workshop. While the roundtable began, he said, as a way to bring together thought leaders from multiple sectors, he expressed excitement that this workshop was engaging "people on the ground," or, as he said, "people who actually do the work to make a difference."[3]

At the time of this workshop, the IOM had produced more than a dozen consensus reports[4] on different aspects of obesity, such as ways in which community resources can be used to reduce both child and adult obesity, ways in which government can make a difference, and evidence relating to prevention of obesity. With respect to the role of physical activity in preventing and treating obesity, Dzau highlighted two of the more recent consensus reports. The first, *Accelerating Progress in Obesity Prevention: Solving the Weight of the Nation* (IOM, 2012), calls for physical activity to be an integral and routine part of life and for community planners, government officials, and others to work together to increase opportunities for and access to physical activities. The second, *Educating the Student Body: Taking Physical Activity and Physical Education to School* (IOM, 2013), emphasizes the need for a whole-school approach to foster and provide access to 60 minutes of physical activity per day in the school environment. Additionally, in 2015, just prior to this workshop, the roundtable issued a series of prospective papers on disparities in physical activity (Adeigbe and

[2] This section summarizes information and opinions presented by Victor Dzau, M.D., president of the National Academy of Medicine.

[3] In addition to the final session's being dedicated to a discussion of three "on the ground" strategies currently being implemented, three active breaks were built into the workshop schedule—the first led by Shape Up Sisters of Vicksburg, Mississippi; the second by DC SCORES of Washington, DC; and the third by BOKS in Canton, Massachusetts.

[4] In addition to these consensus reports, the IOM had produced a comparable number of workshop summaries on various aspects of obesity.

Ramirez, 2015; DiPietro, 2015; Rimmer, 2015; Taylor, 2015; Warne and Roanhorse, 2015; Whitaker and Gehris, 2015; see Appendix B).

In addition to its many publications on obesity, the IOM partnered with HBO to develop a series called *The Weight of the Nation*. Out of that partnership, Dzau said, came The Public Good Projects, which, together with the IOM, has been working on a campaign titled "A Healthy America" and addressing many of the same issues on which the roundtable focuses.

Dzau said he views the obesity challenge in the United States, as well as in other Western nations, as a problem of affluence and technology—with technologies today being less conducive to physical activity than in the past—but also as a problem of a lack of opportunities. For example, career circumstances and money challenges are reducing free time, and dangerous neighborhoods deter walking. From community planners to transportation and other government officials, Dzau said, "Everybody is thinking about how to create the right environment for physical activity." He observed that the issue is a timely one, as reflected, among other efforts, in First Lady Michelle Obama's Let's Move! Campaign; the Partnership for a Healthier America; the National Physical Activity Plan; and work by the President's Council on Fitness, Sports, and Nutrition.

AN INTRODUCTION TO PHYSICAL ACTIVITY AND ITS IMPACT ON HEALTH AND WELL-BEING[5]

Walking is man's best medicine. —Hippocrates

A Brief History of Physical Activity and Health

The idea that physical activity is important to health is not new. Ancient scholars and physicians believed it, and Hippocrates wrote about it (460-357 B.C.). Probably intuitively, Russell Pate said, great leaders throughout history have understood the link between physical activity and health, but as noted earlier, it was not until the 20th century that what is known as science was applied to physical activity and exercise. European exercise physiologists—notably 1920 Nobel Prize winner August Krogh (1874-1949) and 1922 Nobel Prize winner A. V. Hill (1866-1977)—were among the first to work in the field. Pate noted that the field has not produced a Nobel Prize winner since then, and, he said, "We are overdue." In the United States, the Harvard Fatigue Lab was active at around the same time, up until the end of World War II (1927-1947). It trained many of the scientists who

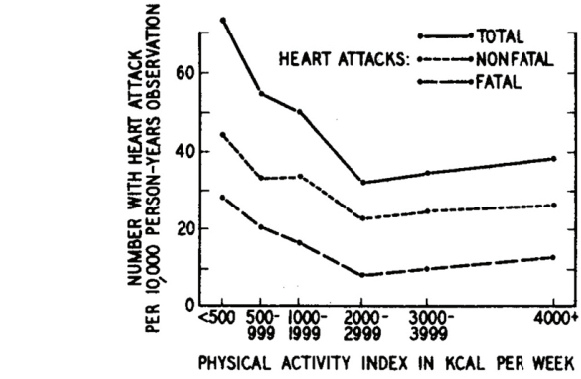
[5] This section summarizes the information and opinions presented by Russell R. Pate, Ph.D., Arnold School of Public Health, University of South Carolina, Columbia.

populated the academic programs in exercise science across the country that continue to exist today, according to Pate.

In the first half of the 20th century, most of the science on physical activity and exercise was focused on understanding the basic physiological responses to exercise. By mid-century, some highly prestigious epidemiologists, including Jeremy Morris (1910-2009) and Ralph Paffenbarger (1922-2007), had become interested in the health implications of physical activity. Pate said, "I think you could probably argue that we are here this morning in no small way because of the work of Jeremy Morris in the U.K. and Ralph Paffenbarger in the U.S." The field has benefited tremendously, in his opinion, from the credibility those early epidemiologists brought to their work. Morris is well known for his work in the early 1950s comparing health outcomes in active double-decker bus conductors versus sedentary drivers. Paffenbarger continued that work across a range of occupational groups, such as active longshoremen (i.e., cargo handlers) versus sedentary longshoremen, and conducted a well-known study of Harvard alumni with different physical activity levels (Paffenbarger et al., 1978). He also created what is known by many as the Paffenbarger curve, illustrating the relationship between physical activity and heart disease outcomes, with the low end of the activity continuum being associated with substantially elevated risks of fatal and nonfatal heart attacks (Paffenbarger et al., 1978) (see Figure 1-1). The Paffenbarger curve has been used to describe the relationship between physical activity and a wide range of other chronic disease outcomes as well, with fitness sometimes being used as a surrogate marker for physical activity (Blair et al., 1989) (see Figure 1-1). The basic message of the curve, said Pate, is that "you don't want to be sedentary."

By the early 1990s, evidence supporting the important health implications of physical activity had reached a critical point. In 1992, the American Heart Association issued what Pate believes, in retrospect, was a seminal statement on exercise, acknowledging that inactivity or low physical activity should be recognized as a risk factor for coronary heart disease (Fletcher et al., 1992). That statement, Pate said, "opened the floodgate." Just a few years later, CDC and the American College of Sports Medicine collaborated to issue the first public health statement on physical activity, recommending that all adults accumulate 30 minutes or more of at least moderate-intensity physical activity on most, preferably all, days of the week (Pate et al., 1995). The 1995 statement was followed quickly by production of the first and still only surgeon general's report on physical activity and health, which, according to Pate, essentially endorsed the same recommendations (HHS, 1999).

Concurrently with the release of some of these authoritative documents, "the science continued to accumulate," Pate remarked, with publications on physical activity or exercise and health increasing curvilinearly.



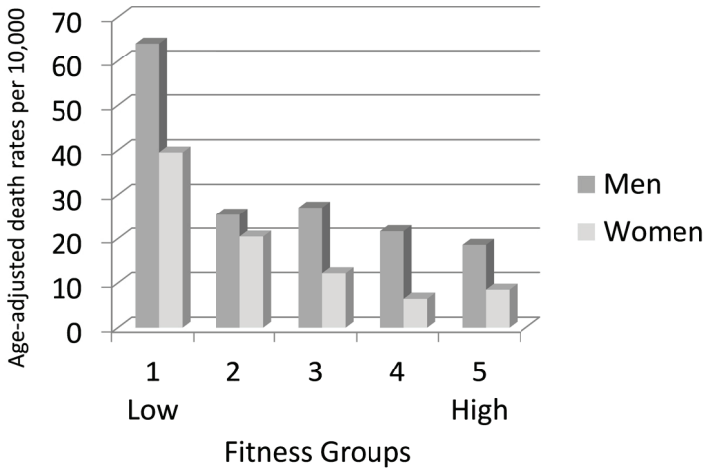


FIGURE 1-1 The so-called Paffenbarger curve, showing the relationship among physical activity or fitness, heart disease outcomes, and all-cause mortality.
NOTE: kcal = kilocalorie.
SOURCES: Presented by Russell Pate on April 14, 2015 (Blair et al., 1989; Paffenbarger, R. S., Jr., A. L. Wing, and R. T. Hyde. 1978. Physical activity as an index of heart attack risk in college alumni. *American Journal of Epidemiology* 108(3):161-175 by permission of Oxford University Press).

In the early 1990s, there were fewer than 5,000 publications on physical activity and health and fewer than 5,000 on exercise and health. Between 2011 and 2015, there were nearly 35,000 publications on physical activity and health and more than 30,000 on exercise and health.

As noted earlier, in 2008, the U.S. federal government for the first time issued fully approved physical activity guidelines (HHS, 2008). The advisory committee that informed the production of that report conducted an extensive review of the literature, according to Pate. That review revealed strong evidence for a broad constellation of important chronic disease and health benefits associated with higher levels of physical activity in both adults and older adults, including the prevention of weight gain. Additionally, there was moderate to strong evidence for reduced abdominal obesity, again in both adults and older adults. In children and adolescents, strong evidence supported an association between physical activity and favorable body composition. In sum, Pate said, the advisory committee concluded that physical activity was associated with important benefits with respect to the avoidance of overweight and obesity across the age range considered. The committee recommended 2.5 hours per week of moderate-intensity activity, which Pate noted was not really very different from the previously recommended 30 minutes most days of the week (i.e., Pate et al., 1995). For children and adolescents (6-17 years of age), the advisory committee recommended 1 hour per day.

Because most Americans are not meeting those guidelines, Pate said, the risk attributable to failure is tremendous. A number of published analyses have examined that risk, producing estimates ranging from 191,000 to 300,000 premature deaths per year in the United States attributable to physical inactivity (e.g., Danaei et al., 2009). Worldwide, Lee and colleagues (2012) estimate that 7-10 percent of several important chronic disease outcomes (e.g., coronary heart disease, colon cancer) can be explained on the basis of physical inactivity. "It is a remarkable conclusion," Pate said. "Clearly the impact of physical inactivity constitutes a very substantial public health problem."

Studying the Health Impact of Physical Activity

Pate provided an overview of the principles and premises applied by scientists in their study of physical activity. First, to study a construct, Pate said, scientists need to define it. Physical activity has been defined as "any bodily movement produced by skeletal muscles that results in energy expenditure." Pate underscored the importance of the "energy expenditure" component of that definition and remarked that the energy throughput impact of physical activity is a fundamental component of physical activity research.

Pate emphasized the complex nature of physical activity. It is a behavior with many attributes, he explained, all of which are relevant to studying its health impact. They include the type of activity (e.g., aerobic, resistance), specific form (e.g., walking, swimming), frequency (e.g., bouts/day,

days/week), intensity, duration, and context (e.g., physical location, social setting).

To study a construct, Pate continued, scientists also need to be able to measure it. Physical activity has been measured in many different ways, including self-report; surrogate report (e.g., by parents or others around the target individual); direct observation; and, over the past 15 years or so, objective assessment (e.g., accelerometry, pedometry). In Pate's opinion, the development of methods for objective assessment of physical activity represents an enormous advance in scientists' ability to study physical activity and to produce findings well regarded by the scientific community.

Pate noted that physical activity is communicated in the literature in various ways. Sometimes it is expressed as a selected intensity of activity per unit time, such as moderate- to vigorous-intensity physical activity (MVPA) minutes per day. Sometimes it is expressed in terms of overall dose—for example, metabolic equivalent of task (MET)-minutes, a metric based on resting energy expenditure multiplied by the intensity and duration of an activity.[6] Finally, physical activity sometimes is expressed in terms of compliance with a guideline (e.g., days/week).

Researchers have studied many different health outcomes associated with physical activity, including biomarkers (e.g., lipids, blood pressure, insulin, adiposity, fitness), disease morbidities and mortalities (e.g., cardiovascular disease, type 2 diabetes, obesity), and all-cause mortality. In Pate's opinion, the field achieved a new status when the large epidemiologic databases matured such that it became feasible to examine all-cause mortality as an outcome.

As to why physical activity exerts its influence on health, Pate remarked that while scientists certainly have much to learn about underlying mechanisms, they know that acute exercise produces a profound physiologic response. The energy expended by skeletal muscle tissue during acute exercise requires such a response, and support for that response engages essentially all bodily systems, particularly the neuroendocrine control and cardiorespiratory function systems. The average person can increase his or her metabolic rate during physical activity by 5 to 10 times his or her resting level, and athletes can increase their rates by 15 to 20 times their resting levels. Regular participation in physical activity (i.e., chronic exercise) produces a broad range of adaptations, including multiple effects on the muscle metabolic apparatus (e.g., the muscles get better at performing the activity), changes in cardiorespiratory function, changes in neuroendocrine control mechanisms, tissue adaptations to the increased activity (e.g., in connective tissue, bone, adipose tissue), and improved fitness.

[6] For example, a physical activity with a MET value of 5 is one that involves expending 5 times the energy expended at rest.

With respect to the mechanisms underlying the health effects of physical activity, insulin sensitivity is recognized as one such mechanism, especially with regular exercise, but also with acute bouts of exercise. Other known underlying mechanisms include lower visceral adiposity, improved immune function, increased blood volume and hemoglobin mass, and improved cardiac structure and function. Pate noted an ongoing effort to encourage the National Institutes of Health (NIH) to allocate more funding to research aimed at better understanding these and other yet to be confirmed or determined underlying mechanisms.

Looking at Physical Activity and Health Through Reductionist Versus Teleological Lenses

For Pate, there are two ways to look at the issue of physical activity and health. The first is to take a reductionist approach, that is, to examine in great detail specific changes that occur with increased physical activity. Another approach is to think teleologically about how human bodies evolved to be what they were when humans were physically active hunter-gatherers. If the human body evolved to support a lifestyle that humans are no longer living, Pate said, "it should not be that surprising things don't always go well." A teleological approach to examining the issue of physical activity and health would suggest that the adaptations produced by regular participation in physical activity reflect a "reversion to the norm, not some odd behavior pattern. . . . When we go back to living that way, good things happen."

KEYNOTE: DOES PHYSICAL ACTIVITY HAVE A ROLE IN REDUCING OBESITY?[7]

Media headlines such as that for *Time* magazine's August 17, 2009, cover story, "The Myth About Exercise," have been sending the message that exercise really is not doing that much for you, remarked keynote speaker James Hill. While one might think, Hill said, "That's the media . . . you can't really pay that much attention to that," the same message is being communicated in the peer-reviewed scientific literature. As an example, he pointed to a 2013 article published in the *International Journal of Epidemiology* titled "Physical Activity Does Not Influence Obesity Risk: Time to Clarify the Public Health Message" (Luke and Cooper, 2013). One of the arguments made to support that claim is that changes in physical activity happened long ago and that, as Hill said, "food is driving the

[7] This section summarizes information and opinions presented by keynote speaker James O. Hill, Ph.D., University of Colorado Denver.

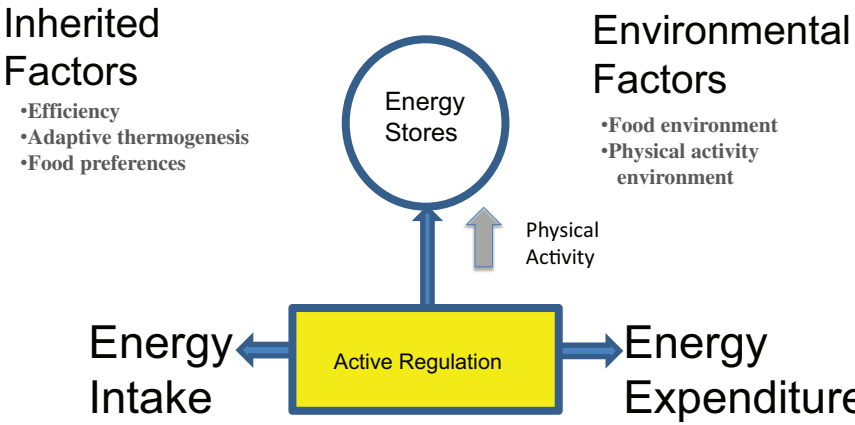


FIGURE 1-2 The energy balance system, with active regulation being a whole physiological system in and of itself.
SOURCE: Presented by James Hill on April 14, 2015.

bus right now." Another argument often made is that one can consume a 560-calorie burger in 3 minutes, but it takes 45 to 60 minutes, depending on the activity, to burn it off, so physical activity cannot be that important. Hill asked, "Are we still lacking evidence that physical activity is important in obesity?"

To answer that question, Hill went back to his "roots," that is, the science of energy balance. Anything that affects obesity must work through the energy balance system, he explained. That system is not as simple as calories in and calories out but is highly complex with interrelated parts, such that a change in any one factor changes the entire system. Moreover, an integral part of the system is active regulation, which is a whole physiological system in and of itself (see Figure 1-2). For the remainder of his presentation, Hill described what scientists do and do not know about how adding or subtracting physical activity impacts the energy balance system.

What Scientists Know About the Effects of Increasing Physical Activity

When physical activity is increased, whether an individual gains, maintains, or loses weight depends, Hill said, on compensation. Those who increase their level of physical activity may compensate in one of two ways: by being more sedentary at other times (i.e., when they are not exercising) than they were in the past or by consuming more calories. Most analyses of the effects of increased physical activity or exercise have failed to account for compensation, according to Hill.

Washburn and colleagues (2014) conducted a systematic review of the only approximately 30 studies in which researchers have considered whether participants were compensating for increased physical activity by being more sedentary at other times. They found strong evidence indicating that compensation did not occur in most cases. No reductions were seen in nonexercise physical activity or energy expenditure in response to prescribed physical activity or exercise training in 100 percent of cross-section studies (n = 4), 90 percent of short-term studies (n = 10), 50 percent of nonrandomized trials (n = 10), and 100 percent of randomized controlled trials (n = 7). "Certainly we need more data," Hill said. But the data that do exist strongly suggest that people who exercise do not compensate, at least not completely. For most people, the net impact of adding exercise is a total increase in energy expenditure.

With regard to whether people who exercise eat more, which is what the *Time* magazine article argues, Hill stated that a fair amount of data indicate, again, that most people do not completely compensate in this way. In a meta-analysis of studies on acute exercise and subsequent energy intake, Schubert and colleagues (2013) conclude that, despite variability across studies, strong evidence suggests that exercise is effective for producing a short-term energy deficit and that individuals tend not to compensate for all of the energy expended during exercise by eating more. In a study of overweight sedentary people who underwent a 12-week supervised exercise program in which food intake was not controlled, John Blundell and colleagues found that while some participants gained or maintained weight, most lost weight (King et al., 2008). In a follow-up study conducted to determine how those who gained and lost weight in the King et al. (2008) study differed, Blundell's group found that those who gained ate more, that is, increased their energy intake, while those who lost actually decreased their energy intake by a small amount.

In sum, the scientific literature indicates that when physical activity is added to a weight loss program, the majority of people do not compensate, at least not completely. The net result is that adding physical activity produces a negative energy balance. While results may vary among individuals, with some losing more weight and others less, Hill said, "There is no magic here. When you give people an exercise program, most people will lose weight." Moreover, regardless of weight loss, other studies have shown that increased physical activity or fitness (e.g., as measured by VO_2 max, which is the maximum rate of oxygen consumption as measured during incremental exercise) is associated with a lower percentage of stored body fat (e.g., Kriketos et al., 2000).

What Scientists Know About the Effects of Decreasing Physical Activity

Next, Hill considered what happens when people decrease their physical activity and whether doing so poses a risk for weight gain. He referred workshop participants to the energy balance science conducted in the mid- to late 1990s. In a calorimetry study on the effects of decreasing energy expenditure, for example, Stubbs and colleagues (2004) found that most people's energy intake did not change—that is, they did not compensate by decreasing their energy intake, leaving them with a positive energy balance. In Hill's opinion, a fair amount of evidence suggests that most people do not immediately decrease their energy intake when they decrease their physical activity, suggesting that decreased physical activity is likely an important risk factor for weight gain.

Active Regulation of Energy Balance

In Hill's opinion, the greater question is not how physical activity affects energy expenditure or intake but how it affects the active regulation of energy balance (see Figure 1-2). Regarding what is involved in the active regulation of energy balance, scientists have learned a great deal in recent decades about how brain circuitry regulates food intake, how physical activity can impact that circuitry, and how the neural regulatory system differs between active and inactive people (e.g., Spiegelman and Flier, 2001). In addition to its impact on the brain, physical activity affects muscle, such that large changes are seen in both the structure and function of skeletal muscles when physical activity is increased (Egan and Zierath, 2013).

An important concept underlying the active regulation of energy balance, Hill continued, is metabolic flexibility versus inflexibility (Kelley, 2005). Metabolic flexibility is the ability to switch efficiently among fuels. During fasting, someone with a flexible metabolism is able to quickly suppress glucose oxidation and increase fat oxidation. A metabolically inflexible person, in contrast, has a blunted preference for fat oxidation and is not as able to suppress glucose oxidation. During insulin-stimulated conditions, again, a metabolically flexible person is able to quickly suppress, in this case, fat oxidation and increase glucose oxidation. A metabolically inflexible person, in contrast, is less able to suppress fat oxidation and stimulate glucose oxidation. Findings from Audrey Bergouignan in Hill's lab have shown that metabolic flexibility is directly related to physical activity (Bergouignan et al., 2011).

Hill described metabolic flexibility as "the way your metabolism came out of the factory." When people stop moving, their metabolism loses its flexibility. Losing weight does not necessarily increase metabolic flexibility, Hill said, which he suspects is one reason why weight loss without physical

activity is difficult to maintain. "You get the weight off," he said, "but you don't increase the metabolic flexibility." Being metabolically inflexible does not necessarily mean that one is going to gain lost weight back, but it does increase the risk, depending on behavior and food intake patterns. People who are metabolically inflexible are more susceptible to storing rather than burning fat. "You have to be very vigilant with food intake," Hill said.

To help explain active regulation of energy balance, Hill referred to Jean Mayer's concept of a threshold of physical activity for optimal weight regulation (Mayer et al., 1956) (see Figure 1-3). Hill stressed that the threshold is a theoretical one, at least for now (Hill et al., 2012).

Above the threshold is what has been called the "regulated zone." For people who occupy the regulated zone, Hill explained, as physical activity increases, energy intake increases, but body weight remains the same. The implications of this relationship are at least twofold. First, when conducting studies on physical activity, it is important to consider whether participants occupy the regulated or unregulated zone. If one were to conduct a study

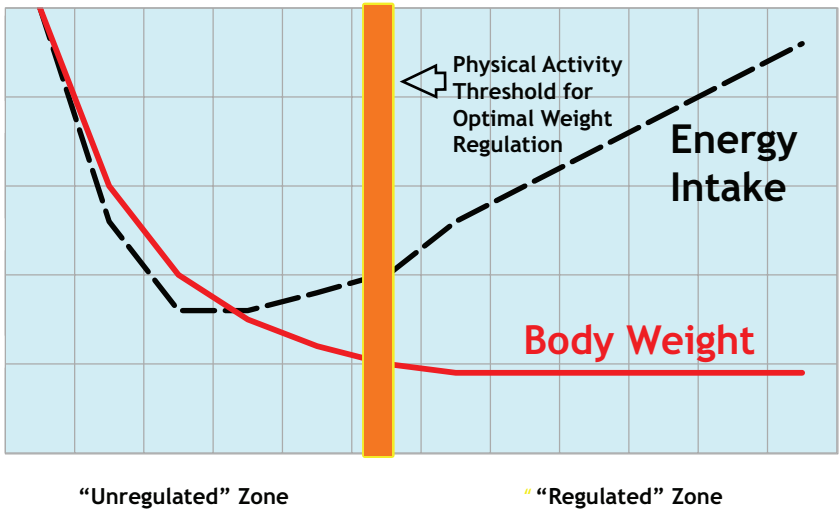


FIGURE 1-3 A theoretical graph illustrating the active regulation of energy balance. NOTE: The dashed line represents energy intake as a function of physical activity level; the solid line represents body weight as a function of physical activity level. SOURCE: Presented by James Hill on April 14, 2015 (modified and reprinted with permission from Mayer et al., *American Journal of Clinical Nutrition* [1956; 4:169-175]).

on people who occupy the regulated zone, one would observe a total compensation of energy intake with increased physical activity but no weight change. Second, the relationship suggests some feedback between physical activity and food intake, with people in the regulated zone being able to match intake with expenditure. Another way to think about this, Hill said, is that for people in the regulated zone, physical activity is driving the bus; food is just along for the ride. "I think this is the way our bodies work best," he said.

On the other hand, for people who occupy the unregulated zone, as physical activity decreases, food intake actually increases. In contrast with the regulated zone, the coupling of physical activity and food intake is not very tight. Hill opined that most of the world is probably in this zone, where food intake, not physical activity, is in fact driving the bus.

There is no question, Hill said, that physical activity levels have decreased over the past decades. Church and colleagues (2011) report that daily occupational caloric expenditure decreased by 120 calories per day between 1960 and 2010. "That is enough," Hill said, "to explain most of obesity." While trends in housework energy increased for men (from 1,013 kcal/week in 1965 to 2,034 in 2010), they decreased for women over roughly that same time period (from 4,653 to 2,806). Physical activity levels are still declining, Hill said, and rapidly so in some parts of the world, such as China. "Everything we know about the science of energy balance suggests that this trend is a risk factor for weight gain," he noted. According to Hill, every study conducted on highly palatable energy-dense diets combined with physical activity has shown less weight gain when physical activity was added to the diet compared with the diet alone. Even among people genetically susceptible to weight gain (with the fat mass- and obesity-associated *FTO* gene variants being among the strongest predictors of weight gain), adding physical activity can mitigate the effects of the genetic predisposition (Kilpeläinen et al., 2011).

Hill suspects that the decline in physical activity is the reason why most people today occupy the unregulated zone. In his opinion—which he admitted is based on theory, but supported by an increasing amount of data—the first step should be to get people into the regulated zone. It is not that physical activity alone is the answer; food intake, Hill agrees, is critically important. However, developing any single diet that will help people in the unregulated zone maintain their weight will be extremely difficult. And to enter the regulated zone, that is, to attain a healthy state in which they can regulate their energy balance, people need to exercise.

Regarding whether physical activity can help treat obesity, Hill remarked that John Jakicic would be exploring that question in detail during his presentation (see Chapter 4). Therefore, Hill mentioned only briefly some calorimetry work conducted in his lab showing that energy expendi-

ture decreases after weight loss because the body is smaller. If a 100 kilogram (220 pound) person were to lose 10 percent of his or her weight, or about 20 to 30 pounds, that person's energy requirements would decrease by roughly 170 to 250 calories per day. A 20 percent weight loss (i.e., 40 to 60 pounds) would reduce the person's energy requirements even further (i.e., by 325-480 calories/day). Work from Hill's lab and elsewhere suggests an association between filling the "energy gap" with physical activity and the likelihood of maintaining weight loss. An increase in energy expenditure is more sustainable than a reduction in energy intake. Reducing energy intake by 200 calories per day is not trivial, Hill said, because it is very difficult to counter biological hunger mechanisms.

Should People Be Told to Exercise?

In summary, good evidence suggests that for most people, exercise will lower body fat mass. In terms of output, many studies have shown that physical activity increases energy output, as well as the capacity for protein, carbohydrate, and particularly fat oxidation. In terms of input, there may be some compensation for increased physical activity, but it is not complete, at least not among people who occupy the unregulated zone. (People who occupy the regulated zone and who are able to match energy intake with energy expenditure are "pretty good compensators," Hill said, but they do not have a problem with excess body fat.) The bottom line, Hill concluded, is that everything known about the science of energy balance suggests that adding exercise has a positive effect on body fat mass.

Hill emphasized that physical activity and energy intake are two sides of the same coin. The best diet for an active, fit person is not the same as that for a sedentary, unfit person. Part of the problem in the obesity field, Hill said, is that dietary recommendations are aimed at sedentary, unfit people. During the Tour de France, for example, bicycle riders have been found to consume between 6,000 and 9,000 calories per day, 75 to 80 percent of which are carbohydrates, including 400 grams of simple sugars. Dietary recommendations for people burning calories the way those riders do are obviously different from those for most of the rest of the population. In Hill's opinion, "we have one hand tied behind our back if we are just looking at the intake." For the Tour de France riders, being as active as they are, what they eat does not matter. But that is true for only a small number of people, Hill said. Not many people are achieving energy balance at low fat mass through physical activity alone. Nor are very many people achieving energy balance at low fat mass through diet alone. Based on data from the National Weight Control Registry, only about 8 percent of the registry population is maintaining a reduced weight with diet alone. Most people, he said, are maintaining a reduced weight through a combination

of physical activity and diet, with greater levels of physical activity allowing for greater leniency with dietary intake.

What Is Missed by Focusing on Food Alone

Hill stressed that it is unlikely that obesity can be solved with food alone. The scientific evidence around energy balance strongly suggests that increasing physical activity prevents weight gain and that decreasing physical activity promotes it. More important, Hill reiterated the importance of physical activity in moving people from the unregulated to the regulated zone. Moreover, by focusing on food intake alone, many other benefits of physical activity are missed. Beyond helping to regulate weight, physical activity improves learning and cognitive function, cardiorespiratory fitness, and mental state (e.g., reduced depression), and it potentially leads as well to greater economic growth and stronger national security. In Hill's opinion, however, the real challenge is getting people to increase their physical activity. People come to his clinic who do not really want to change their diet and do not want to exercise. They need a pretty powerful "why," Hill said.

In conclusion, Hill highlighted four key points. First, studies of energy balance strongly suggest that changes in physical activity are directly related to changes in body weight in most people. Second, the greatest impact of physical activity may be in changing the active regulation of energy balance. Third, increasing physical activity should be an effective way to prevent and treat obesity. And fourth, the greatest challenge remains how to permanently increase people's physical activity. Hill's overarching conclusion was that the obesity epidemic cannot be reversed without increasing physical activity in the population.

DISPARITIES IN SOCIODEMOGRAPHIC DIMENSIONS OF PHYSICAL ACTIVITY[8]

Aviva Must began by suggesting that obesity in the United States was initially called an epidemic in the late 1990s because of its rapid and dramatic rise. Later, as it became apparent that obesity affected virtually all population subgroups, some called it a pandemic. Although the prevalence of obesity has increased in all groups, however, its distribution across subpopulations is not uniform. Like other health disparities, disparities in obesity and its determinants, notably physical activity, cut across social, demographic, environmental, and geographic groups, said Must. The bias,

[8] This section summarizes information and opinions presented by Aviva Must, Ph.D., Tufts University, Boston, Massachusetts.

discrimination, and stigma experienced by socially disadvantaged and marginalized groups often are reflected in poor health and occupation of the "unregulated" zone described by Hill (see the previous section). Said Must, "We need to think about equitable access to physical activity opportunities, and with appropriate adaptations, and to appreciate how these can contribute to all groups achieving the highest level of health possible."

Social disadvantage can limit physical activity in several ways, Must continued, the simplest being lack of access to the necessary material and time resources. The environment also matters; Must cited in particular the influence of stressful environments that induce depression on the uptake of physical activity. Additionally, racial discrimination and segregated neighborhoods create environments characterized by little investment in open space or facilities to promote physical activity. Finally, socially disadvantaged groups have reduced access to primary care and preventive services, so they may not receive information on physical activity's preventive health benefits.

Must identified and went on to explore several key dimensions of both obesity and disparities in physical activity: race/ethnicity; disability; immigration status; socioeconomic status; geography (in terms of both where in the United States one lives and urban versus rural residence); and, cutting across all of these, age and gender. Regarding age and gender, she noted that, based on data from the National Health and Nutrition Examination Survey (NHANES), trends in obesity prevalence across the life course are striking, showing a steep increase with increasing age until about age 60, when a moderate decline is seen. There are no large disparities in gender across age, however (Ogden et al., 2014). Must included disability in her examination of disparities in physical activity because of an increasing awareness that disability, apart from any underlying physical manifestation, is also a social experience. People with disabilities often are subject to the same social marginalization experienced by racial and ethnic minorities, along with its consequences (i.e., lack of resources, lack of power, and lower social standing).

Race/Ethnicity

Probably the most striking disparity in obesity prevalence by race/ethnicity, in Must's view, is the very high rate of obesity in African American women (Ogden et al., 2014). The prevalence of obesity is lower in children than in adults for all races/ethnicities, and for both children and adults, higher in blacks and Hispanics (compared with whites and Asians) and lowest in Asians (compared with whites, blacks, and Hispanics) (Ogden et al., 2014) (see Figure 1-4). Must noted that far less is known about other racial and ethnic groups and that although Hispanics encompass multiple

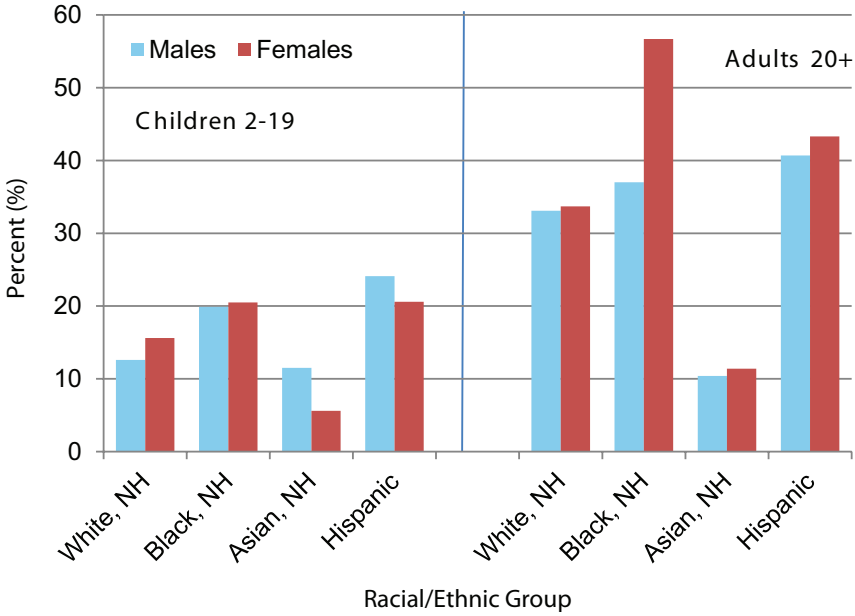


FIGURE 1-4 Prevalence of obesity by race/ethnicity and sex (National Health and Nutrition Examination Survey).
NOTE: NH = non-Hispanics.
SOURCE: Presented by Aviva Must on April 14, 2015 (Ogden et al., 2014).

groups, the most is known about Mexican Americans because they are the largest and most studied segment of the Hispanic population. Thus, data disparities exist as well.

With respect to physical activity, NHANES data, which include objective accelerometry measures of total activity minutes, indicate that MVPA in youth is similar for the three racial/ethnic groups considered (white, African American, Mexican American) (Belcher et al., 2010). Across all three groups, the data show a rapid and striking decline in activity in youth from 6-11 years to 12-15 years, and then again to 16-19 years (Belcher et al., 2010). Among youth, only males overall (all ages combined) and the youngest children (6-11 years) are meeting the recommendation of 60 minutes of MVPA per day.

Among adults, as with children, self-report data from the Behavioral Risk Factor Surveillance System (BRFSS) show very little racial/ethnic variation in physical activity, with low rates among all racial/ethnic groups. Based on 2013 BRFSS data, only about 20 to 25 percent of adults in most

racial/ethnic groups meet the U.S. national physical activity guidelines (i.e., those issued in the *Physical Activity Guidelines for Americans* [HHS, 2008]). In contrast, BRFSS data do show some variation in physical *inactivity* in adults across races/ethnicities, with blacks and Hispanics more likely to be physically inactive than whites and other subgroups. Must noted that estimates based on self-report data have more error than accelerometry-based data, but that no national survey accelerometry data exist with which to compare population subgroups of adults.

Epidemiologic data can be highly informative about physical activity levels by group, but they reveal very little about culturally determined attitudes toward physical activity and the extent to which those attitudes may be acting as either facilitators or barriers. According to Must, qualitative studies have shown that, while norms in some Asian cultures do not support strenuous activity for girls, in other Asian cultures physical activity is very much a part of daily life and is viewed as being important to maintaining one's overall balance. Other qualitative work has shown that African American women often put the needs of others (particularly family members) before their own and are not encouraged to take care of themselves, creating a cultural barrier to physical activity.

Disability

Data show higher rates of obesity in people with disabilities (greater than 35 percent) than in any racial/ethnic group, even African Americans (CDC, 2010). Likewise, self-report data from the National Survey of Children's Health show a higher prevalence of obesity among children who experience any of several different disabilities (hearing/vision disorder, learning disorder, developmental or physical disability, autism, attention-deficit/hyperactivity disorder [ADHD]) relative to children overall (Chen et al., 2010).

It is not surprising, Must offered, that given their unique needs, persons with mobility disabilities spend far fewer minutes in MVPA per day compared with people without disabilities, according to NHANES data (Loprinzi et al., 2014) (see Figure 1-5). Most remarkable for Must is the difference in the total amount of time spent engaged in MVPA: 28 minutes per day for people without disabilities and 12 minutes per day for people with mobility disabilities. "It is terrible for everybody," she said, "but much worse for people with mobility limitations."

In Must's opinion, meeting the unique physical activity needs of individuals with disabilities is clearly a priority given the high rates of obesity in this population. She noted that meeting those needs requires special equipment and special training.

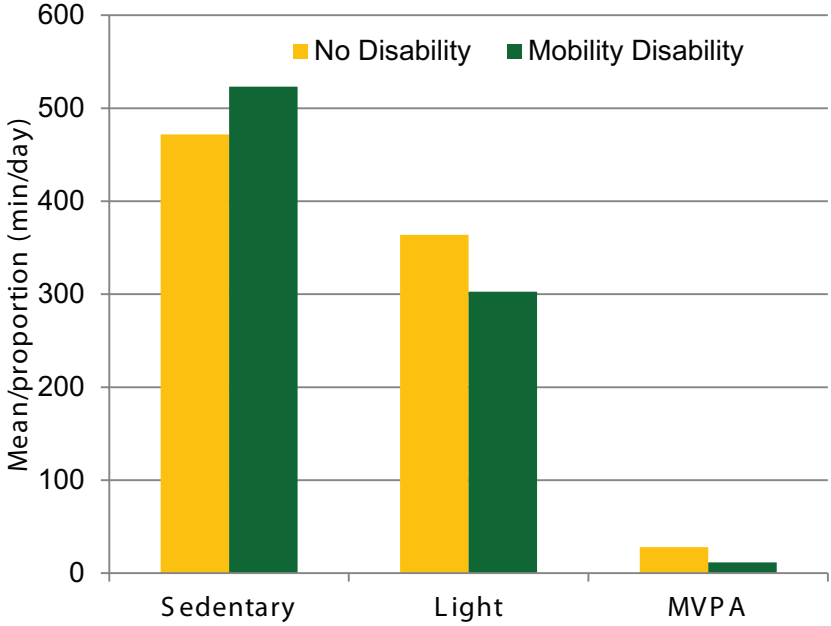


FIGURE 1-5 Time spent being sedentary, lightly active, and moderately to vigorously active for people with no disability compared with people with mobility disability.
NOTE: Mobility limitation status was self-reported; accelerometer-measured estimates of sedentary, light, and moderate- to vigorous-intensity physical activity (MVPA) were determined.
SOURCE: Presented by Aviva Must on April 14, 2015 (Loprinzi et al., 2014).

Immigration Status

National Health Interview Survey (NHIS) self-report data show rates of obesity increasing from 5-10 percent among people who have resided in the United States for less than 1 year to greater than 20 percent among those who have resided here for 15 years or more (Singh et al., 2011). This finding suggests to Must that immigrants arrive with better health behaviors than they acquire after they have arrived.

In contrast and somewhat surprising, in Must's opinion, are self-report data from the National Survey of Children and Health (NSCH) showing that regular physical activity in children aged 6-17 years is greater among those who are U.S.-born with either one immigrant parent or two U.S. parents, compared with both foreign-born and U.S.-born children with

two immigrant parents (Singh et al., 2008). The same is true of sports participation; that is, U.S.-born children with one immigrant parent or two U.S. parents are more likely to participate in sports compared with both foreign-born and U.S.-born children with two immigrant parents. These patterns may be explained by socioeconomic status, as described in the following section.

Socioeconomic Status

Disparities in obesity and physical activity based on socioeconomic status are complicated, Must said, especially with respect to income and by sex. Based on NHANES data, obesity rates in white women decline as income increases (Chang and Lauderdale, 2005). For other racial/ethnic groups, in contrast, specifically non-Hispanic blacks and Mexican Americans, the trend is more variable (e.g., rates of obesity remain approximately the same for Mexican American women, while they vary for non-Hispanic blacks by income level but remain high in all income groups). Among non-Hispanic white men, although rates of obesity decrease as income increases, the differences are not as striking as is the case for white women. In contrast, for non-Hispanic black and Mexican American men, rates of obesity *increase* as income increases.

The relationship between income and physical activity is a little more straightforward, Must observed. According to 2013 BRFSS data, the likelihood of an adult's meeting the national physical activity guidelines increases with income level. Must pointed out, however, that the percentage of adults meeting the guidelines is low across all income levels, with only 26 percent of people earning $75,000 or more meeting the nationally recommended levels of aerobic and muscle-strengthening physical activity.

Available income data do not reveal which aspect of financial resources drives income disparities in physical activity in adults. For example, are more affluent individuals more physically active because they are able to buy high-end bikes? Do they have more flexible work schedules that give them the time to engage in physical activity? Or are they privy to knowledge that makes health-related behaviors a priority?

Among children, recess policies have been shown to reflect some of the same income disparities; for example, access to school recess increases as income increases (Barros et al., 2009). School recess policies also vary by race/ethnicity, with white children having greater access than black and Hispanic children (Barros et al., 2009).

Geography

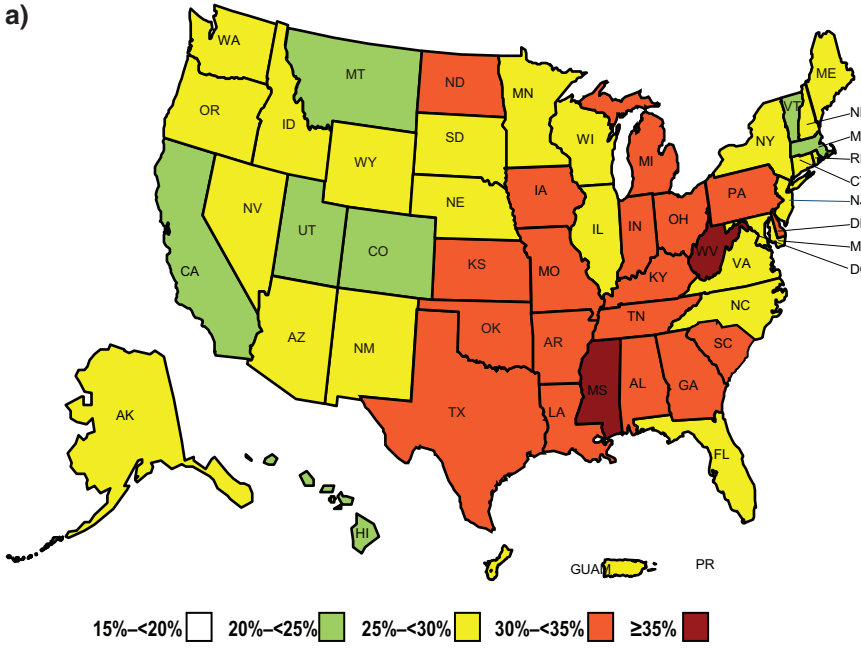
CDC's map of adults meeting national guidelines for aerobic and muscle-strengthening physical activity corresponds quite well with CDC's map of obesity prevalence, Must pointed out. Thus states that have the highest rates of obesity also have the lowest percentage of adults meeting the guidelines (see Figure 1-6).

In addition to being associated with geographic location, obesity rates have been associated with urbanization level, with NHIS data showing much higher prevalence in rural than in urban areas in the United States. Rural/urban differentials also are seen in physical inactivity levels: the prevalence of no leisure-time physical activity among adults is higher in rural than in urban areas, with the exception of a slight increase in physical inactivity among women in inner-city areas. Must suggested the need for better understanding of rural environments and the extent to which they may pose unique barriers to physical activity.

Although there has been little focus on rural versus urban living and its relationship to physical activity, Must observed that awareness of the impact of the built environment on physical activity is increasing. Many aspects of the built environment—such as sidewalks, accessibility of parks and recreation, bike lanes, and lighting at intersections—and their effects on physical activity have been studied. Must described one study of adults, by Gordon-Larsen and colleagues (2006), showing that the odds of engaging in five or more bouts of MVPA per week increased with the number of physical activity facilities per block (by 26 percent with seven facilities per block compared with one facility) and that the odds of being overweight decreased (by 32 percent with seven facilities compared with one facility). In Must's opinion, public health practitioners can form strategic alliances with other public sectors to affect the built environment in ways that improve physical activity patterns for all inhabitants.

FIGURE 1-6 Behavioral Risk Factor Surveillance System (BRFSS) self-report data showing (a) the prevalence of obesity across the United States, and (b) the percentage of adults meeting national physical activity guidelines.*
NOTE: * = engaging in at least 150 minutes/week of moderate aerobic physical activity or 75 minutes/week of vigorous aerobic physical activity and in muscle-strengthening activities on 2+ days/week.
SOURCE: Presented by Aviva Must on April 14, 2015 (Centers for Disease Control and Prevention).

a)



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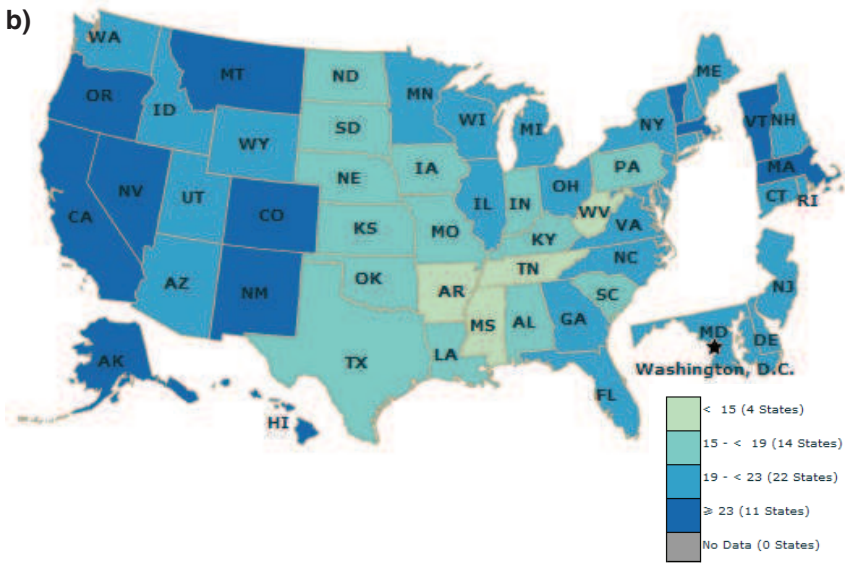

Achieving Physical Equity in Activity

"It is important that people become active," Must asserted. But the barriers that socially disadvantaged groups face in becoming physically active are much greater than those faced by more advantaged groups. For the disadvantaged, said Must, "Getting from the unregulated zone to the regulated zone will be a longer journey." She referred workshop participants to the series of commentaries on disparities in physical activity issued by the Roundtable on Obesity Solutions just prior to this workshop (Adeigbe and Ramirez, 2015; DiPietro, 2015; Rimmer, 2015; Taylor, 2015; Warne and Roanhorse, 2015; Whitaker and Gehris, 2015; see Appendix B).

PANEL DISCUSSION

To begin the panel discussion following Must's presentation, moderator Pate asked whether the "cut-off" point for physical activity between the regulated and unregulated zones, as described by Hill, is possibly or likely different for different demographic subgroups given some of the trends described by Must. Hill responded, "I would be surprised if it is actually the same." He reiterated that the threshold between the regulated and unregulated zones is theoretical. He suspects that, in actuality, it is different not only for different groups and subgroups but also among individuals within groups. Depending on genetics, some individuals may be able to occupy the regulated zone at lower levels of physical activity.

Pate asked Must whether anyone has combined or examined the interaction between the large datasets on overweight/obesity and physical activity. Must replied that some attempts have been made to examine the extent to which physical activity at the population level predicts some of the changes being observed in obesity prevalence, but no close associations have been reported. In her opinion, the lack of a close association is not surprising given the many other forces at play. Yet based on the physiology, she believes the association exists. The challenge is demonstrating that association given the crude measures and study designs available. "It's always dangerous to draw firm conclusions from null studies," Must cautioned. Hill agreed. If something makes sense physiologically, he said, null results mean "we still need to dive deeper."

Pate added that, so often, the paradigm applied in studying the relationship between physical activity and weight status focuses on weight loss. If one were to buy into a prevention paradigm, in contrast, then the null, or no change, would in fact be the goal. But studies designed to understand no change in weight have been rare, Pate said. Hill agreed that such studies would be powerful but cautioned, "Those are tough studies to do." They require a long period of time and large sample sizes. Plus, Hill said,

it is difficult to recruit participants to studies expecting no outcome. Must added that to some extent, those studies already exist in the natural experiments happening across the country as communities establish more physical activity–friendly policies and the prevalence of obesity decreases as a result.

To close the session, Pate asked the presenters whether they wished to communicate anything further to the workshop audience. Hill said that one of the things he thinks about a great deal with respect to physical activity is why? Why is anybody going to want to change his or her level of physical activity? People like their fast food, their big-screen televisions, and their automobiles. Yes, they would like to be fitter and leaner, but they are essentially choosing not to become fitter and leaner. He said, "We really need to know, what is the powerful 'why?'"

Must called for a greater understanding of what she referred to as the physical activity version of making the healthy or natural choice. She wondered what could be learned from cultures in which physical activity is valued as something that keeps human beings "in balance."

2

Physical Activity and Primary Prevention of Obesity in Youth

OVERVIEW

In a session moderated by Howell Wechsler, Kathleen Janz and Shari Barkin explored the current state of the science regarding the impact of physical activity on the prevention and treatment of obesity in youth. This chapter summarizes their presentations and the discussion that followed.

Researchers involved with the Iowa Bone Development Study, a 16-year longitudinal study, found that children and adolescents who are more moderately to vigorously active have lower adiposity. Janz, who was involved in that study, identified it as one of several observational studies on the association between physical activity and adiposity in youth. Other prospective studies, but not all, have likewise shown high levels of adiposity associated with low levels of physical activity. The relationship between adiposity and physical activity, Janz continued, is bidirectional, with other evidence indicating that adiposity leads to less moderate- to vigorous-intensity activity (MVPA). The good news, Janz opined, is that some families are doing it right—their children are maintaining healthy levels of activity and adiposity throughout childhood. She encouraged learning from them and underscored the importance of starting early, before children begin school.

Focusing on these youngest children, Barkin and her research team found that preschoolers average more than 100 minutes per day of MVPA, but they get that activity in spurts and sporadically over a period of up to 11 hours. These findings suggest to Barkin that providing "structured" time to play does not capitalize on normal preschool child development. She stressed the importance of aligning policies with childrens' natural

movement patterns. She then went on to describe promising results from three intervention trials on physical activity in preschool and kindergarten school settings regarding the sustainability of the beneficial effects of physical activity interventions. Shifting her focus from the school setting to the community at large, Barkin highlighted the importance of teaching families—not just children but also adults—how to use nearby parks and recreation facilities and other physical activity–promoting features of their built environment. Merely having features of the built environment that are supportive of physical activity is necessary but not sufficient; families must understand how to use these facilities to promote and sustain family health behaviors.

EVERYDAY PHYSICAL ACTIVITY AND ITS ROLE IN PREVENTING OBESITY[1]

Value of Observational Studies for Understanding Physical Activity and Adiposity

The two most common study designs used to study healthy children, Kathleen Janz began, are cross-sectional and prospective longitudinal designs. Cross-sectional studies measure the explanatory variable (i.e., physical activity) and the outcome (i.e., adiposity) at the same time. In contrast, prospective longitudinal studies measure the explanatory and outcome variables on two or more occasions. Think of cross-sectional studies as "snapshots," Janz suggested, and longitudinal studies as "feature films." While prospective longitudinal studies do not necessarily prove cause and effect, they do support inferences about cause and effect. They also complement randomized controlled trials by providing information on real-world or everyday physical activity dimensions (e.g., frequency, intensity, duration), domains (e.g., active transport, leisure activity), and patterns in relationship to adiposity.

Importantly, in Janz's opinion, both types of studies provide unique information about real-world associations, with implications for both the prescription of individual-level exercise strategies to prevent obesity (i.e., with respect to dose–response) and population-level public health guidelines (i.e., with respect to practicality as well as dose–response).

[1] This section summarizes information and opinions presented by Kathleen F. Janz, Ed.D., University of Iowa, Iowa City.

Physical Activity as an Explanatory Variable for Adiposity

Among the many studies conducted over the past few decades on the association between high levels of physical activity and low levels of adiposity, Janz focused first on the Iowa Bone Development Study, a 16-year follow-up study with which she has been involved since its inception. She and her colleagues have been following 500 children who were 5 years old at the start of the study, in 1998, having conducted eight clinical exams of each child as of the time of this workshop.

This was one of the first studies able to afford, with funding from the National Institutes of Health (NIH), an accelerometer with which to measure physical activity objectively. Additionally, Janz and her team have been using physical activity questionnaires to collect self-report data on participation in organized sports, sports lessons, television viewing, and videogame playing.

With respect to adiposity measures, Janz's team has been using dual-energy X-ray absorptiometry (DXA) to sort the body into three components—lean tissue, fat tissue, and bone tissue—and measure the amount of each. Today, the technology has advanced to the point where it is also possible to measure visceral adipose tissue. One of the useful features of DXA technology, suggested Janz, is that the scanner is backward compatible, so that her research team has been able to rerun old DXA scans and distinguish between visceral and subcutaneous adipose tissue.

To provide the workshop audience with a sense of how adiposity changes in children as they age, Janz showed DXA images of two Iowa Bone Development Study participants, a girl and a boy, over a 10-year time span (see Figure 2-1). The girl entered the study at the age of 4 years and at a weight of 13.4 kg with 3 kg fat, so 23.1 percent body fat. That is normal, Janz said, for a young child. As the girl aged, both her weight and adiposity increased, but her percent body fat stayed approximately the same. At the end of 10 years, she had what Janz considered a healthy level of adiposity. The boy was 5 years old when he entered the study, and he had a healthy level of adiposity for a boy of his age. Between the ages of 5 and 9, however, something dramatic happened: his weight increased significantly, his percent adiposity increased threefold, and he became obese.

Today, about two-thirds of the Iowa Bone Development Study cohort have maintained a healthy level of adiposity as they have aged, like the girl in the top row of Figure 2-1. Regrettably, Janz said, 22 percent of the cohort were obese by the age of 19, defined as 32 percent body fat in females and 25 percent body fat in males. Another 12 percent of the cohort were already obese at the age of 5.

Something to keep in mind when conducting longitudinal research with children, in Janz's opinion, is that the timing and tempo of growth

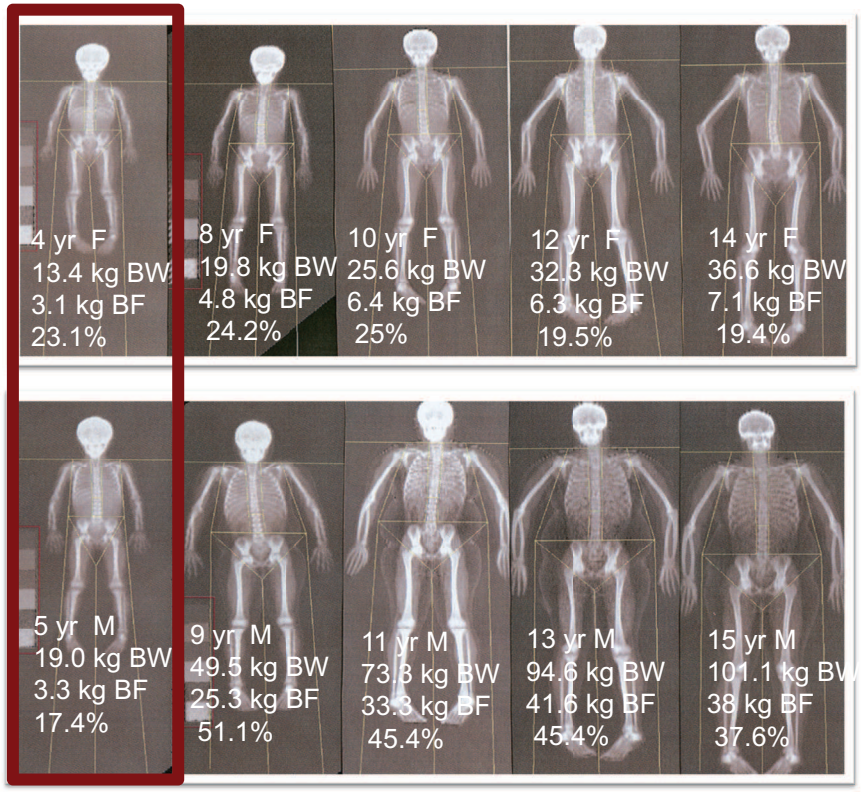

FIGURE 2-1 Dual-energy X-ray absorptiometry (DXA) images of two Iowa Bone Development Study participants, a girl (top row) and boy (bottom row), over a 10-year time span.
NOTE: % = percent body fat; BF = body fat; BW = body weight; F = female; kg = kilogram; M = male; yr = year.
SOURCE: Presented by Kathleen Janz on April 14, 2015.

and development are variable among individuals. Twelve-year-old girls, for example, can look very different from one another with respect to not only body height and weight but also maturation. Janz cautioned that when one is evaluating the epidemiological literature on physical activity and adiposity, it is important to look carefully to ensure that variation in timing and tempo is being represented.

Because the Iowa Bone Development Study data were collected on the same children across time, the investigators have been able to control for individual variation in both timing and tempo, making this a very powerful

study, in Janz's opinion. They controlled for individual variation by using a multilevel regression analysis that involved first building an individualized growth curve for each child explaining adiposity changes over time, and then predicting total and visceral adiposity from measures of MVPA and sedentary time (i.e., obtained through accelerometry) and self-reported television (TV) viewing time.

The researchers found that total sedentary time does not matter in predicting adiposity, but TV viewing time (a subset of sedentary time) does matter, as does MVPA. More specifically, Janz explained, when her team examined the MVPA of a typical 11-year-old, that is, an 11-year-old average in terms of height, maturity, sedentary time, TV viewing, and every other measured variable (except MVPA), they found a 7.5 percent difference in adiposity between girls with high and low levels of MVPA, and a 5 percent difference in boys. When they conducted the same analysis but averaging all variables except, in this case, TV viewing time, they found a 5 percent difference in adiposity between girls who watched a great deal of TV and girls who watched the least amount of TV, and a 9.3 percent different in boys. Averaging all variables except both MVPA and TV viewing time yielded an 11.8 percent difference in adiposity between girls with low activity levels and high TV viewing time and girls with high activity levels and low TV viewing time, and a 21.3 percent difference in boys.

Other research groups also have been examining the association between physical activity and adiposity. In a 2013 review of studies that have used accelerometers to measure physical activity, Pate and colleagues (2013) identified seven prospective studies on the association between physical activity and adiposity, six of which found negative associations (i.e., that high levels of adiposity were associated with low levels of physical activity and vice versa), and one found no association. Of the seven studies, however, only two used criterion (i.e., DXA) adiposity measures. This is problematic, Janz said, because relying on body mass index (BMI) (instead of using DXA) can hinder precise interpretation of the data, given that boys and girls with the same BMI, even at the same age, can have different amounts of fat tissue. Additionally, Pate and colleagues (2013) identified four prospective studies on the association between sedentary time and adiposity, only one of which found a positive association (i.e., high levels of sedentary time associated with high levels of adiposity); the other three found no association. Again, however, only one of the four studies used a criterion (i.e., DXA) measure of adiposity.

In a similar review, Ekelund and colleagues (2014) identified nine longitudinal studies on the association between sedentary time and adiposity. All used accelerometers to measure sedentary time. Of the nine studies, eight showed no association, and one showed an association but only at higher levels of adiposity. Additionally, the reviewers identified eight longitudinal

studies on the association between TV viewing time and adiposity. All relied on self-reported TV viewing time, but only one used a criterion (i.e., DXA) measure of adiposity. Of the eight, five showed a positive association, and three showed no association. Janz interpreted these results to mean that in general, sedentary time does not appear to be associated with adiposity, but a subset of sedentary time—probably TV viewing time—does appear to matter. Janz cautioned, though, that some of the findings related to TV viewing time could be a reflection of researchers having measured this component of sedentary time more than others.

Using a cross-sectional study design, Katzmarzyk and colleagues (2015) examined physical activity, sedentary time, and obesity in more than 6,000 children aged 9 to 11 years at 12 sites worldwide. The children wore accelerometers, and World Health Organization (WHO) BMI standards were used to determine obesity. The researchers found that across all 12 sites, all with very different economic statuses, according to Janz, the best predictor of lower obesity was MVPA, as opposed to either vigorous-intensity physical activity or sedentary behavior. Specifically, 55 minutes per day of MVPA was the best predictor of lower obesity. These results support what has been observed longitudinally, Janz remarked.

Adiposity as an Explanatory Variable for Physical Activity

In addition to examining whether physical activity predicts adiposity, Janz has been curious about whether adiposity predicts physical activity. A bidirectional relationship, should it exist, may represent a positive feedback loop, she said. In the first such study of which she is aware that used accelerometers to measure physical activity, Metcalf and colleagues (2011) showed that MVPA at age 7 did not predict change in body fat between the ages of 7 and 10, but percent body fat at age 7 predicted decreases in MVPA between the ages of 7 and 10. Specifically, a 10 percent increase in adiposity at age 7 was associated with 4 fewer minutes per day of MVPA at age 10. Subsequently, three additional studies using accelerometers yielded the same conclusion—that adiposity is a good predictor of decreases in physical activity (Hjorth et al., 2014; Kwon et al., 2011; Richmond et al., 2014).

Developmental Trajectories for Physical Activity and Adiposity

Data from the Iowa Bone Development Study show that across time and for both boys and girls, MVPA decreases, although less so for boys. Using latent class group cluster modeling, Janz and colleagues found that children who were consistently active over time (i.e., engaged in 45 minutes per day of MVPA) were 60 percent less likely to end up obese at the age of 19 than children whose level of MVPA decreased as they aged. Specifi-

cally, 9 percent of children who were consistently active became obese by the age of 19, compared with 24 percent of children whose level of MVPA decreased (from an initial medium level) over time (Kwon et al., 2015).

Implications for Public Policy

In summary, both MVPA and TV viewing predict adiposity; sedentary time is not as important. These findings, Janz said, support the current national guidelines emphasizing 60 minutes per day of MVPA and 2 hours or less of TV viewing.

That adiposity predicts future MVPA implies, in Janz's opinion, that intervening at the age of 5 years may be too late for some children. She called for more work in preschool children and possibly prenatally, and she encouraged a greater understanding of the possibility of healthy metabolic profiles in overweight and obese children. Finally, because longitudinal studies are enabling researchers to understand the development of obesogenic behavior in youth, including that some children maintain healthy levels of activity and adiposity through childhood to adulthood, Janz encouraged learning from those families who are "doing it right."

PHYSICAL ACTIVITY AND PEDIATRIC OBESITY PREVENTION: PUTTING SCIENCE TO WORK[2]

The preschool period of growth is unique, Shari Barkin began. While most preschoolers look chubby at the age of 2 or 3, she said, no one would call their chubby centers "visceral adiposity"—"we would just call it being a preschooler." Typically, between the ages of 3 and 7, children sprout in height without incurring the same change in weight. This phenomenon is known as "salutatory growth," with the timing and tempo differing among individuals and impossible to predict. During this period, growth in BMI is typically nonlinear, with a dip in BMI occurring during the salutatory growth years (see Figure 2-2). After age 6 or 7, BMI increases linearly.

Barkin emphasized the importance of understanding nonlinear growth in young children when evaluating intervention studies. For example, suppose that a child who entered a study at age 3 had a BMI greater than 18, which would be considered obese, and when measured again at 4 years, after an intervention, still had a BMI of 18. Without understanding the nonlinear growth that is typical of preschoolers, one might conclude that the intervention had worked. But that is just normal growth, said Barkin.

Not only is normal preschool growth nonlinear, but it also has a wide

[2] This section summarizes information and opinions presented by Shari Barkin, M.D., M.S.H.S., Vanderbilt University School of Medicine, Nashville, Tennessee.

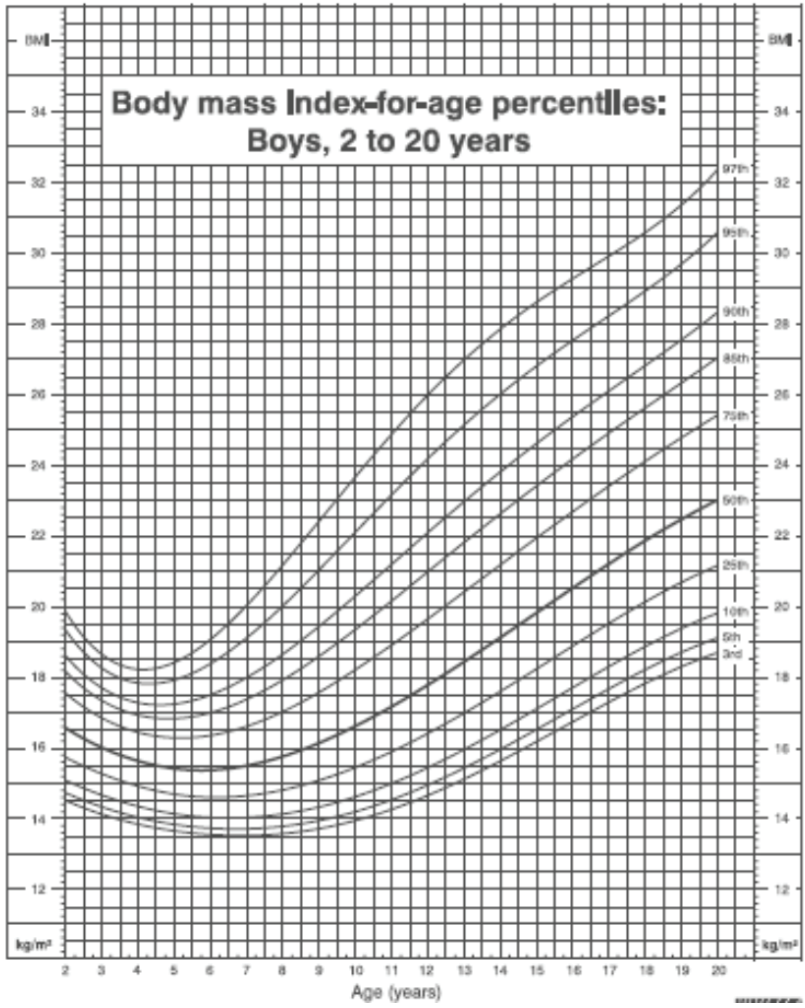

FIGURE 2-2 Changes in body mass index over time for boys ages 2 to 20 years. SOURCE: Presented by Shari Barkin on April 14, 2015 (Centers for Disease Control and Prevention).

range. All of Figure 2-2 between the 5th and 85th percentiles is considered normal, Barkin pointed out. BMIs between the 85th and 95th percentile are considered overweight, and BMIs equal to or greater than the 95th percentile are considered obese.

What Does Physical Activity Look Like in Preschoolers?

"While we may be a chair-loving society, our preschoolers are not," Barkin said. In fact, preschoolers often need to be forced to sit down. They are meant to move, they move all the time, and how they move is unique. In a study of physical activity in preschoolers, Barkin and her research team placed accelerometers on 50 children aged 3 to 5 years for 7 days (Ruiz et al., 2013). Accelerometers, she explained, pick up muscle movement every second, and validated preschooler threshold values were used to derive time spent in sedentary and light-, moderate-, and vigorous-intensity physical activity (Pate et al., 2006). All of the children were from underserved communities, and 51 percent were African American. By design, none of the children were obese, but 26 percent were overweight and the remaining 74 percent of normal weight. The children wore the accelerometers like princess or superhero belts, Barkin said. They wore them for almost 24 hours per day (an average of 23.4 hours per day) for the entire 7 days. That the children wore the accelerometers for nearly 24 hours per day, compared with the usual minimum wear time of 6 hours, allowed the researchers to asses not only whether the preschoolers were achieving the recommended 60 minutes of daily MVPA but also what that activity looked like.

The researchers found that the children spent 14.5 percent of their awake time in MVPA, averaging more than 100 minutes per day, which Barkin said was not surprising. The surprising finding, she said, was that it took the children 11 hours to accumulate that much MVPA. Unlike adults, she remarked, children do not go to the gym and work out for 30 to 60 minutes; they are active throughout the majority of their day (see Figure 2-3).

Regarding what the preschoolers' physical activity looked like, Barkin and her team identified four patterns. The first they called an "isolated spurt"—defined as a single spurt of MVPA that lasts less than 1 minute and is followed and preceded by periods of quiescence. Running to a parent is an example of an isolated spurt. The second type they called "isolated sustained activity"—defined as a period of MVPA that is both preceded and followed by a period of quiescence and that lasts for more than 1 minute. Running after a dog until one gets tired and stops is an example of an isolated sustained activity. The third pattern is what Barkin and her colleagues called a "cluster spurt"—defined as a brief burst of MVPA that lasts less than 1 minute, followed by a rest that lasts less than 1 minute, followed by another burst of activity that lasts less than 1 minute. An example is playing the game red light, green light. The last type of physical activity observed by Barkin and her team was what they called "clustered sustained activity"—defined as a sedentary period followed by MVPA lasting longer

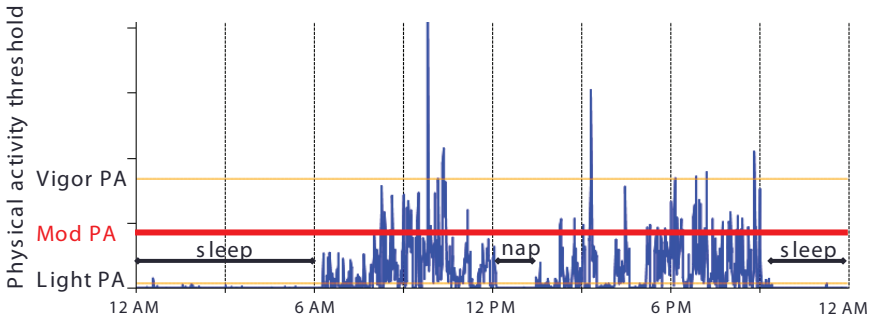

FIGURE 2-3 Sample 24-hour activity recording of preschoolers from accelerometry readings.
NOTE: PA = physical activity.
SOURCE: Presented by Shari Barkin on April 14, 2015 (Ruiz, R. M., D. Tracy, E. C. Sommer, and S. L. Barkin. A novel approach to characterize physical activity patterns in preschool-aged children. *Obesity* 21[11]:2197-2203. Copyright © 2013 John Wiley & Sons Ltd.).

than 1 minute, then a brief period of rest of less than 1 minute, and then another longer period of activity. An example is playing a chasing game, such as tag or kick the can.

Again, it took the preschoolers about 11 hours to accumulate their more than 100 minutes per day of MVPA. With respect to the different types of physical activity observed, both girls and boys participated in all types. Girls were active in isolated spurts more often than boys were (isolated spurts accounted for 16.9 percent of girls' MVPA, compared with 13.8 percent for boys, $p = 0.01$), and boys engaged in more clustered sustained activity than girls did (clustered sustained activity accounted for 23.6 percent of boys' MVPA, compared with 17.1 percent for girls, $p = 0.01$). The difference between girls and boys was not in *whether* they were physically active, Barkin said; both sexes achieved the recommended 60 minutes of daily MVPA. The difference was in *how* they achieved that activity. In terms of daily events, both boys and girls achieved their MVPA largely through isolated spurts, which averaged one-third of a minute, and clustered spurts, which averaged 3 minutes.

For Barkin, these findings suggest that providing structured time to play does not capitalize on preschoolers' normal development, which entails moving in spurts and sporadically. This conclusion is important, Barkin said, and should shape preschool physical activity programs and policies.

Intervention Trials in the Classroom Setting

Barkin highlighted three intervention studies conducted in the school setting. The first, by Nyberg and colleagues (2015), examined the effectiveness of a universal parental support program in promoting healthy dietary and physical activity in 14 preschool classrooms in Sweden. Most participants (80 percent) were of normal weight, with a total of 243 children participating. The 14 classrooms were randomized into intervention and control groups, with the intervention classrooms receiving health information for parents and 10 teacher-led classroom activities—both didactic and physical—for 6-year-old children. At the end of the 6-month trial, the researchers found no significant effect of the intervention on either physical activity or BMI.

In another classroom-based physical activity intervention study, this involving kindergarteners and first-graders in two urban schools in New York, Reznik and colleagues (2015) tested the effects of an intervention in which an audio CD consisting of 10-minute aerobic activities (led by the teachers) was used three times per day. At the beginning of the study, 58 percent of the children were of normal weight, with a total of 988 children participating. At the end of the 8-week study, pedometer measures revealed that the intervention children had taken 300 more steps per day, on average, compared with the controls, and that the intervention had been equally effective across sex, grade, and BMI subgroups.

Barkin suggested, however, that 8 weeks is a short period of time. In a longer study involving 342 Arab-Israeli kindergarteners aged 4 to 6 years, 71 percent of whom were of normal weight, Nemet and colleagues (2011) tested the effects of training teachers to incorporate both nutrition and physical activity into the existing curriculum. The physical activity program was conducted 45 minutes per day, divided into three 15-minute sessions, six times per week. Eighty percent of the physical activity involved running games and 20 percent endurance activities. Barkin noted that the segmented nature of the physical activity sessions was consistent with what she and others have learned about how preschoolers move. The researchers found, at the end of the school year, a significant difference in reduction in BMI percentile in the intervention group compared with the control group. They also observed a significant difference in change in fitness levels, based on a shuttle run lap test: fitness increased in the intervention group (11.6 more shuttle run laps at the end of the year than at the beginning), compared with a decrease in fitness in the control group (10.2 fewer shuttle run laps).

In Barkin's opinion, more important than the significant difference observed in changes in BMI percentile and fitness between the intervention and control groups was what Nemet and colleagues found when they reevaluated the preschoolers 1 year later to see whether the effects of the

intervention had been sustained (Nemet et al., 2013). The effect on fitness had indeed been sustained, with fitness in the intervention group having actually increased slightly; moreover, the changes in BMI percentile had also been sustained.

Interventions in the Community Setting

When Barkin arrived in Nashville, in 2006, the city's then mayor, Bill Purcell, had helped the city double the number of parks and recreation centers, many of them in dense urban areas where residents previously had lacked access to a built environment supportive of physical activity. Barkin and colleagues wanted to take advantage of this "natural experiment" by examining how people were using the newly built parks and recreation centers for physical activity and how use of these facilities could be promoted for routine physical activity in early childhood.

With funding from the state of Tennessee and the Vanderbilt Institute of Clinical and Translational Research, the *Salud con la Familia* (Health with the Family) study examined a family-based, community-centered intervention designed to prevent and treat obesity in Latino parent–schoolchild pairs. Barkin and colleagues enrolled 106 Latino families with preschool-age children in a 12-week session on dyadic skill building. The researchers determined that almost all participating parents knew they should be physically active, should not be feeding their children high-fat, high-sugar foods, and so on. In other words, they did not need knowledge; they needed skills. Finding a way to feed one's children with only $10 in one's pocket is a skill, Barkin explained, as is using a recreation center in the community. The goal of the intervention was to improve outcomes not only in children but also in participating parents. The focus in the control group was on promoting school readiness, with control group participants being provided a library tour and membership. Intervention group participants received a tour of and membership in a recreation center as 1 of 12 skill-building sessions.

At the start of the study (Barkin et al., 2012), 41 percent of children were already overweight or obese. Based on accelerometry measurements—surprisingly, in Barkin's opinion—70 percent of awake time (when they were wearing accelerometers) for the preschool-age children, who, she said, "are built to move," was sedentary (Ruiz et al., 2011). Parents had a mean BMI of 30 and a mean waist circumference of 100 cm, the latter indicating visceral adiposity, and 80 percent of their awake wear time was sedentary behavior.

The 12-week intervention made a big difference, Barkin said. By the end of the study and compared with children in the control group, children in the intervention group were twice as likely to have changed their weight category from obese to overweight or from overweight to normal

weight (Barkin et al., 2012). In fact, children in the control group actually increased their BMI over time.

Barkin emphasized that it was not just the children but their parents as well who were using their new built environment for physical activity. She and her research team found that when families were taught how to use their built environment for physical activity, that skill was sustainable: parents from the intervention group were still visiting their community recreation center with their child 1 year later (Barkin and Poe, 2012).

In other formative research work, Barkin and colleagues found that the reason many Nashville parents were not sending their children outside to play was not just because of crime, traffic, or any of a number of other seemingly likely factors, but also because of stray dogs.

Conclusions

Barkin's conclusions were fourfold. First, physical activity patterns are spurt-like and sporadic in preschool children. Programs and policies should consider how to align with this developmental stage to reinforce early MVPA patterns. Second, families with young children benefit from being taught the skills needed to use the existing built environment to support regular physical activity. "You don't just build it and they come," Barkin said. "You build it and then you teach them how to use it and then they will come." Third, the use of the existing built environment for regular physical activity is influenced by perception. Even if there are no stray dogs outside, parents who perceive that stray dogs are a problem will not send their children outside to play. Finally, children's routine physical activity is influenced by the activity of their parents. "Don't think about this as one child at a time," Barkin said. "Think of this as one family at a time."

PANEL DISCUSSION

Following Shari Barkin's presentation, Barkin and Janz participated in a panel discussion with the audience. To begin the discussion, Howell Wechsler asked both speakers to identify one public policy change inspired by their research conclusions that they think could have the greatest impact on increasing physical activity in children. Barkin stressed the importance of starting early, given that physical activity patterns are established early. "You don't want to wait until children are school aged," she said. Additionally, she stressed the importance of aligning programs and policies with normal development rather than, for example, imposing 30 minutes of structured play. Janz said she would like to see a rediscovery of outdoor education and exploration.

The Role of Light as Opposed to MVPA

An audience member commented on how much of the research described by Janz and Barkin focused on MVPA versus sedentary behavior. She asked about the role of light activity, which in her opinion is what is displaced by sitting, and whether either speaker had explored "that very gray area."

In Janz's opinion, at least in children and based on her research team's data, MVPA matters more than light activity with respect to reducing adiposity and affecting other metabolic outcomes. "We need to see real movement," she said. She is unsure whether the same is true of adults.

Barkin observed that the science has focused on MVPA, and much less is known about the health benefits of shifting from sedentary behavior to light physical activity. Based on her observations both in the clinic and in parks and recreation facilities, in her opinion, the latter shift is more achievable than increasing MVPA for many families. "The question is," she said, "will it make a difference in terms of health?" That question has not been answered in the literature, either because the impacts of light activity on metabolic health outcomes have as yet not been fully explored, perhaps because of a publication bias, or because there simply is less interest in examining this question.

Pate agreed that this is an important and interesting question. He observed that the issue of physical activity and obesity is often approached from what he described as an algebraic standpoint—that is, energy in plus energy out—yet in their presentations, both Janz and Barkin had emphasized the importance of MVPA. If MVPA is particularly important in the prevention of excessive weight gain and obesity, he asked, is that because of its higher rate of energy expenditure? Or does it have a unique impact on the regulation of weight status?

Janz replied that, again based on her data with children, even at the same level of energy expenditure, MVPA appears to be more important than light activity. She suspects that this form of activity has a unique regulatory effect.

Barkin added that MVPA at a young age sets up many systems with long-term effects. For example, it helps establish bone density and muscle mass and, depending on how one interprets the literature, metabolism as well. She said, "There is no doubt that MVPA has really important effects for health, not just short term, but long term too." Those effects do not mean that light physical activity does not have a benefit as well. "We just haven't yet answered that question," Barkin said. On a practical level, however, especially given that 40 percent of preschoolers in some communities are already overweight or obese, getting sedentary people to engage in routine MVPA is, she said, "not going to happen like a light switch." In

her opinion, moving people in the right direction along that gradient (i.e., from sedentary to light activity initially, then to increasingly more vigorous-intensity physical activity) has benefits regardless of whether those benefits are reflected in the measure of BMI.

Community Interventions

An audience member commented on the association between density of physical activity opportunities in a community and decreased obesity and the importance of educating families about physical activity opportunities. He asked, first, whether a reasonable policy direction would be to increase the density of physical activity opportunities in areas where there is a low density of such opportunities and, second, whether teaching families how to use available facilities could help move them in the right direction along the physical activity gradient.

In response to the first of these questions, Barkin suggested that policies should focus on after-school programs that involve family-based use of parks and recreation facilities. In response to the second question, Barkin said, "Absolutely. It is not really about education. It is about skills." She and her research team, as part of Salud America!, found it took only one time getting a family through the door of a recreation center and teaching them what they needed to wear, which classes their children could attend, and other practical information to get that family to become regular users. She reiterated, "Just building it is not enough. Teaching people how to use these environments is critical."

Physical Activity During Pregnancy

A question was asked about evidence on whether physical activity during pregnancy affects developmental programming in offspring such that some children may actually become addicted to physical activity. Barkin replied that many different areas of science have begun to explore the effects of physical activity during pregnancy. For example, what is the appropriate amount of physical activity during pregnancy, and when should pregnant women exercise (first, second, and/or third trimester)? Timing and intensity are really important questions, Barkin said, with no clear answers. She mentioned interesting work being done in epigenetics research with respect to how food and the physical environment are impacting placental and fetal function and whether and how fetal function can predict later adiposity (e.g., at the age of 3 years). At least in rodent models, evidence suggests that physical activity during pregnancy is a powerful mechanism for improving health in both mothers and offspring.

3

Physical Activity and Primary Prevention of Obesity in Adults

OVERVIEW

In a session moderated by Loretta DiPietro, Ulf Ekelund and Robert Ross discussed evidence on the impact of physical activity on the prevention of obesity in adults. This chapter summarizes their presentations and the discussion that followed.

Ekelund described evidence showing only a very weak association between physical activity and weight gain and other evidence suggesting that physical activity reduces the risk of obesity, but only in people with normal weight status at baseline. In contrast, Ekelund continued, yet other evidence indicates a strong relationship between physical activity and other health outcomes, including all-cause mortality. Increasing physical activity by simply adding 20 minutes of brisk walking per day has been shown to reduce the risk of mortality by 24 percent in people of normal weight and 16 percent in those who are obese. Ekelund called for a greater focus on promoting physical activity for health rather than for weight.

Ross differentiated between efficacy studies on the association between physical activity and weight gain and effectiveness studies on the association between encouragement to increase physical activity and weight gain. Those are two different questions, he said, and they require different study designs. Based on a review of evidence from randomized controlled efficacy trials, Ross concluded that unless individuals eat more, exercising under supervised conditions increases energy expenditure and leads to both weight loss and reduced waist circumference. Echoing keynote speaker James Hill's sentiment, he said, "I just don't think there is any ambiguity there. I think

the evidence from rigorously controlled studies is very clear." Turning to evidence from randomized controlled effectiveness trials, Ross said this evidence indicates that lifestyle interventions designed to prevent weight gain are generally effective, although it is unclear which component of the interventions—diet or exercise—is responsible. He suggested that treatment of obesity (e.g., sustained weight loss) may be too great a challenge and that a more desirable outcome may be prevention of weight gain.

PHYSICAL ACTIVITY AND PREVENTION OF WEIGHT GAIN AND OBESITY IN ADULTS[1]

Cross-sectional studies have revealed a strong inverse relationship between higher levels of physical activity and body weight and obesity, Ulf Ekelund began. Based on a systematic review of evidence from observational studies, however, Summerbell and colleagues (2009) concluded that overall, physical activity is not associated with subsequent excess weight gain and obesity. When studies do report associations, the associations are small and negative. To focus on the association between physical activity and body weight and obesity in more detail, Ekelund addressed five questions:

1. Do higher levels of physical activity prevent weight gain over time?
2. Do higher levels of physical activity prevent the development of obesity over time?
3. Does the association between activity and weight gain differ depending on baseline weight status?
4. Is change in activity associated with change in body weight?
5. Does weight status predict physical inactivity over time?

Does Physical Activity Prevent Weight Gain?

To measure the effect of physical activity on weight gain, epidemiologists measure physical activity at baseline, measure body weight at follow-up, and adjust for confounding factors, Ekelund explained. Confounding factors are associated with both the exposure (in this case, physical activity) and the outcome (in this case, body weight at follow-up) and include, for example, diet, alcohol consumption, socioeconomic status, age, and sex. Importantly, to study temporal associations, baseline body weight needs to be included in the model, in Ekelund's opinion, given that it is probably the most important predictor of follow-up body weight. He noted

[1] This section summarizes information and opinions presented by Ulf Ekelund, Ph.D., FACSM, University of Cambridge, United Kingdom.

that there has been some debate around whether baseline body weight is a confounding factor, with some experts considering adjustment for it to be overadjustment.

In a prospective cohort study on physical activity and abdominal adiposity and body weight gain among 288,498 men and women, Ekelund and colleagues (2011) followed individuals for 5 years. They assessed physical activity using a validated questionnaire and categorized individuals into four groups: inactive, moderately inactive, moderately active, and active. At follow-up, they measured weight and waist circumference. The researchers adjusted for a number of confounding factors, including baseline body weight or waist circumference, depending on the outcome being considered. They concluded that physical activity at baseline did not predict weight gain at follow-up, but it did predict waist circumference in both men and women. However, the magnitude of the association with waist circumference was minor, Ekelund said, with the difference in gain over 5 years between the inactive and moderately inactive groups being only 0.05 cm. While statistically significant in such a large sample, such a small difference, in Ekelund's opinion, is not clinically significant.

Does Physical Activity Prevent the Development of Obesity?

To measure the effect of physical activity on obesity at follow-up, Ekelund continued, the same confounding factors need to be controlled. In the same study discussed in the previous section (Ekelund et al., 2011), he and colleagues observed that baseline physical activity was associated with the risk of developing obesity at follow-up, with a one-category increase in physical activity index (e.g., moving from inactive to moderately inactive) reducing the risk of obesity in women by 10 percent and in men by 7 percent.

In another study, based on data from the Women's Health Study, which followed women for 11.6 years, Britton and colleagues (2012) showed that vigorous-intensity physical activity was associated with about a 20 percent lower risk of becoming overweight or obese, without adjusting for baseline body mass index (BMI). When the researchers adjusted for baseline BMI, the association disappeared.

In yet another study, using Coronary Artery Risk Development in Young Adults (CARDIA) data, with physical activity and body weight being measured repeatedly over time, Hankinson and colleagues (2010) found that individuals who were consistently active over 20 years showed less increase in BMI; this was the case even for individuals with lower BMIs at baseline. Ekelund noted that despite the smaller BMI gains among active individuals, BMI increased in all individuals over the course of the study. Also of note, only 11-12 percent of study participants remained in the

active group over the course of the study (total n = 3,554 [1,689 men and 1,865 women participated]). The researchers concluded that maintaining high activity levels through young adulthood may lessen weight gain as young adults, particularly women, transition into middle age.

Does Baseline Weight Matter?

The third question addressed by Ekelund was whether associations between baseline physical activity and the development of obesity differ depending on baseline weight status. Adjusting for confounders, Lee and colleagues (2010) used Women's Health Study data (n = 34,079) collected over the 15-year period from 1992 to 2007 to assess the effect of baseline BMI on the association between physical activity and weight gain at 3-year intervals. The women gained an average of 2.6 kg every 3 years. For the analysis, the researchers stratified the women into three groups based on metabolic equivalent of task (MET) hours per week: less than 7.5 MET hours per week, between 7.5 and 21 MET hours per week, and 21 or more MET hours per week (7.5 MET hours corresponds to about 150 minutes of physical activity). The women also were stratified into three BMI groups: normal weight, overweight, and obese. The only observed association between physical activity and weight gain was among the women with normal BMI (i.e., lower than 25), with greater levels of physical activity being associated with less weight gain. The researchers found that women who were successful in maintaining normal weight and gaining less than 2.3 kg over 13 years averaged approximately 60 minutes per day of moderate- to vigorous-intensity physical activity (MVPA).

As part of the same study discussed in the previous two sections, Ekelund and colleagues (2011) conducted a similar analysis. When they stratified their participants into normal weight, overweight, and obese BMI categories, they observed a significant inverse association between physical activity and weight gain in the normal weight category among both men and women. Ekelund concluded, "There may be differential associations between physical activity and weight gain depending on the initial BMI or body weight status."

Is Change in Physical Activity Associated with Change in Body Weight?

The simplest model used to determine whether a change in physical activity is associated with a change in body weight entails measuring both exposure (physical activity) and outcome (body weight) at two different points in time and calculating the associations between changes in the two variables. While this type of analysis is very robust, Ekelund said, he cautioned that it cannot be used to determine the direction of an association.

Using data from the Nurses Health Study, Mekary and colleagues (2009) found that, compared with women who were active for less than 30 minutes per day, women who sustained 30 or more minutes of activity per day had a 32 percent reduced risk of gaining more than 5 percent of their baseline body weight between 1989 and 1997. Women who increased their level of physical activity over time (i.e., went from being active less than 30 minutes per day to being active 30 or more minutes per day) had an even greater reduced risk of gaining weight (36 percent). Women who decreased their physical activity over time (i.e., moved from being active 30 or more minutes per day to less than 30 minutes per day) had a 12 percent elevated risk of gaining more than 5 percent of their baseline body weight.

Using a combined dataset from three different American cohorts of men and women (n = 120,877), Mozaffarian and colleagues (2011) stratified participants into five equal-size quintiles based on level of physical activity and examined change in weight at 4-year intervals. They found that as physical activity increased, change in body weight decreased (i.e., individuals gained increasingly less weight over time), with the most active quintile being associated with a –1.86 pound reduction in body weight (i.e., individuals gained 1.76 fewer pounds within each 4-year period). In the results section of their paper, the authors state, "Absolute levels of physical activity, rather than changes in these levels, were not associated with weight change (data not shown)." Ekelund interpreted these findings to mean that physical activity at baseline did not predict weight gain, but change in physical activity did.

Reverse Causality: Does Weight Status Predict Physical Inactivity?

Finally, Ekelund explored reverse causality, as Kathleen Janz had done during her presentation (see Chapter 2): Do higher levels of body weight or adiposity at one point in time predict lower levels of physical activity or higher levels of sedentary behavior at a later point in time? As with the other four questions, answering this question requires measuring both exposure (in this case, baseline body weight) and outcome (in this case, activity levels), and then controlling for confounding factors.

Using a small dataset (n = 390), Ekelund and colleagues (2008) objectively measured both physical activity (using individually calibrated heart rate monitoring) and adiposity (using bioimpedance). They found that while higher levels of sedentary time at baseline did not predict gains in adiposity at follow-up, higher levels of adiposity at baseline predicted higher levels of sedentary time at follow-up. Additionally, they found at follow-up that, compared with individuals who lost fat mass over time, those who gained fat mass over time had spent more sedentary time. This same trend has been observed in other studies as well, according to Ekelund. For example,

Golubic and colleagues (2013) found that weight gain over 10 years was a significant determinant of physical inactivity and that great weight gain over just 3 years (more than 2 kg per year) was a significant determinant of physical inactivity. Ekelund interpreted these findings to mean that there may be some sort of reverse causality or bidirectional association between body weight or adiposity and physical inactivity.

Summary

In summary, first, the prospective association between physical activity and gain in body weight and BMI is weak, in Ekelund's opinion. It has been observed in some studies, but not others. Ekelund suspects that some of the variability may be due to error in measurement of the exposure variable, in this case physical activity. Second, maintaining a high level of physical activity appears to reduce the risk of becoming obese over time; however, this association may be limited to those who are of normal weight at baseline. Third, the association between physical activity and obesity is likely bidirectional, suggesting reverse causation. Fourth, the amount and intensity of activity needed to maintain a healthy body weight throughout adulthood are unknown, but likely substantial.

One of the most important changes that could be made for public health, in Ekelund's opinion, is to increase population levels of physical activity, with small shifts at the population level likely having significant effects on public health outcomes. To demonstrate, using data from the European Prospective Investigation into Cancer and Nutrition (EPIC) Study and stratifying the data into three different BMI groups, Ekelund and colleagues (2015) found that people of normal body weight had a 24 percent reduced risk of all-cause mortality if they were moderately inactive rather than inactive. People who were obese had a 16 percent reduced risk of all-cause mortality if they were moderately inactive rather than inactive. When people with an unhealthy and a healthy waist circumference were compared, mortality risk reductions observed in the moderately inactive versus inactive groups were similarly substantial. The difference between being moderately inactive and inactive, Ekelund explained, was about 20 minutes of brisk walking per day, or 100 kilocalories expended in physical activity.

Ekelund's take-home message was that physical activity prevents weight gain in a small segment of the population who are of normal weight and who are highly physically active, but the health benefits of physical activity are well established and indisputable. Therefore, he believes a stronger emphasis should be placed on physical activity for health rather than for weight. The challenge, he suggested, is to shift the focus from losing body weight to promoting lifestyle behavior change across the entire population.

EXERCISE AS AN EFFECTIVE STRATEGY FOR PREVENTING WEIGHT GAIN IN ADULTS: TRIAL EVIDENCE[2]

Asking whether exercise is an effective strategy for preventing weight gain in adults is really two questions, Robert Ross began. First, what happens with respect to weight gain when adults exercise or increase their physical activity? Second, what happens with respect to weight gain when adults are encouraged to exercise or increase their physical activity? Those are two very different questions that require different types of studies and yield different results, Ross suggested. Unfortunately, in his opinion, the differences often are misunderstood in the literature. Both questions call for randomized controlled trials, but different types of trials. The first question calls for an efficacy trial, which is characterized by strong internal validity and is concerned primarily with physiological response. That is, if people increase their physical activity, what happens physiologically? The second question, in contrast, calls for an effectiveness trial, which is concerned primarily with changing behavior. That is, if people are encouraged to increase their physical activity, does their behavior change? Ross discussed evidence in the literature derived from both types of trials.

Efficacy Studies: What Happens When Adults Exercise or Increase Their Physical Activity?

Jean Mayer's initial observations many years ago showed a mismatch between body weight and caloric intake among people who were more physically active (Mayer et al., 1956) (see Figure 3-1). "It was a seminal observation," Ross said. While Mayer's observations were limited by their cross-sectional nature, they nonetheless suggested that physical activity can prevent weight gain despite increasing energy intake. As James Hill had elaborated during his keynote presentation, Ross reminded the workshop audience how the mismatch between body weight and energy intake initially observed by Mayer and colleagues (1956) led to the notion of a theoretical threshold for optimal weight regulation (see Figure 1-3 in Chapter 1) (Hill et al., 2012). On one side of the threshold is the "regulated" zone, characterized by the mismatch, while on the other side is the "unregulated" zone.

Ross described evidence from his work showing what happens when people in the regulated zone both increase their physical activity and consume more calories relative to baseline. He and his research team found that when participants, both men and women, exercised an additional 50-60 minutes daily for 4 months and consumed an additional 500-700 calories

[2] This section summarizes information and opinions presented by Robert Ross, Ph.D., R.Kin., FACSM, FAHA, Queen's University, Kingston, Ontario, Canada.

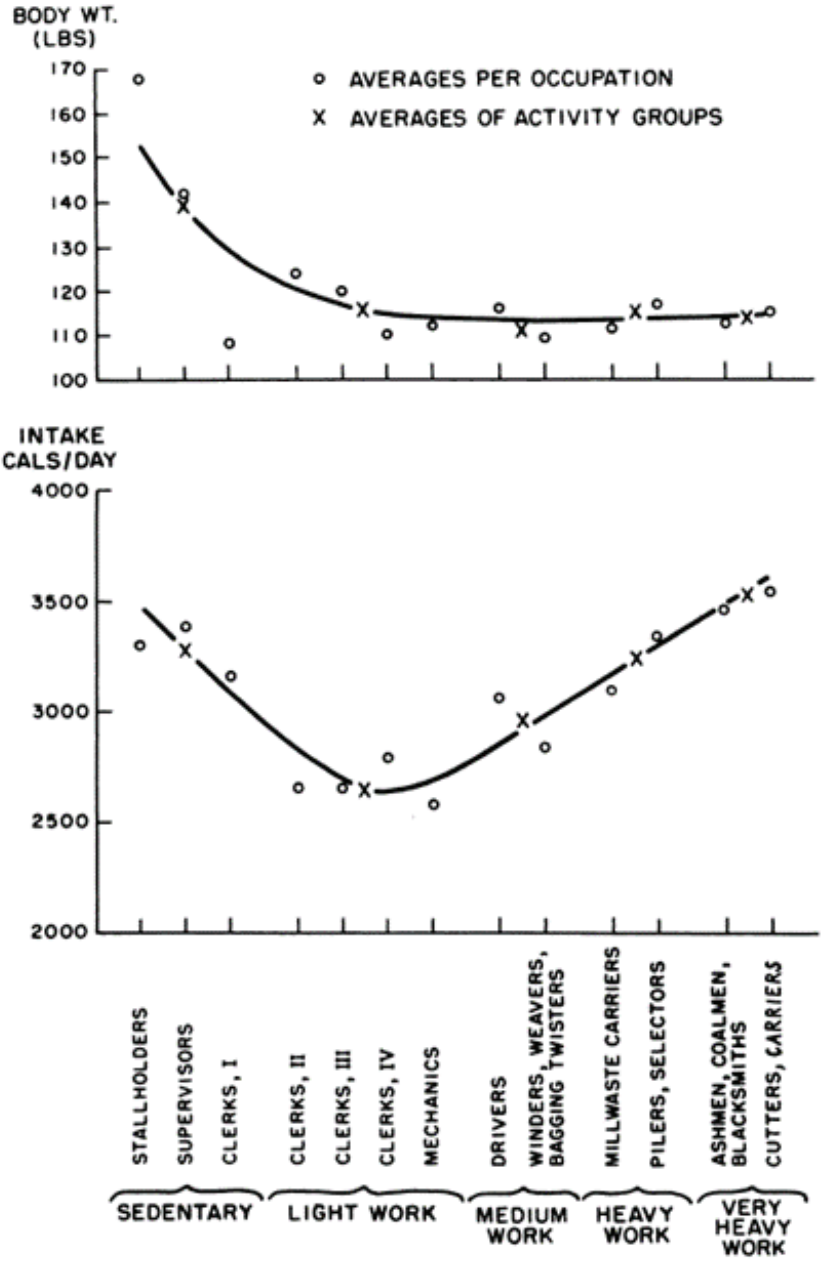

FIGURE 3-1 Body weight and caloric intake as a function of physical activity. SOURCE: Presented by Robert Ross on April 14, 2015 (reprinted with permission from Mayer et al. *American Journal of Clinical Nutrition* [1956; 4:169-175]).

every day to offset the exercise-induced energy expenditure, they did not gain weight (Ross et al., 2000, 2004). In fact, Ross said, it was a challenge for them not to lose weight.

In a study on the effects of the amount and intensity of physical activity on blood lipids, Kraus and colleagues (2002) counseled subjects to maintain their weight. If participants started losing weight, they were asked to consume more calories to offset the loss. The researchers found that, regardless of the level of exercise and despite the counseling, participants lost weight when exercise was added.

Ross and his team conducted a similar study on the effects of the amount and intensity of exercise on abdominal obesity and glucose tolerance in 300 obese adults. All participants received personalized diet counseling, but in this case, they were asked to maintain their baseline energy intake, that is, to eat no more (Ross et al., 2015). When exercise was added 5 days per week for 6 months under supervised conditions, the researchers observed a tremendous loss in body weight and decreased waist circumference among all treatment groups (the treatment groups varied in the amount and intensity of exercise). Additionally, the researchers saw no compensation in terms of participants increasing their sedentary time. These findings suggested to Ross that, unless one eats more, if one is exercising under supervised conditions, one will increase one's energy expenditure and lose weight. "I just don't think there is any ambiguity there. There is none whatsoever. I think the information is very clear."

In summary, according to Ross, efficacy randomized controlled trials have demonstrated that exercise without compensation in caloric intake leads to weight loss and that exercise with compensation in caloric intake prevents weight gain.

Effectiveness Trials: Is Exercise an Effective Strategy for Preventing Weight Gain in Adults?

What happens when adults are asked to exercise? In a systematic review of interventions aimed at preventing weight gain in adults, Lombard and colleagues (2009) identified nine randomized controlled trials with intervention lengths varying from a few weeks to 5 years. Overall, the interventions included far more women (1,595) than men (375). All of the interventions included diet and physical activity with behavior change strategies. Five of the nine studies found a significant difference in weight gain (1-3.5 kg) between treatment and control groups, due largely to increased body weight in the control groups. That result was expected, Ross remarked, given that the goal of the interventions was to prevent weight gain. In his opinion, it is impossible to identify which component(s) of the interventions (diet and/or exercise) were responsible for success. Additionally, he noted that

intensive interventions were not always successful, and interventions that included mixed modes of delivery with some personal contact tended to be successful. The authors of the review concluded that more evidence is urgently needed.

In a 24-month intervention trial aimed at preventing weight gain in healthy, nonobese first-year medical students, Hivert and colleagues (2007) used cognitive-behavioral techniques to encourage a healthy lifestyle among the students. They observed what Ross considered a modest difference in weight change (1.3 kg) between the intervention and control groups: the control group gained weight, and the intervention group lost a slight amount of weight.

In another trial, Levine and colleagues (2007) tested three interventions, one behavioral (i.e., clinic-based), one a correspondence intervention, and the third an information-only intervention (the control). Participants were given goals for diet and exercise. The trial was conducted for 2 years, with a 1-year follow-up (i.e., at year 3). Although the researchers observed no significant difference in weight change among groups, they detected a trend toward weight gain in the control and correspondence groups and prevention of weight gain in the clinic group.

In what Ross described as an atypically long 54-month intervention study, Kuller and colleagues (2001) encouraged modest weight loss among 535 peri- to postmenopausal women and then conducted an intervention with the goal of maintaining that weight loss in subsequent years. Reponses were varied, with a mean change in weight of –0.1 kg in the intervention group compared with a gain of 2.4 kg in the control group, representing a modest but significant difference. Additionally, participation in the intervention substantially reduced several cardiometabolic risk factors in the intervention compared with the control group.

As a final example of evidence from effectiveness trials aimed at understanding what happens when people are encouraged to exercise, Bruins and colleagues (2014) conducted a study of individuals with psychotic disorders. They found significant weight gain prevention in the intervention groups.

Most other trials of interventions to prevent weight gain have been successful in achieving that goal, according to Ross. However, all of the trials prescribed both diet and exercise programs, and none of the researchers were able to identify which component of the intervention contributed to weight gain prevention. Additionally, in general, the quality of such trials has been poor, in Ross's opinion, with none having used intent to treat or being appropriately powered.

The Notion of Small Change: A Focus on the Prevention of Weight Gain

Keynote speaker James Hill was among the first in the field to champion the notion of small change, according to Ross (Hill et al., 2003). Ross echoed the call. Not only is prevention of weight gain important, he said, "but maybe that is what we should be striving for. Maybe treatment of obesity in this environment is just too great a challenge for us." In a family-based study designed to test a small-change approach, Hill and colleagues asked participants to either increase their steps by 2,000 per day (i.e., about 100 calories spent) or decrease their caloric intake by 100 calories per day (Rodearmel et al., 2006). Those are very small changes, Ross observed. It was a short study, only 13 weeks, so almost a proof-of-concept study, he said. Not only did the intervention successfully prevent weight gain over time, but there was even some modest weight loss. Ross called for larger, longer studies of this type. At the time of this workshop, he and his team had just completed the recruitment phase of a 3-year randomized trial that would be testing a small-change approach.

Summary

According to Ross, evidence from efficacy-based randomized controlled trials clearly indicates that if adults increase exercise or physical activity, even if they compensate by eating more, the added exercise or physical activity prevents weight gain. "I don't think there's any doubt about that," he said. Evidence from effectiveness studies suggests that lifestyle interventions designed to prevent weight gain are generally effective, although it is impossible to identify which aspects of such interventions—diet and/or exercise—are contributing to their success. Nor is there sufficient evidence to determine an ideal "dose" of exercise required to prevent weight gain. Many of the trials have been small, short term, and based on weak experimental designs, Ross observed.

Ross concluded by asking two questions. First, is it possible or important to identify the independent contributions of physical activity and diet in preventing weight gain? Second, what are the vital components of the ideal trial for determining the effects of lifestyle on the prevention of weight gain? Given the many ways to conduct trials, Ross encouraged ongoing dialogue.

PANEL DISCUSSION

Following Ross's talk, he and Ekelund fielded questions from the audience.

Prevention of Weight Gain as a Goal

First, moderator Loretta DiPietro asked whether there is a survival advantage to keeping weight constant through middle age and whether the goal should really be to prevent weight gain, as opposed to attenuating the curvilinear shift that normally occurs.

Ekelund replied that his team's data, collected over a period of about 5 years, showed a positive association between physical activity and gain in fat-free mass in adults older than 52 years (i.e., with higher levels of physical activity predicting greater gain in fat-free mass). In his opinion, that high levels of physical activity preserve fat-free mass in older adults is tremendously important for a number of different health outcomes.

Advantages of Measuring Body Composition Versus Weight

Jim Sallis observed that in his opinion, the most encouraging outcome described by Ekelund was related to waist circumference, not weight. He asked whether any conclusions presented by either speaker would have been different if the questions they had asked had been phrased in terms of body composition or body fat rather than weight.

Ross responded, "There is absolutely no question." He and others have demonstrated not just an increase in fat-free mass and a reduction in adiposity with increased physical activity and in the absence of any change in body weight, but reductions in other cardiometabolic risk factors as well. "I have been a big proponent of that," he said.

Ekelund added that it was important to keep in mind that almost all data obtained from observational research have been on body weight or BMI, and in some cases waist circumference. Very few large-scale epidemiologic studies have measured body composition. The few that have shown a differential effect by age on fat mass versus fat-free mass have demonstrated, as Ross's data have, that physical activity has a positive effect on maintaining fat-free mass in older adults. Ekelund reiterated that the negative (or inverse) association between physical activity and waist circumference that he described was statistically, but probably not clinically, significant and that the observed change in waist circumference in the intervention group was minor.

Sustained Adoption of Behaviors

There was some discussion around the sustained adoption of behavioral strategies implemented in effectiveness trials—that is, whether indi-

viduals continue, after their trial has ended, to do what they were taught to do during the intervention to prevent weight gain. Ross remarked that participants do very well when they maintain contact with the interventionist. During that time, they sustain and benefit from their activities. "When they start to lose contact," he said, "we've seen an erosion of benefits."

4

Physical Activity-Related and -Induced Outcomes with Overweight and Obesity

OVERVIEW

Several speakers at various times during the workshop agreed that most youth who are obese will probably remain so for their rest of their lives. The question then arises of whether it is possible for overweight or obese children, adolescents, and adults to have healthy metabolic profiles. In the final session of the first day, moderated by Cedric Bryant, speakers addressed that question.

First, Andrea Kriska discussed results of the landmark National Institutes of Health (NIH)-funded Diabetes Prevention Program (DPP) and its 10-year follow-up in high-risk adults. Among other findings, the researchers noted a decreased incidence of diabetes in the lifestyle intervention arm, with physical activity being a critical component of the intervention. This decrease in the incidence of diabetes was similar in both men and women and appeared to hold across all age and ethnic/racial groups. Kriska remarked that researchers are still analyzing data from an expanded community-wide lifestyle intervention program translated from the successful DPP to suit the community setting. Thus far they have observed increased physical activity, reduced weight, and significant improvements in diabetes and cardiovascular risk factors. For Kriska, the evidence indicates that increasing physical activity levels in adults who are overweight and showing signs of prediabetes and/or metabolic syndrome is doable, and that improvement in physical activity levels may have a significant impact on diabetes prevention and other health outcomes. She echoed calls made

earlier in the workshop to increase understanding of the impact of all intensities of physical activity, not just that of moderate to vigorous intensity.

Shifting the focus back to children, Gabriel Shaibi examined evidence demonstrating that, independent of any effect on weight, physical activity can both improve health status and reduce risk factors for disease in children who are overweight or obese. He cautioned that researchers need to think carefully about the outcomes they are measuring to determine the success of interventions in youth who are overweight. He suggested that, instead of weight, cardiometabolic risk factors may be more relevant indicators of health improvement for children and adolescents. Among other findings, researchers have reported that exercise training increases cardiac function in children who are obese, essentially normalizing mycocardial dysfunction, even without weight loss. Shaibi also stressed thinking about the kind of exercise, or physical activity, in which youth like to engage and suggested that incentives to get them moving may be worth considering.

If obesity is not part of the discussion on the effects of physical activity on health outcomes, John Jakicic cautioned, "we will miss something." He discussed evidence demonstrating that, indeed, weight matters. For example, data from the cross-sectional Look AHEAD trial show that while physical activity predicts hypertension, weight has an independent effect as well. Studies on adults with knee osteoarthritis illustrate this same point—that is, exercise improves outcomes, but exercise combined with weight loss improves those outcomes even more. "Yes, we can get the effect [with exercise alone]," he said. "But how do we maximize the effect?"

In the question-and-answer period following Jakicic's talk, a key topic of discussion was identifying weight loss interventions that work in the long run. The challenge, in Jakicic's opinion, is not to determine which dose of physical activity to prescribe, but how to get more people to adopt what researchers know works. "I think that's where the action really should be," he said.

PHYSICAL ACTIVITY AS PART OF COMMUNITY LIFESTYLE INTERVENTION EFFORTS BASED ON THE DIABETES PREVENTION PROGRAM[1]

The Diabetes Prevention Program

The strength of the DPP, Andrea Kriska began, was in the diversity of its participants, in terms of age (25 years and up), ethnicity and race, and geography (27 sites across the United States). A total of 3,234 individuals,

[1] This section summarizes information and opinions presented by Andrea M. Kriska, Ph.D., M.S., University of Pittsburgh, Pennsylvania.

all with high weight and prediabetes, were randomly assigned to one of three groups: lifestyle intervention, drug intervention (i.e., metformin), or placebo.

Kriska focused her presentation on differences between the lifestyle and placebo groups. The minimum goals of the lifestyle intervention were for participants to lose 7 percent of body weight and engage in the nationally recommended 150 minutes per week of moderate-intensity physical activity, similar to a brisk walk. Over the course of the 3-year study, participants randomized to the lifestyle intervention reported significantly greater physical activity levels relative to participants in the other two randomized arms, as determined by the past-year version of the Modifiable Activity Questionnaire (MAQ). Lifestyle intervention participants also had significantly greater weight loss than participants in the other two groups by the end of the study (Diabetes Prevention Program Research Group, 2002). Interestingly, at the end of the first year, secondary analyses showed a significant decrease in weight—about 7 to 8 percent—for all racial and ethnic groups in the lifestyle intervention group with the exception of black women, who lost significantly less than that (4.5 percent) (West et al., 2008).

In terms of diabetes prevention, the lifestyle intervention worked, Kriska said, as those participants showed a 58 percent greater decrease in diabetes incidence relative to the placebo group. The intervention worked across all subgroups, including age, sex, baseline body mass index (BMI), and ethnicity and race (see Figure 4-1). The decrease in diabetes development, which was demonstrated across all of these subgroups, was a very important finding, in Kriska's opinion, with respect to using the DPP as a model for lifestyle intervention in diverse community settings. Additionally, the lifestyle intervention group showed a 41 percent decrease in the incidence of metabolic syndrome relative to the placebo group.

Early in the study, the DPP investigators, including Kriska, examined the separate impacts of weight and physical activity on the risk of developing diabetes among lifestyle intervention participants only (Hamman et al., 2006). Although the study was not designed to separate out the effect of each lifestyle goal individually, these secondary results suggested that change in weight from baseline significantly predicted reduced diabetes incidence, but change in reported physical activity levels from baseline did not (although activity itself was shown to predict weight loss). Yet if physical activity was handled categorically instead, with regard to whether participants met the physical activity goal, those who did achieve that goal had a 46 percent reduced incidence of diabetes.

After the DPP results had been presented, the investigators were funded to conduct a 10-year follow-up (the Diabetes Prevention Program Outcome Study or DPPOS), with all participants being offered the lifestyle intervention. Over the course of the DPPOS, participants from the original lifestyle

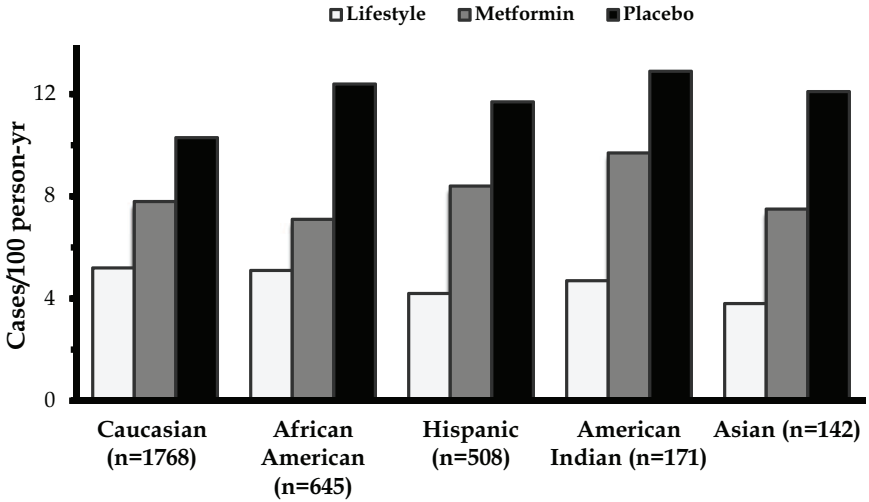

FIGURE 4-1 Diabetes incidence rates by ethnicity at the end of the 3-year Diabetes Prevention Program.
SOURCE: Presented by Andrea Kriska on April 14, 2015 (Diabetes Prevention Program Research Group, 2002).

intervention group continued to maintain an advantage over those from the original placebo group, Kriska said, in the form of a 34 percent reduced incidence of diabetes (Diabetes Prevention Program Research Group et al., 2009).

In the last 2 years of the DPPOS, an ancillary accelerometer study was conducted across nearly all of the DPPOS sites to advance the investigation of the importance of physical activity in preventing diabetes. Although still being analyzed, objective accelerometry data, coupled with data from the past-year MAQ (administered every year since baseline), suggest that physical activity may be an independent predictor of diabetes incidence, even after controlling for weight. In summary, results from the DPP and its follow-up DPPOS indicate that diabetes can be prevented with lifestyle intervention and that physical activity is a critical component of such intervention.

Community Translation of the DPP Lifestyle Intervention

DPP investigators in Pittsburgh modified the DPP lifestyle intervention to develop a more community-friendly program called Group Lifestyle Balance, a 1-year program that entailed 16 sessions during the first half and

monthly sessions thereafter. The researchers were funded by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) to test the program in three very different types of community settings: three community senior centers of varying socioeconomic status, a worksite, and a military base. Participants had to be 18 years of age or older, have a BMI of 24 or greater, and have prediabetes or metabolic syndrome but no reported history of diabetes. The mean age of participants was 58 years; 63 percent were female.

According to 6-month attendance data, median attendance across all sites was 14 of the first 16 sessions, with 75 percent of participants attending 12 or more sessions. The researchers are still analyzing weight loss data from the 18-month follow-up, but the combined data from all sites at both 6 and 12 months demonstrated a 5-6 percent weight loss, representing approximately 12-13 pounds. Of equal importance is that the combined physical activity data from all sites showed a highly significant increase in physical activity from baseline to both 6 and 12 months, even after adjusting for changes in activity due to season (Eaglehouse et al., 2015).

This evidence of significant improvement in physical activity levels in these community translation intervention efforts is an important finding, according to Kriska, considering that nearly half of existing translation studies provide no information on change in physical activity (Eaglehouse et al., 2015). Moreover, none of those studies adjust their results for seasonal variation, which, she noted, can be a considerable factor in intervention studies that occur over several months in locations that experience substantial changes in weather/season. Kriska and colleagues had already demonstrated the impact of season/weather on physical activity levels in a previous clinical trial in older women residing in a region with changing seasons (Newman et al., 2009). Reported baseline past-week physical activity levels of these women (as determined by the MAQ) varied dramatically throughout the 18-month recruitment period, with recruits being more active in summer and less active in winter even before the intervention started. Kriska and her team saw the same influence of season on activity levels prior to and during intervention in the community study. In addition to its impact on weight loss and physical activity, the lifestyle intervention positively improved several diabetes and cardiovascular risk factors—fasting glucose, hemoglobin A1c (%) (not measured at the military site), systolic blood pressure, diastolic blood pressure, LDL (low-density lipoprotein) cholesterol, HDL (high-density lipoprotein) cholesterol, and triglycerides—in the 286 participants from all of the sites combined (12-month data not yet available for military base participants). All factors except HDL cholesterol showed positive changes at 6 months, and all but LDL cholesterol showed positive changes at 12 months. These analyses were presented for all participants combined, as is often done in intervention efforts.

Kriska also ran the above analyses separately for participants with above-normal values at baseline for each risk factor—that is, those who needed improvement in the specific outcome variable of interest. When the data were analyzed using this "high-risk approach," Kriska said, in every case and at every site, not only did the effect size improve for that variable, but it became statistically significant if not significant before (Kriska et al., 2014). This approach is most striking when the results for only one site are considered, representing a sample size more in line with current community translation efforts. For example, an analysis of 6-month changes among all worksite participants showed statistically significant positive changes in hemoglobin A1c (%), systolic blood pressure, and triglycerides. When only high-risk participants were included in the analysis, fasting glucose, LDL cholesterol, and HDL cholesterol showed statistically significant positive changes as well. This information is critical to understanding the effectiveness of lifestyle intervention translation efforts, considering that such studies typically report their results for all participants combined, likely underestimating the impact of the intervention for those at highest risk.

Summary of Lessons Learned

Kriska identified several key lessons learned from the DPP and the DPP-based community studies. First, results from both types of study (efficacy and effectiveness) suggest that physical activity levels can be increased in high-risk adults. The DPP provided further evidence that improvement in physical activity can have a significant impact on health outcomes, including the prevention of diabetes. Second, when evaluating the effects of community translation efforts, Kriska suggested considering use of a high-risk approach to understand the full extent of the impact of lifestyle intervention on participants' health. Additionally, she suggested paying attention to the potential influence of seasonal variation on physical activity levels.

Finally, Kriska commented on newer research focusing on low intensities of physical activity and, conversely, sedentary behavior such as sitting, and their impact on health outcomes. As part of the DPP, she and colleagues assessed television (TV) watching at baseline (as a surrogate for sitting time) and then again at the 3-year follow-up. They found that, among lifestyle intervention participants, TV viewing declined more than it did in either the metformin or placebo group, despite the fact that this was not a primary goal of the intervention (Rockette-Wagner et al., 2015). Additionally, each hour per day of TV watching was associated with a 3.4 percent increased risk of developing diabetes over the follow-up period in this cohort of individuals with prediabetes at baseline (although the risk reduction became nonsignificant and was attenuated to 2.1 percent after controlling for weight).

Gaining a better understanding of the health impact of decreasing time spent sitting is the focus of Kriska's next NIH-funded study. She is currently examining whether the significant beneficial changes in weight and in diabetes and cardiovascular risk factors that she and her colleagues observed in the NIH-funded community translation study will be seen if the goal is not to increase levels of moderate-intensity physical activity but to sit less.

PHYSICAL ACTIVITY, EXERCISE, AND YOUTH OBESITY: REFOCUSING EFFORTS FROM WEIGHT LOSS TO HEALTH GAINS[2]

Building the Conceptual Case

Gabriel Shaibi presented a three-part conceptual case for physical activity and exercise in youth who are already overweight or obese. First, long-term successful weight loss is possible but challenging, he said. Defining successful long-term weight loss as intentionally losing at least 10 percent of initial body weight and keeping it off for at least 1 year, Wing and Hill (2001) suggest that at least 20 percent of overweight or obese individuals who attempt to lose weight can achieve long-term success. Physical activity is a primary driver of that success, Shaibi said. The other 80 percent who are unable to lose weight or maintain their weight loss over the course of 1 year enter what Shaibi called a "vicious cycle." Newer data have shown that weight cycling has a deleterious effect on health outcomes, including end organ damage.[3] In Shaibi's opinion, losing weight is the right thing to do only if the lost weight will not be regained. "If you are going to gain it back," he said, "you are probably better off not losing weight in the first place."

Second, most youth who are obese will remain so for the rest of their lives. Adolescents who are obese by the age of 14 to 16 tend to remain obese into adulthood. Some data indicate that 8 to 10 percent of children between 0 and 2 years of age are already obese, Shaibi said, which to him "screams that there are strong biological drivers in this population." Pediatric obesity is highly heritable, he noted, and there may be a genetic predisposition to obesity in childhood, especially early in life (Bouchard, 2009).

Finally, physical activity has been shown to be protective against morbidity and mortality, independent of obesity (Ekelund et al., 2015).

[2] This section summarizes information and opinions presented by Gabriel Q. Shaibi, Ph.D., Arizona State University, Tempe.

[3] End organ damage usually refers to damage occurring in major organs fed by the circulatory system (such as the heart, kidneys, brain, and eyes), which can sustain damage as a result of uncontrolled hypertension, hypotension, or hypovolemia.

Experimental Data Supporting the Role of Exercise in Health Promotion and Disease Prevention Among Youth Who Are Obese

In a review of four exercise-only interventions in youth who were already obese, Watts and colleagues (2005) found that on average, the youth actually gained weight after 2-5 months of exercise. Averaged over the four studies, however, observed weight gain was accompanied by an increase in fat-free mass and a slight but significant decrease in fat mass. In a meta-analysis of more than 300 studies, Kelley and Kelley (2013) identified similar reductions in percent body fat in youth who were already obese and who participated in an exercise program. They found no significant changes in any other measure of adiposity (i.e., BMI-related measures, body weight, and central adiposity).

Shaibi suggested that because youth are still growing, weight itself is probably not a good marker of health improvement following exercise in youth who are obese. Rather, changes in body composition may be better outcome measures.

Another alternative to weight for evaluating the impact of exercise in youth may be cardiometabolic health (i.e., combined cardiovascular disease and type 2 diabetes risk factors). At the population level, according to Shaibi, 30 percent of children or adolescents who are obese have the constellation of risk factors that puts them at risk for cardiometabolic disease later in life and a 25-fold increased odds ratio of having a cardiovascular event in adulthood. The Centers for Disease Control and Prevention (CDC) published data suggesting that as many as 50 percent of youth born in 2000 will develop type 2 diabetes in their lifetime. "This is a compelling argument for us to think about not necessarily weight loss in this population," Shaibi said, "but targeted health promotion and disease prevention programs."

Data from recent meta-analyses on the effects of exercise in children who are already overweight or obese indicate only small effects on blood pressure (Garcia-Hermoso et al., 2013), lipid profile (Escalante et al., 2012), and insulin resistance (Fedewa et al., 2014). However, Shaibi pointed out, while those results do not suggest that exercise has a robust or a very large effect on cardiometabolic outcomes, the outcomes analyzed in those three studies were based on clinical outcomes in adult populations. He questioned how relevant those outcomes are in younger populations. He suggested that exercise in youth can protect the cardiovascular system in ways that cannot be detected by changes in traditional clinical outcome measures. He referred to Joyner and Green's (2009) notion of a risk factor gap, where exercise appears to be far more protective in terms of morbidity and mortality than it should be based on changes in traditional risk factors alone (e.g., blood pressure, lipid profile, insulin resistance). Relating that

notion to youth, he asked, what does a lowering of blood pressure by 5 or 10 percent mean in terms of long-term health outcomes 40, 50, 60, or 70 years down the road? What does a one- or two-point change in LDL cholesterol mean? The long subclinical period between elevated risk (in youth) and eventual disease outcome (in adulthood) suggests that the risk factor gap may be particularly wide in pediatric populations, in Shaibi's opinion.

As an example of a study on the effect of exercise on a nontraditional cardiometabolic health outcome measure in youth, Shaibi cited Ingul and colleagues' (2010) study on the effects of 13 weeks of twice-weekly high-intensity interval training on cardiac function in adolescents who were obese. The researchers examined stroke volume (an indication of how much blood the heart is able to pump in relation to body size) and global strain. This was a small study with only 10 participants, so almost a proof of concept, Shaibi said. The interval training entailed extremely high intensity (90 percent of VO_2 max [the maximum rate of oxygen consumption as measured during incremental exercise]) for 4 minutes, followed by 4 minutes off, then 4 minutes on, and so on, for 40 minutes. The researchers compared the 10 obese adolescents with 10 lean adolescents. Before the training started, the obese youth had significantly reduced stroke volume compared with their lean counterparts. After the 13 weeks of interval training, stroke volume in the obese adolescents had increased significantly, so much so that there was no statistical difference in stroke volume between them and the lean controls by the end of the study. The researchers observed similar changes in global strain, but no change in weight, lipid profile, or blood pressure. "In essence," he said, "this intervention normalized myocardial function in this population."

Regarding the feasibility of a twice-weekly 40-minute high-intensity exercise regimen, Shaibi noted that about 95 percent of the sessions in the Ingul et al. (2010) study were attended. Adolescents who are obese tend to like that kind of high-intensity interval training, in his opinion, more than they do a continuous exercise program.

In a similar study, Watts and colleagues (2004) examined the effects of 8 weeks of thrice-weekly circuit training on vascular function in 19 obese adolescents. They measured endothelial function using brachial artery flow-mediated dilatation (FMD) and compared outcome measures in the obese individuals and a lean control group. At baseline, they observed significant differences between the obese and lean adolescents. After the intervention, endothelial function in the obese adolescents was found to be normalized. As in the Ingul et al. (2010) study, there was no change in weight, lipid profile, or blood pressure. Again, Shaibi said, the results suggest that exercise can improve, in this case, vascular function—one of the earliest signs of atherosclerosis—without changing traditional risk measures.

Results of Shaibi's own research on the effects of 16 weeks of twice-

weekly resistance training on insulin sensitivity in Latino adolescents who were overweight or obese suggest that exercise also increases insulin sensitivity (Shaibi et al., 2006). In addition to measuring insulin sensitivity, using the frequently sampled intravenous glucose tolerance test (FSIVGTT), Shaibi and his team measured body composition using dual-energy X-ray absorptiometry (DXA). They observed about a 45 percent increase in insulin sensitivity in the resistance training group compared with a nonexercising control group, but with tremendous individual variation in change in insulin sensitivity in the intervention group. Shaibi noted that the control group experienced a small increase in insulin sensitivity as well, which may have been a transient change related to puberty. The change in insulin sensitivity in the resistance training group was independent of any change in body composition. Individuals in the resistance training group also showed a subtle, but not statistically significant, decrease in fat mass and a slight, but again not statistically significant, increase in body weight.

The benefits of resistance training for obese youth are not just metabolic, in Shaibi's opinion. There is also a psychosocial benefit. If one asks a classroom of youth to run a mile, he said, those who end up last are almost always those with the higher weights. By contrast, if one puts that same classroom of youth in a resistance training room, those with the higher weights end up being the strongest. In Shaibi's opinion, resistance training supports children and adolescents who are obese in being physically active because it is an exercise they can do well.

Translating Research to Practice

Translating the research results described above into real-world practices is a challenge, Shaibi said. Most of the studies conducted in this area have been very small proofs of concept that exercise can improve health outcomes not typically measured in the clinic, but meaningful with respect to cardiometabolic disease.

Additionally, not all individuals respond to interventions in the same way. In collaboration with a local YMCA, Shaibi and colleagues (2012) developed a diabetes prevention program for Latino adolescents who were obese. It was a family-based program, with youth working out with other youth, and with nutrition education provided by health educators from the adolescents' community. Overall, Shaibi and his team observed statistically significant improvements in insulin sensitivity and glucose tolerance. But on an individual basis, not all the adolescents showed improvement: nine exhibited increases in insulin sensitivity in response to the intervention (the "responders"), and six showed either no change or a decrease (the "nonresponders").

Subsequently, Shaibi's research team analyzed blood samples to see

whether there were any biochemical differences between the responders and nonresponders. They found that the responders had more than 1,000 genes that were significantly up- or down-regulated, compared with about 120 such genes in the nonresponders. The two groups of adolescents shared very few of the same up- or down-regulated genes. Shaibi interpreted these findings to mean that there may be a biological basis for responses to lifestyle intervention in adolescents. He suggested that clinicians keep this possibility in mind when they tell youth to exercise and the youth return to the clinic not having lost any weight. Nonresponders may require a different approach.

With respect to other novel practice and policy approaches, Shaibi suggested encouraging clinicians to prescribe exercise the same way they prescribe medications. "Give the kid a prescription pad," he said, "and tell them what you want them to do." Exercise prescriptions will require better models for community intervention programs, he noted, so that community center providers or exercise specialists will know what to do when children and adolescents show up with such prescriptions from their physicians. Additionally, he suggested incorporating behavioral change strategies into the prescriptions.

Shaibi suggested further that, with respect to reimbursement and incentives, it is not just providers who need to be incentivized but children and adolescents as well. He mentioned the development of novel programs that incentivize children and adolescents to exercise and how these programs may be beneficial if the evidence is supportive.

With respect to how scientific research can continue to help inform practice and policy, Shaibi asserted that scientists need, first, to gain a better understanding of outcomes beyond BMI that are relevant in children and more proximal to the cardiometabolic disease process. Shaibi suggested considering not just metabolic health but also psychosocial or emotional health. Additionally, scientists need to optimize exercise parameters by conducting dose–response studies and better-designed randomized controlled trials involving children and adolescents who are already obese.

PHYSICAL ACTIVITY: IMPLICATIONS FOR WEIGHT LOSS MAINTENANCE AND RELATED HEALTH OUTCOMES[4]

Asking whether the focus should be physical activity (and its relationship to health) or obesity is the wrong approach, John Jakicic began. It may even be self-defeating, because one pathway by which physical activity may improve health is through its effect on body weight. If obesity is not part of

[4] This section summarizes information and opinions presented by John M. Jakicic, Ph.D., University of Pittsburgh, Pennsylvania.

the discussion, he said, "We are probably going to miss the combined benefit of both addressing excess body weight and increasing physical activity."

Obesity Matters

To explain why obesity matters, Jakicic highlighted baseline cross-sectional data from his own work with the Look AHEAD trial. Among its 5,145 participants, all with type 2 diabetes, decreased levels of fitness were associated with increased odds of high hemoglobin A1c (HbA1c),[5] regardless of BMI (Wing et al., 2007). If one were to consider just those HbA1c data, Jakicic explained, one might conclude that having a higher BMI does not necessarily influence health and that health is significantly influenced by level of fitness. In this example, the higher the fitness level, the better individuals were able to manage their diabetes as reflected by level of HbA1c. With hypertension, however, which the researchers defined as either taking medication to control blood pressure or meeting the criteria for high systolic or diastolic blood pressure, the odds ratio increased as fitness decreased, but the odds ratio also was higher for individuals with class II or III obesity compared with those who were overweight or had class I obesity. In other words, Jakicic explained, in contrast with HbA1c, both fitness and body weight appear to influence blood pressure and diagnosis of hypertension. Thus, when thinking about how to maximize the influence on patient-centered outcomes broadly, he said, "Both body weight and fitness or physical activity have to be part of the discussion."

In other work, based on self-report data, Hergenroeder and colleagues (2011) demonstrated an increase in both disability limitation and physical function limitation with increasing weight (i.e., across five weight categories—normal, overweight, obese I, obese II, and obese III). In a study of obese older adults with knee osteoarthritis, Messier and colleagues (2000) showed that exercise over 6 months improved various knee osteoarthritis outcomes, but exercise combined with weight loss yielded even greater improvement. Subsequent work by Messier and colleagues (2004) revealed a similar larger effect when weight loss was added to a diet and exercise program for older adults with knee osteoarthritis. Again, Jakicic said, exercise provides benefits, but weight loss induced by dietary change adds to the benefits observed.

Jakicic emphasized that he was not arguing that a focus on obesity is more important than a focus on physical activity. Again, he used data from the Look AHEAD trial, in this case follow-up data, to illustrate how both need to be part of the discussion to maximize the effect of intervention. Trial participants were randomized into either a diabetes support and

[5] High levels of HbA1c are associated with an increased risk of diabetes-related complications.

education (DSE) group or an intensive lifestyle intervention (ILI) group. The emphasis of the intervention was on weight loss, with participants in the ILI group receiving weekly intervention contact; individuals in the DSE group received standard care and little intervention contact. Four-year data from the trial showed, generally, a decline in HbA1c with increasing fitness (Jakicic et al., 2013). More specifically, in the DSE group and when DSE and ILI data were combined, the data revealed an almost dose–response relationship, Jakicic observed: the greater the increase in fitness, the greater the decline in HbA1c. In the ILI group, HbA1c levels declined in a dose–response way until the highest increase in fitness level was reached (>10 percent increase in fitness), at which point the levels increased slightly. All of these changes in HbA1c were observed after controlling for weight change and use of medication to treat diabetes. Based on these findings, in Jakicic's opinion, if people with type 2 diabetes were told that all they needed to do was take their medication and lose weight, other potential benefits of fitness (e.g., lower HbA1c) would be missed.

Jakicic suspects that in addition to directly impacting health-related outcomes, physical activity may impact health indirectly through its effects on body weight and adiposity. Physical activity also may change dietary behavior, again indirectly impacting health-related outcomes. Jakicic encouraged a greater understanding of the different pathways that impact health-related outcomes.

The Important Role of Physical Activity in Maintaining Weight Loss

Not only is physical activity important for weight loss, but it is also important for the maintenance of weight loss, Jakicic continued. In a study of about 150 individuals who participated in an 18-month weight loss program, he and his research team classified participants into three categories based on their physical activity levels and examined their weight loss trajectories (Jakicic et al., 1999). The researchers showed that individuals in the highest activity category (average dose of 280 minutes/week) lost more weight during the first 6 months than individuals in the other categories and were able to maintain that lost weight over the next 12 months. Individuals in the other categories lost less weight during the first 6 months and regained more of their lost weight over the next 12 months.

In a separate trial involving about 170 individuals, Jakicic and colleagues (2008) analyzed the effect of physical activity on 24-month weight loss and found that, when participants were stratified by percent weight loss into four groups, every group showed an increase in physical activity during the first 6 months. However, the only group that showed sustained physical activity (1,500 kcal/week or 275 minutes/week above baseline)

over the course of the entire 24-month period was the group that lost the most weight (10 percent or greater weight loss).

The Jakicic et al. (1999, 2008) studies both were based on self-reported physical activity data. More recently, Jackicic and his research team used an objective measure of physical activity obtained from a wearable device to determine whether activity patterns differ for people who maintain a 10 percent weight loss over time compared with those who are unable to sustain that weight loss (Jakicic et al., 2014). The researchers separated participants into four groups based on whether they had achieved and then maintained a 10 percent weight loss at both 6 and 18 months and analyzed their activity patterns. The group that had lost weight at the 6-month mark and maintained that weight loss over the course of the entire 18 months lost and sustained, on average, an impressive 18 percent of body weight, Jakicic said. That is the same magnitude of weight loss typically observed following gastric band surgery, he noted, and it may even be greater. In terms of activity patterns, the "maintainers" compared with the other groups sustained much greater levels of moderate- to vigorous-intensity physical activity (MVPA), measured in bouts of 10 minutes' or longer duration, over time (about 1,200 metabolic equivalent of task [MET]-minutes per week at both 12 months and 18 months). In contrast, there appeared to be no relationship between weight loss and bouts of MVPA shorter than 10 minutes in duration.

In the same study, Jakicic and colleagues also examined effects of light physical activity on maintenance of long-term weight loss. Again, they found that those who lost 10 percent or more and maintained that weight loss over time showed a sustained increase in activity over time. Jakicic interpreted this finding to mean that individuals who successfully lost 10 percent or more of their body weight and maintained that loss over time did not simply convert what had formerly been light activity into MVPA. Rather, the people who were most successful with their weight loss management were those who increased both types of activity. He said, "We should be targeting both of those behaviors in order to potentially improve long-term weight loss outcomes."

Variability in Response to Physical Activity

Like Gabriel Shaibi before him, Jakicic expressed curiosity about variability in responses to physical activity (see the previous section for a summary of Shaibi's presentation). Data from the Midwest Exercise Study, a 16-month study involving 4 to 5 days per week of supervised 45-minute exercise sessions at about 70 to 75 percent of VO_2 max, showed that about half of the women in the exercise intervention gained weight, while the other half lost weight (Donnelly and Smith, 2005; Donnelly et al., 2003).

In other words, there was great variability in terms of gaining versus losing weight with the same exercise intervention. The question for Jakicic was, why? He said he was exploring the possibilities and was especially interested in eating behavior.

Jakicic described a study conducted in his laboratory that served as the basis for a doctoral student's dissertation. Women were brought into the lab on two separate occasions—once to sit for 45 minutes and once to exercise at about 70-75 percent of their age-predicted maximum heart rate for 45 minutes—and then provided free access to food (Unick et al., 2010). Half the women ate more on the day they exercised, and the other half ate more on the day they rested. Jakicic suggested that this finding may indicate a differential response to physical activity whereby physical activity may stimulate hunger in one person and produce a satiety effect in another. He called for a greater understanding of the hunger versus satiety response to exercise.

Finally, Jakicic expressed curiosity about expenditure patterns of physical activity. For example, the expenditure patterns of three 10-minute bouts of MVPA within a 60-minute period and one 30-minute bout within that same 60-minute period are very different. Jakicic suggested that different patterns may produce different responses.

PANEL DISCUSSION

Following Jakicic's presentation, he and the other speakers participated in a panel discussion with the audience.

Weight Cycling

An audience member asked about weight cycling and what it bodes for weight loss and maintenance in the future. Jakicic observed that weight cycling is not discussed now as much it was 20 years ago, yet it is still, in his opinion, a "huge deal." It is difficult to conduct randomized controlled trials of weight cycling. He and his team have done a small amount of work on the psychological response to weight regain and the vicious cycle it starts, beginning with people becoming less adherent. In an 18-month study, they proactively targeted some participants in places where they would tend to slip and observed a 10 percent sustained weight loss among those participants (Jakicic et al., 2015). Participants who were not proactively targeted regained their lost weight. Kriska added that, in both the DPP and its follow-up study, help was provided to participants who started slipping with either their weight or their physical activity in determining what they needed to do to get back on track.

Diabetes Prevention Program (DPP) Results

Kriska was asked why the lifestyle intervention in the community study did not work as well at the workplace site as at the other sites. Kriska replied that the program worked quite well at the worksite, but not as well as at the other two sites, probably because of the younger and employed nature of the worksite participants. In the DPP, she said, older individuals did better, and she speculated that the reason may be that they were retired and could devote more time to their healthy lifestyle program. She suspects that the same may have been true of the community intervention program.

A question was raised as to whether the lifestyle intervention arm of the DPP was more expensive than the metformin arm and if so, whether it is realistic for communities to consider an intense lifestyle intervention. Kriska replied that in the DPP, while the metformin arm was somewhat more economical than the lifestyle intervention, the one-on-one delivery of the lifestyle intervention contributed to its cost. As these effective lifestyle intervention programs move into communities, the intervention generally is being offered in a group setting, with the bulk of the cost related to the provision of lifestyle coaches to lead these groups. Because the programs are offered in groups, they can be more feasible to run in the community setting, as well as more cost-efficient. Kriska and others are also working on developing other cost-effective lifestyle intervention approaches, such as offering the intervention online or via DVD.

Obesity as a Physical Disability

A comment was made about obesity being a physical disability in the sense that it keeps people from being active. Jakicic recalled his work in a physical therapy setting where patients presented with back pain. It was clear to Jakicic that many of these people were carrying significant amounts of body weight, yet nothing was done in that setting to address their weight issues. He said, "I think we need to be thinking cross-disciplinarily . . . in order to have the biggest effect." Another audience member observed that, at least with respect to osteoarthritis, physical therapists today are much more aware of weight than they have been in the past.

Physical Activity Versus Obesity

An audience member asked Jakicic what would be lost by dissociating physical activity from weight loss. If someone engages in physical activity, in the questioner's opinion, eventually their obesity will be managed. The real tragedy, he believes, is when people discontinue their weight loss behaviors because they have not lost any weight. Jakicic stated that very

few people with a BMI of more than about 35 are physically active at a level that would help them achieve the health benefits of physical activity. In his opinion, for people with BMIs greater than around 35, one of the best ways to start may be with weight loss. "There are a lot of people out there," he said, "who need to lose weight just to be functional." In his opinion, dissociating physical activity from weight loss would be doing those people an injustice.

5

Policy Strategies for Promoting Physical Activity

OVERVIEW

On the second day of the workshop, the focus shifted from the science of physical activity to the promotion of behavior that promotes physical activity. Russell Pate provided some introductory remarks. Then, in the first session of the day, which was moderated by Ginny Ehrlich, Amy Eyler and Jamie Chriqui discussed policies aimed at promoting physical activity. Pate's introductory remarks, Eyler's and Chriqui's presentations, and the discussion at the end of their session are summarized in this chapter.

First, Eyler asked, why policy? In her opinion, two key advantages of policies are, first, that they reach a large percentage of the population and, second, that they remain sustainable over time. She described public policies across several sectors that impact physical activity and identified barriers to promoting and implementing innovative policies of this sort. In community planning and zoning, a major challenge is not only to build sidewalks and places where people can walk but also to maintain those areas. In the public transportation sector, while ballot issues that would encourage physical activity (e.g., installing a bus stop that would encourage walking) often receive widespread support, funding remains a challenge (e.g., people are not willing to approve tax increases). In Eyler's opinion, promoting physical activity will require a culture change, similar to that required to promote smoking cessation—one that will likely emerge from a convergence of top-down (public) and bottom-up (organizational) policies.

Chriqui discussed research results on a wide range of public policies and explained how research has helped identify challenges to promoting

and implementing policies on physical activity. Most of this work, she said, has been in the education sector. For example, studies have shown that many state laws are silent on the actual amount of time in physical education classes devoted to moderate- to vigorous-intensity physical activity (MVPA). That reality, combined with the confusing wording of many state laws regarding what physical activity actually means, results in many students failing to engage in the nationally recommended amount of physical activity. Among other gaps in the evidence base, Chriqui highlighted the lack of data on how "complete streets" policies impact not just health outcomes but economic development outcomes as well.[1] In her opinion, moreover, studies too often focus on single policies, mainly in education, and only on policies that have been implemented. She called for longitudinal studies examining the collective impact of policies across multiple sectors.

PROMOTING PHYSICAL ACTIVITY: AN INTRODUCTION[2]

Physical activity is a complex behavior, Russell Pate began, yet people often use the term "physical activity" as though it were a simple construct. Over recent decades, as physical activity has begun to achieve a place in U.S. public health, the fact that it is a complex behavior that takes many forms and is packaged in many ways, with multiple combinations of frequency, intensity, duration, and dose, has become increasingly clear. Additionally, physical activity is performed for many reasons—not just positive health outcomes, which Pate characterized as far from the only reason and probably one that historically played very little role. Historically, Pate suggested, people likely were physically active because they had to be in order to survive or live the way they wanted. Adding to its complexity, physical activity is influenced by many factors, so that, Pate opined, it is highly unlikely that there is a single magic bullet for promoting it.

Research on promoting physical activity typically has been theory based, Pate continued, with many different and, over the years, evolving theories being applied to the design and testing of interventions aimed at increasing physical activity. One widely applied theory is that of planned behavior, which, Pate explained, posits that intention to be physically active is a central construct. Social cognitive theory is another frequently applied theory, according to which important interactions among an individual, behavior, physical activity, and the environment in which the activity is performed profoundly influence future participation in that activity. One's

[1] Complete streets policies are designed to ensure that new streets are built not just for cars but for all users, including pedestrians, bicyclists, and public transportation vehicles and users.

[2] This section summarizes the day two introductory remarks provided by Russell Pate, Ph.D., Arnold School of Public Health, University of South Carolina, Columbia.

confidence and sense of competence with regard to being physically active are important concepts of social cognitive theory. Finally, the stages of change theory posits that when thinking about the promotion of physical activity, it is important to recognize that not all people are equally ready to adopt physical activity. According to this theory, Pate explained, some people have never even thought about exercising; others have been thinking about it but have not spent much time trying it; still others are "nibbling" at it, trying it with limited success; and some have mastered the behavior such that it is part of their lifestyle. The stages of change theory suggest to Pate that trying to apply a single intervention to a range of people with varying readiness to be active makes little sense.

Every multivariate analysis of the prediction of behavior with which Pate is familiar has revealed a great deal of unexplained variance, which to him suggests that researchers cannot measure very well what accounts for whether people are engaged in a behavior on a regular basis. Nonetheless, researchers do know that participation in physical activity is influenced by interpersonal variables (i.e., social factors), institutional characteristics (e.g., features of schools, worksites, and other places where people spend their time), and community characteristics (e.g., where people live), as well as more distal factors related to public policy and mass media. As work on the promotion of physical activity has evolved, what researchers refer to as the social ecological model, which takes all of these different factors into account, has become a framework for thinking about what will be required to make real progress on physical activity at the population level.

Intervention studies designed to determine what works to increase physical activity have tested a range of targets, Pate continued, including individuals, peer groups and families, institutions (e.g., schools, worksites), community resources, and policies and media. With respect to the effectiveness of tested interventions, Pate referred workshop participants to the physical activity component of the *Guide to Community Preventive Services*, which, although dated, is based on a rigorous review of the then-current literature on physical activity interventions (i.e., papers published between 1980 and 2000) (Kahn et al., 2002). That review generated a number of conclusions. First, Pate noted, the literature offered strong evidence in support of community-wide campaigns as an informational approach to increasing physical activity, but less support for other informational approaches. Additionally, strong evidence was found for three types of behavioral and social strategies for increasing physical activity: school-based physical education, social support interventions in community settings, and individually adapted health behavior change programs. Among environmental and policy approaches studied, the review yielded strong evidence for the creation of or enhanced access to places for physical

activity. Pate said he looks forward to an updating of the community guide given how much research has been conducted since its publication.

Also as a source of information on the effectiveness of tested interventions, Pate mentioned the *Physical Activity Guidelines for Americans Midcourse Report*, which summarizes evidence on interventions for increasing physical activity in children and adolescents according to setting (i.e., school, preschool and childcare centers, community, family and home, primary care) (HHS, 2012). Only two intervention strategies received what Pate said was the highest level of support (i.e., "sufficient," as opposed to "suggestive," "emerging," or "insufficient"): multicomponent school interventions and school-based interventions focused entirely on enhancement of physical education. In Pate's opinion, the less than sufficient rating received by other interventions does not necessarily mean they are ineffective in "the real world." Rather, it means the evidence available at the time the review was conducted was not compelling enough to warrant higher ratings. Some of the strategies, such as classroom-based activity breaks, have been studied only fairly recently, with literature still emerging.

Finally, Pate mentioned the *National Physical Activity Plan* as another source of evidence-based information on the effectiveness of various interventions (National Physical Activity Plan Alliance, 2010). Based on a compilation of evidence-based approaches to promoting physical activity, the plan provides a comprehensive set of policies, practices, and initiatives aimed at increasing physical activity in the U.S. population. According to Pate, the plan was developed differently from similar plans in other countries. In most other countries, development of a national physical activity plan is a government undertaking. In the United States, while government supported, this effort was based largely outside of government and under the leadership of a coalition of organizations, most in the health sector but some in other sectors as well. The plan was developed by panels of experts who recommended strategies organized around eight societal sectors (public health; education; volunteer and nonprofit organizations; transportation, urban design, and community planning; mass media; health care; business and industry; and parks, recreation, and sports). The plan recommends more than 250 strategies and tactics.

PROMOTING PHYSICAL ACTIVITY THROUGH POLICY: AN OVERVIEW[3]

"Why policy?" Amy Eyler began. Policies, she said, more so than individual-level interventions, have the potential to impact a broad commu-

[3] This section summarizes information and opinions presented by Amy A. Eyler, Ph.D., C.H.E.S., Washington University in St. Louis, Missouri.

nity or population. Once in place, they also have the potential to be more sustainable over time compared with trends. In Eyler's opinion, much of the major impact of public health over the past decades is attributable to policies. She cited as examples changes in sanitation, fluoridation, drunk driving, and tobacco use.

Policies can affect physical activity in many ways. They can improve access to opportunities for physical activity—for example, by changing the way communities are designed and increasing bike lanes or parks. They can regulate, as is the case with state laws related to the quantity and quality of physical education. They can promote programs and national campaigns, such as First Lady Michelle Obama's Let's Move!. They can provide funding to promote physical activity from the state down to the local level. Finally, they can coordinate efforts, particularly at the state level—for example, through state laws that create councils or boards to share information and resources across activities.

Like the definition of policy itself, the definition of physical activity policy is broad, Eyler continued. It can be legislative action, organized guidance, or just a general rule. It can be formal (e.g., a formal written code) or informal (e.g., written standards).

Policies have a broad range of actual and potential impacts. Since about 2005, Eyler has been inventorying state laws related to childhood obesity and examining the quality and quantity of 27 categories of legislation. As an example of what she considers a weak policy, she described how, every year since 2009, a Missouri state law was introduced to designate the jumping jack as the state's official exercise; finally, in 2014, the law was enacted. Apparently, Eyler explained, jumping jacks were "created" by Missouri-born General John J. Pershing in the late 1800s as a drill exercise for cadets. In Eyler's opinion, the jumping jacks law is a weak physical activity policy because it does not, for example, require everyone to do jumping jacks for 20 minutes three times per week. In contrast, a law enacted in Oklahoma in 2014, Enrolled Senate Bill No. 1876, specified detailed improvements in the physical education curriculum.

In the mid-2000s, Tom Schmid and colleagues at the Centers for Disease Control and Prevention (CDC) created a physical activity policy framework outlining the different sectors and scales of policy that can impact physical activity. They identified five relevant sectors (health care, transportation/planning, parks/public spaces, worksite, and school) and four scales (local, regional, state, and national). For the remainder of her presentation, Eyler discussed each of the five sectors in turn.

Physical Activity Policy in the Health Care Sector

> *Physicians need to change their paradigm and start considering physical activity evaluation and exercise prescription as essential parts of patient care. Exercise prescription needs to be as equally important as medication prescription.* —Chen et al., 2013

Policies related to physical activity counseling could play an important role in facilitating physical activity, Eyler suggested. In her opinion, however, and touching on some of what Gabriel Shaibi had discussed on the first day of the workshop (see Chapter 4 for a summary of Shaibi's presentation), there are several barriers to developing, implementing, and enforcing such policies. First, physicians have no diagnostic code to use on their charts so they can be reimbursed for counseling on physical activity aside from any comorbidity. Additionally, exercise prescriptions would require systems of referral, that is, systems that would provide the means for physicians to communicate with community partners so that patients could be given not just exercise prescriptions but also detailed information about where to go. Providers also would have to be trained to counsel and give advice about physical activity, raising questions about what type of curricular changes would be needed in medical schools to facilitate such policies.

Barriers to physical activity policy in the health care sector, Eyler continued, stem not necessarily from a lack of support for "Exercise is Medicine" and other initiatives, but from a lack of priority. She observed that physicians and medical care systems are overwhelmed, and physical activity counseling is not a priority. Another barrier is a lack of personal interest or knowledge. If one were to ask physicians what the U.S. national physical activity guidelines are, Eyler said, their answers would vary. Other barriers include time, cost, and the need for integration of services (e.g., coordinating and maintaining counseling provided by ancillary health care workers).

Physical Activity Policies in the Transportation/Planning Sector

Eyler pointed to two examples of federal transportation policies with implications for physical activity: (1) the Safe, Affordable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, or SAFETEA-LU; and (2) Moving Ahead for Progress in the 21st Century, or MAP-21. Both programs provided funding not only for transportation in general but also for ways to promote active transportation—more so, according to Eyler, in SAFETEA-LU than in MAP-21. Programs such as the Safe Routes to School initiative, which promotes safe ways for youth to walk or bike to and from school through the funding of infrastructure (e.g., sidewalks) and educational programs, grew out of these federal funding programs, Eyler

explained. She noted that the Safe Routes to School initiative was being evaluated for its impact on physical activity as well as on body mass index (BMI) and social factors (e.g., neighborhood awareness).

In addition to the promotion of active transportation, how communities are planned and zoned has a large impact on opportunities for physical activity, Eyler continued. She cited sidewalks as an important example. If walking is the main exercise in the United States but people lack safe places to walk, that clearly is a barrier to physical activity. Sidewalks need to be not only built, Eyler emphasized, but also maintained. She referred to the *Guide to Community Preventive Services* (Kahn et al., 2002), which Pate had mentioned in his introductory remarks, and identified three types of policies recommended for increasing physical activity that are relevant to planning and zoning: (1) community-scale urban design and land use policies, (2) street-scale urban design and land use policies, and (3) creation of or enhanced access to places for physical activity combined with informational outreach activities.

Regarding access to places for physical activity, Eyler noted that, based on a 2010 survey, Smart Growth America reported that almost three-quarters of Americans feel they have no choice but to drive as much as they do. This finding suggests to Eyler that changing not only the infrastructure but also the mindset of the U.S. car-driving community will require a great deal of work. She noted that more than half of those surveyed indicated they would like to spend less time in their cars.

Complete streets policies have taken hold and are being implemented in communities across the country, said Eyler, with almost 500 such policies in place in 2014. The policies range in scope and strength. Eyler mentioned Boulder, Colorado, and Portland, Oregon, as good examples of communities where complete streets policies have been not only implemented but also evaluated, and with good results.

Public transportation policy is another area of the transportation and planning sector with implications for physical activity. Americans who use transit, according to Eyler, have the opportunity to walk to and from transit stops as part of their recommended 30 minutes of daily physical activity. Like sidewalks, however, transit stops need to be maintained, Eyler said, not just built, and funding remains an issue. She and her colleagues conducted a survey through the Physical Activity Policy Research Network to gain insight into Americans' support for physical activity policy. When asked whether their city should allocate funds for building or maintaining public transit, 65 percent of those surveyed responded "yes"; when asked whether they would support a tax increase to pay for the public transit, however, barely half said "yes." According to Eyler, many public transportation policies are ballot issues that require a majority to pass. So while there is support for building and maintaining public transit, the funding of

such efforts is problematic largely because of how people prioritize their communities' needs.

Physical Activity Policy in the Parks/Public Spaces Sector

Again, one of the evidence-based recommendations in the *Guide to Community Preventive Services* is to create or enhance access to places for physical activity, combined with information outreach activities (i.e., the promotion of those places). In a focus group study, Eyler and colleagues asked women across the country why they did or did not engage in physical activity and whether there were places in their communities where they could do so. The majority of respondents reported that there were parks in their communities, but when asked why they were not using those parks, they replied that the parks were not well maintained. For example, one woman told Eyler that she had to walk over homeless people to get to the park, while another told her that there were dirty needles at the end of the slide in her park. In addition to building parks and instituting policies that create or enhance access to them, Eyler said that, as with sidewalks and transit stops, "Maintaining the quality of those parks is equally important."

In addition to parks, trails are an important component of public space with implications for physical activity. People who live near trails have easy access to physical activity, Eyler said, whether they ride their bikes, walk, or rollerblade. Policies to build, maintain, connect, and update trails can facilitate this behavior.

Promoting physical activity in the public sector is a matter of not just building and maintaining sidewalks or trails, Eyler continued, but also connecting them. She mentioned that her own neighborhood has about a three-quarter-mile stretch without sidewalks. She showed a photo of some out-of-town visitors to her neighborhood who, on their way to an ice cream store, were struggling with a stroller on the side of a dangerous road. She said, "Having policies in place that connect these [sidewalks or trails] to make sure that the destinations can be reached safely is another important aspect of policy."

Open streets policy, which originated in Bogotá, Colombia, in the 1980s, closes streets to motor vehicles and opens them to physical activity for a period of time. Even though the open streets period may occur only once per week or once per month, it nonetheless, in Eyler's opinion, gives individuals in the community an opportunity not only to interact with each other but also to become aware of places where they can be physically active. About 100 cities across the United States have some form of open streets policy. These policies are currently being evaluated, Eyler noted.

Finally, another component of parks/public spaces policy that can affect physical activity is joint-use policy. Joint-use policies are agreements

between schools and communities to make school facilities available when school is not in session. The benefits of such policies are that they are low cost, and the facilities are already built. Barriers include maintenance and liability issues and the facilities themselves.

Physical Activity Policy in the Worksite Sector

Given that the majority of Americans spend a great deal of time at work, Eyler observed that worksite policies offer a good opportunity to facilitate physical activity. Flextime policies, facilities (e.g., gyms, bike racks, lockers, or places to change clothes), and active transportation incentives (and also disincentives, such as high parking prices) all can facilitate physical activity. As an example, Eyler described the walking paths across the Washington University medical school campus (the "MedPaths" trails). Other informal worksite physical activity policies include standing desks, gym subsidies, the encouragement of breaks, and walking meetings.

Physical Activity Policy in the School Sector

> *No school house shall be considered in the city of New York without an open-air playground attached.* —New York State Law, 1895[4]

Physical activity policy in schools is probably the most obvious and most well-studied category of physical activity policy, Eyler said. She referred workshop participants to the 2013 Institute of Medicine (IOM) report *Educating the Student Body* (IOM, 2013) for information on opportunities before, during, and after school to promote physical activity among children and adolescents. During school, for example, physical activity can be promoted through physical education, through recess and breaks, and in the classroom. Eyler emphasized the importance of policies that not only promote recess but also discourage or forbid taking recess away as a punishment. Additionally, she noted that policies on before- and after-school programs can require that a certain percentage of program time be dedicated to physical activity.

Final Thoughts

Eyler concluded by stating that policies can increase physical activity at the population level, but a culture change also is necessary. It used to be common, she noted, to walk into an office and see an employee smoking

[4] N.Y. EDN. LAW § 2556: NY Code—Section 2556: Buildings, sites, et cetera.

a cigarette. "We don't see that now," she said, not just because of policies but also because of a culture change that occurred over time.

PHYSICAL ACTIVITY POLICY IMPLEMENTATION AND IMPACT: A MULTISECTORAL REVIEW[5]

In her overview of research on physical activity policy, Jamie Chriqui focused on only some of the eight policy sectors highlighted in the *National Physical Activity Plan*, specifically those sectors for which more research has been conducted on public policies (or, as she referred to them, "big P policies") enacted at the state, district, and local levels: the education, transportation, and parks and recreation sectors. She noted that her presentation was based on a very rapid review, not a systematic review, of key literature across these three sectors. Her intention, she said, was to provide a "broad brush" overview of what is known across these sectors about what works and where challenges exist.

The "punch line" of her presentation, she said, is that there is good news when it comes to physical activity policy, but there is also some challenging news. In her opinion, the most important thing to keep in mind when discussing public policy is that policy change is incremental. Large-scale, comprehensive policy changes rarely are made, particularly with respect to physical activity, given today's funding and budgetary climate. Many of the strategies she would be discussing, Chriqui remarked, have been built up over time. Additionally, much of the work has been siloed, she said. She mentioned the call for a systems-level perspective in the 2102 IOM report *Accelerating Progress in Obesity Prevention* (IOM, 2012). Another "challenging" piece of news to keep in mind, she added, is that physical activity policies often are self-enforcing, with little compliance monitoring or enforcement.

Public Policy on Physical Activity in the Health Care Sector

Chriqui was unable to identify any studies on "big P" physical education policy in health care settings. However, she came across a systematic review of physical activity interventions in adults related to some of what Amy Eyler had discussed (Eyler's presentation is summarized in the previous section). The authors (Müller-Riemenschneider et al., 2008) report that prescriptions for exercise can be incorporated into physician licensing standards and medical education and training as a way to promote physical activity.

[5] This section summarizes information and opinions presented by Jamie F. Chriqui, Ph.D., M.H.S., University of Illinois at Chicago.

Public Policy on Physical Activity in the Education Sector

Most research on public policy on physical activity has been in the education sector, according to Chriqui, with a focus on physical education (PE). In a systematic review, Bassett and colleagues (2013) found that mandatory PE was associated with a one metabolic equivalent of task (MET)-hour increase in physical activity. Chriqui emphasized the mandatory nature of the association. "You really need the law," she said. "You can't just encourage something in the physical education arena." Several other, more recent studies have found similar associations between state PE mandates, or requirements, and increased amounts of time spent in PE (Chriqui et al., 2013; Perna et al., 2012; Slater et al., 2012; Taber et al., 2013). Taber and colleagues (2013) found that the association between state PE time mandates and time spent in PE at the elementary and middle school levels holds particularly for girls, with strong state laws being associated with a 22 percent increase in PE participation among girls compared with schools with no state PE time mandates.

While state PE time mandates are necessary, implementing them remains a challenge, said Chriqui. The amount of PE time required in such laws varies greatly from state to state. While SHAPE America recommends 150 minutes of PE per week at the elementary level and 225 minutes per week at the middle and high school levels, Chriqui observed that most state laws do not come remotely close to those standards. More important, in her opinion, in a study based on interviews with state officials, Chriqui and colleagues found that most state laws fail to address the amount of time spent engaged in actual physical activity—particularly MVPA—in PE (Carlson et al., 2013). Additionally, they found that monitoring, implementation, and enforcement of such provisions, where they exist, are lacking.

With respect to recess policies, Chriqui and her research team found that elementary schools are more likely to offer at least 20 minutes or more of recess daily if state law encourages it (Slater et al., 2012). That is one area, she said, where encouragement as opposed to a mandate can actually help. The big "but," she said, is that state laws often treat recess and PE as substitutes. That is, states that meet the minimum recommendations for PE often do not meet the recommendations for recess, and vice versa (Slater et al., 2012). Additionally, the wording in state laws often is such that physical activity is defined very broadly. Thus the physical activity requirement can be met in what Chriqui described as a "laundry list" of ways, including not just PE and recess, but also activity breaks and others. Chriqui observed that schools often take the "path of least resistance," that is, the one easiest to implement and requiring the fewest resources.

With respect to after-school physical activity, Michael Beets and his research group at the University of South Carolina have done a great deal of

work in this area, according to Chriqui. Beets and colleagues (2010) found that policy requirements for physical activity time in after-school programs rarely are followed. But the biggest challenge, Chriqui opined, is that most after-school physical activity policies lack clearly defined benchmarks, making it difficult to measure and understand compliance and impact (Beets, 2012). While there are many state standards governing PE time during the school day, few standards govern before-school or after-school physical activity time.

In recent years, shared-use policies have emerged as a key target in the obesity prevention arena, with a focus on providing community access not just to school grounds but other institutional grounds as well. For example, Chriqui noted that she lives in a community where a baseball field was built on church land, and that many local baseball and softball teams are using the field through a shared-use agreement. She and her research team found that shared-use policies are associated with modest increases in physical activity in children (Slater et al., 2014; Spengler et al., 2011). Such policies may play a greater role in raising awareness than in changing physical activity behaviors, Chriqui suggested, because most of these policies, at least those that are school based, focus on school-affiliated groups and do not give priority to community residents. For example, they often do not allow evening, weekend, or holiday access. Additionally, Spengler and colleagues (2011) found that shared-use policies are lacking in low-income communities, primarily because of liability concerns.

Public Policy on Physical Activity in the Transportation Sector

In the transportation sector, Chriqui cited two "big P" policy studies related to Safe Routes to School laws and other active-travel school policies (Chriqui et al., 2012; Turner et al., 2013). First, Chriqui and colleagues (2012) found that state laws requiring infrastructure improvements around schools to facilitate active travel to school are associated with an increase in such travel. However, Barnidge and colleagues (2013) identified significant barriers to implementing Safe Routes to School policies, particularly in rural communities, including a lack of resources and a lack of support for implementation.

Regarding active transport to work, Chriqui noted that the National Institutes of Health (NIH) was funding five ongoing studies on the implementation and impact of light rail natural experiments in five different U.S. jurisdictions. The results were emerging, she said, with only the first couple of years of baseline data having been collected thus far.

With respect to community or urban design and land use, there has been very little to no work on how zoning policies impact opportunities for physical activity. Yet, as Chriqui explained, it is through their effect

on zoning codes that design and land use policies change such opportunities. Because of the lack of literature linking zoning policies to opportunities for physical activity, she and her research team, with funding from NIH's National Cancer Institute, have been studying zoning policies whose requirements include active living elements (e.g., requirements for street connectivity, bike lanes, trails, paths, mixed-use development, parks, playgrounds, open space, green space). The researchers found that communities with such zoning requirements tend to have more physically active adults (Chriqui et al., in review). Additionally, communities with active living–oriented zoning tend to have more adults taking public transit to work.

With respect to complete streets policies, Chriqui observed that while such policies are diffusing nationally, as Eyler had described, with a couple of evaluations producing good results, the evidence base needs to be built. As part of her zoning study, she and her colleagues found that walking to work and use of public transit are higher in jurisdictions that require complete streets policies (Chriqui, 2015). However, she mentioned having recently attended a meeting where Smart Growth America representatives expressed the need for a body of evidence on the impact of complete streets not just on physical activity, but also on community economic development. She said, "Having a health community is important to policy makers, but if you can focus on the economic aspects of it, that's really what's going to make a difference."

Public Policy on Physical Activity in the Parks and Recreation Sector

According to Chriqui, there is quite a bit of literature on the relationship between park access, availability, safety, renovations, and maintenance and park utilization and physical activity. Most reviews recommend policies that, first, invest in maintenance and improvements to amenities and recreational programming in existing parks and, second, focus on safety (Babey et al., 2005). "We don't need to build a lot of new parks," Chriqui said, "but we need to build up what we have and really improve what we have." She mentioned a number of local-level natural experiments, including, for example, a series of park renovations under way in low-income areas of Chicago, that are facing implementation challenges and need to be studied.

Public Policy on Physical Activity in the Business and Industry Sector

Several studies have demonstrated that worksite promotion policies are associated with higher levels of physical activity and less sedentary behavior (Crespo et al., 2011; Dodson et al., 2008; Matson-Koffman et al., 2005). Additionally, as Eyler had mentioned, worksite transit benefit programs have been shown to increase walking and active travel to work (Lachapelle

and Frank, 2009). According to Chriqui, these can include pretax public policy programs, which require tax code changes, serving as an example of how a "big P" policy change can effect change at the organizational level.

Summary

In summary, Chriqui emphasized that a wide range of policies on physical activity have been studied in terms of implementation and impact. One of the biggest challenges for researchers studying such policies, in her opinion, is that most of these studies are conducted after policies have been enacted, and therefore are limited to cross-sectional analyses. While some statistical modifications can make the analyses more rigorous and allow for comparisons between communities with and without such policies, researchers cannot conduct randomized controlled trials of physical activity policies as they can with much standard bench science work. Chriqui called for more longitudinal studies as a way to truly understand the impact of these policies over time.

In addition to more longitudinal work, Chriqui emphasized the need for studies on the collective impact of the range of physical activity policies. Most studies have focused on the education sector. Chriqui concluded by stating that more research is needed in other sectors and on the combined magnitude of the impact from these policies in all sectors.

PANEL DISCUSSION

Following Jamie Chriqui's presentation, she and Eyler participated in a panel discussion with the audience.

A Call for Community-Wide Strategies

Moderator Ginny Ehrlich opened the discussion by asking the panelists, "If we really want to move the needle around physical activity in the population, what have we learned thus far? What do we know has really worked in the policy realm, and what holds the greatest promise?"

In Chriqui's opinion, although policy researchers have done the most work in the education sector, policies in that sector do not have the greatest impact on physical activity. Aside from the collective impact of policies in all sectors, she believes the greatest impact will come from community-wide strategies, such as infrastructure changes (e.g., trails and parks), that enable communities to facilitative active living. She encouraged more focus on community-wide activities and less on the education sector, especially given the competing demands faced by schools. The childcare sector is another area where more efforts need to be directed, in her opinion.

Eyler added that the promotion of community policies affects both schools, which is where the majority of children spend a good deal of their time, and worksites, which is where adults spend much of their time. Because both schools and worksites are within communities, she agreed with Chriqui on the importance of promoting community-wide policies.

Selection Bias, Longitudinal Data, and Natural Experiments

An audience member remarked that selection bias potentially confounds understanding associations between zoning and land use policies and physical activity. In other words, it is difficult to determine whether communities with policies that promote physical activity (e.g., through mixed-use agreements and trail networks) actually change behavior among people who already live in the community, as opposed to attracting people from elsewhere who want to have an active lifestyle. The audience member asked the panelists to comment on researchers' understanding of that selection bias.

Chriqui responded that her research is among the first to examine the association of zoning and land use laws with physical activity. While the research shows that people are more physically active in communities that facilitate active living, it is not yet possible to determine which comes first. In terms of advocacy, in her opinion, it really does not matter. If people want to move to communities that support active living and are purposefully selecting into those communities, advocates still can use that phenomenon as a case for community improvements.

To truly understand the impact of zoning and land use policies on physical activity behavior will require more longitudinal research, Chriqui continued. She mentioned the growing number of "urbanist" code reforms being registered nationwide. For example, some communities along the Gulf Coast are essentially being rebuilt in the aftermath of Hurricane Katrina, providing a unique opportunity to study the impact of zoning changes longitudinally.

Approaching Policy Makers: How to Frame Funding

An audience member asked about the best way to frame conversations around funding. In Chriqui's opinion, funding is the root problem with respect to both policy implementation and policy research. In her opinion, the more advocates can speak to policy makers about return on investment, in terms of not only physical activity outcome but also economic outcome, the more their case will resonate. Many communities across the country, she said, have been engaging in health impact assessments. But health impact assessments often are not what resonates with policy makers. What reso-

nates with policy makers, in Chriqui's opinion, is economic development, particularly in parts of the country afflicted with budgetary problems. She said, "That's really where I think the focus needs to be in discussions about funding."

The same audience member also asked about the potential for modeling to help inform policy makers. Eyler responded that multiple sectors need to come together to develop a model of best practices within communities that can be used to draw support from policy makers and stakeholders.

Challenges to Policy Implementation

The panelists were asked what separates communities that implement policies from those that do not. For Eyler, implementation is a function of funding and policy wording. For example, Missouri passed a state law in 2008 requiring 30 minutes of physical activity daily in each elementary school grade. However, the law did not specify "physical education" but "physical activity." Based on conversations Eyler had with people from various school districts, walking from class to class was considered part of the 30 minutes of daily physical activity. Nor was there any funding for enforcement of the law.

Chriqui added that universal compliance is another challenge. Among the studies she presented, not a single policy case had 100 percent compliance. "We need to figure out that missing gap," she said. Also, particularly in the education sector, researchers need to determine why the gap exists. Sometimes there are competing demands; sometimes it is how a policy is worded; and sometimes the meaning of a policy has not been communicated very well. Also, policy implementation takes time. Administrative changes lead to changes in policy priorities, with activities being started and then stopped very quickly. "It's a constant battle," Chriqui said, one that requires a concerted effort across multiple sectors.

The Language of Physical Activity Policy

Continuing the discussion around wording, another audience member mentioned working with youth in a gym class in the District of Columbia where much of the class time was spent discussing the rules of playing games rather than actually physically moving. She asked the panelists whether and how language in policies is being regulated.

At the state level, Eyler replied, it varies. Some state laws are very specific with respect to the amount and time of physical education, what physical education should include, or the amount of physical activity required on a daily basis. Even so, whether those specific requirements are implemented

varies among schools, classrooms, and teachers because of a lack of mechanisms for implementation and enforcement.

In Chriqui's opinion, this is a good area for advocacy efforts. She encouraged advocates to work with policy makers to make slight changes in state laws such that the laws include not only mandatory time for physical education but also specific standards regarding what physical education should include.

Physical Activity Policy in a Car-Based Society

An audience member suggested that the "elephant in the room" was the fact that the United States is a car-based society. For her, cars are a "lethal weapon" not only for people around them, but also for people in them. She referred to Howard Franklin's writing and a study by the American Heart Association on the hidden health costs of transportation and suggested a policy intervention aimed at increasing the price of gas to reflect its true cost. Eyler noted that recent studies (i.e., natural experiments conducted after Hurricane Katrina and the recession) showed that higher gas prices can increase active commuting to work and walking and biking in communities. From a social justice perspective, however, she suggested that tax incentives might be a better recommendation than tax increases.

6

Community Strategies for Promoting Physical Activity

OVERVIEW

Following the presentations and discussion on policy strategies to promote physical activity, the focus of the workshop shifted to community strategies in a session moderated by Jim Whitehead.

"Do built environments matter?" James Sallis asked. The short answer is, yes. In Sallis's view, the American landscape of residential subdivisions and highway interchanges has dramatically reduced active travel. Not only are highways built not to accommodate walking or biking, but traveling on an interstate highway by foot or bicycle is against the law. Sallis discussed evidence on the design of activity-friendly communities and their impact on physical activity. Data from one study, for example, show that people who live in "walkable" neighborhoods are active 5 to 7 more minutes every day than those who do not live in such neighborhoods. That may not sound like much on a daily basis, Sallis said, but it amounts to about 50 minutes or 2 miles of additional walking weekly, or about 100 additional miles and 10,000 extra calories spent per year. Theoretically, 10,000 calories could prevent a weight gain of about 3 pounds, which is more than the average annual American weight gain. While it may be difficult to change a landscape once roads and buildings have been laid out, Sallis continued, it is possible to improve "micro-scale" features of the landscape, such as sidewalk quality and the safety of street crossings, to make it more walkable.

Although technology has engineered regular movement out of Americans' daily lives, Abby King asked whether technology could be harnessed to do the opposite. In her opinion, the way technology captures real-

time information and delivers personalized messages could have extraordinary population reach and impacts on physical activity. She advocated for community-engaged "citizen science" and encouraged partnering with industry to capture the tremendous amount of real-time self-movement data being collected by individuals. Additionally, she envisions great potential for information technology to provide personalized advice, citing as an example "Carmen," a bilingual virtual advisor developed for use in community centers as a way to increase walking among older Latino adults.

BLUEPRINT FOR ACTIVE LIVING COMMUNITIES: INNOVATIVE SOLUTIONS[1]

"Do built environments matter?" James Sallis began. The "American Landscapes" series of "Forever" U.S. postage stamps, with one stamp showing an image of a residential subdivision and another of a highway interchange, provide a sense of the massive scale of the built environment and the effect of policies that drive it. Residential subdivision communities have not only effectively reduced active travel but also, with their lack of parks, created limitations for leisure time activity. Highway interchanges were designed to meet the transportation goals of the United States, that is, to move as many cars as rapidly as possible. Not only are they designed not to accommodate walking or biking, but walking or biking on interstate highways is against the law. The postage stamp images of residential subdivisions and highway interchanges represent to Sallis one of the reasons Americans are among the least active and most obese people in the world. Yet, he said, "We do know how to create places where people can walk to destinations—so beautiful that they want to walk around."

For Sallis, the evidence is clear that built environments matter. He presented an example of the evidence linking community design and health. As part of the Neighborhood Quality of Life Study of Adults (NQLS), he and his research team recruited participants from low- and high-income communities in the Seattle, Washington, and Baltimore, Maryland, regions; measured their physical activity with accelerometers; and evaluated the walkability of the different communities (Sallis et al., 2009). They found that people living in walkable neighborhoods were active 5 to 7 minutes more every day than those living in other neighborhoods. This was true regardless of the neighborhoods' income level.

One might question whether 5 to 7 minutes per day is enough to justify changes in zoning and transportation policies, Sallis said. But 7 more minutes of physical activity per day, he explained, translates into 50 min-

[1] This section summarizes information and opinions presented by James F. Sallis, Ph.D., University of California, San Diego.

utes or about 2 miles of walking per week. That 50 minutes amounts to nearly 2 days of the 30-minute per day physical activity guideline. When viewed over the course of 1 year, it amounts to about 100 miles of walking, which, at 100 calories spent per mile, translates to about 10,000 extra calories expended per year. Those 10,000 expended calories could, in theory, prevent a weight gain of about 3 pounds. Consistent with this reasoning, Sallis and colleagues (2009) found substantially lower rates of obesity and overweight in the walkable communities.

Sallis cautioned that not all evidence for a link between walkability and health is as clear or consistent as what he and his research team found in the 2009 study. Nonetheless, he and his colleagues have observed similar trends in other work and across age ranges.

Related to these findings, a policy "bright spot," in Sallis's opinion, is that the new form-based zoning codes, which relate to the shape and design of buildings as opposed to their use in a particular area, encourage mixed-use communities and that adoption of form-based codes has been increasing nationwide in recent years. "Over time," he said, "these should drive changes in the way we build our communities."

Activity-Friendly Streetscapes

In contrast with Bogotá, Colombia, where activity-friendly "complete streets" streetscapes are designed for all users, including bicyclists, walkers, drivers, and transit users and with aesthetics in mind, most U.S. streets are not designed for active travel (see Figure 6-1; see Chapter 5 for a discussion of complete streets). Sallis mentioned a physical activity meeting he had attended in Atlanta, Georgia, where he and a colleague decided to take a walk but were able to go only a couple of miles because the sidewalk ended abruptly. He then showed an image of a woman pushing a stroller and walking with a child along the edge of a busy street with no sidewalks. He asked, "Should you have to put your life in danger to go out and take a walk?" That is the situation for millions of Americans, he said.

While it is difficult to change the macro-scale design of a community once roads and buildings have been laid out, Sallis presented a "snapshot" of data demonstrating how changing micro-scale streetscape features can encourage walking. The data were collected using MAPS-Mini, an observational assessment tool that people carry with them while walking down a street to identify what is present. The original MAPS-Mini assessment included 120 items. Sallis and his team reduced the list to 15 items, which they determined was a useful length to help learn how streets are designed and how their designs impact people's experiences as they walk around. The items were selected based on correlations with physical activity, guidelines and recommendations, and modifiability. The 15-item MAPS-Mini was

FIGURE 6-1 A streetscape designed for vehicles and dangerous for active travel (top), compared with an activity-friendly streetscape designed for all users (bottom). SOURCE: Presented by Jim Sallis on April 15, 2015.

evaluated for validity in more than 3,500 children, teenagers, adults, and older adults from three regions.

Sallis presented results showing that streetlights, benches, and buffers (i.e., a grass strip, parked cars, or some other barrier between pedestrians and traffic) are significantly correlated with active transportation in children, adolescents, and adults; sidewalks are significantly correlated with active transportation in children, adults, and seniors; and curb cuts are

significantly correlated with active transportation in children, adults, and seniors. He interpreted these findings to mean that not all features are important for all age groups and that getting the details right may be most important for children and adults.

When Sallis and his team considered what they called the total "score" for active transport, a measure taking into account all active transport-related variables, they found a significant correlation between that score and active transport across all age groups. Active transport increased as the total score increased, with a more than 200 percent difference in active transport days per week between the least and most walkable streetscapes (Sallis et al., in press). To Sallis, the linear nature of the correlation means a small improvement in the streetscape can lead to a small improvement in active transport, while improving the streetscape as much as possible can lead to a big improvement.

In terms of policy bright spots related to active-living streetscapes, Sallis mentioned the adoption of complete streets policies across the country—an increasing trend in recent years, with more than 600 such policies being adopted by local and state governments by 2014. The challenge now, he said, is to study the quality of these policies and whether they are actually being implemented and funded.

Active Transportation by Youth

An unfortunate trend, Sallis observed, is the observed decline in active transportation in youth (McDonald, 2007). Between 1969 and 2001, car travel to and from school increased (from less than 20 percent to above 50 percent), while walking and biking to and from school decreased (from more than 40 percent to around 12 percent). A Danish study found that adolescents who walked or biked to school were about half as likely to be overweight or obese as those who rode to school in motor vehicles (Østergaard et al., 2012).

In the United States, the Safe Routes to School initiative is intended to improve this situation given that, after distance, traffic safety concerns are the greatest barrier to walking and biking to and from school. In a multistate evaluation of Safe Routes to School programs, Stewart and colleagues (2014) found that most such programs involved building sidewalks, improving crosswalks, and making other similar changes, and that these programs were associated with a 40 percent improvement in walking and biking to and from school. Sallis mentioned but did not describe another study showing that the longer such improvements are in place, the greater is the level of active transport to and from school (McDonald et al., 2014). The distance barrier to walking and biking to and from school, Sallis said, is related to the way zoning separates schools from neighborhoods. He sug-

gested locating schools where the youth are—not on the edge of town but in the middle of the community.

A policy bright spot related to active transportation in youth was the 2005 federal Safe, Affordable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). That legislation included a funding line item for the Safe Routes to School initiative for the first time—an allocation of $1.2 billion, with 14,000 schools receiving funding. The bad news, Sallis said, is that many states did not use their allocated funds. More bad news came in 2012, when the Moving Ahead for Progress in the 21st Century (MAP-21) federal transportation law deleted the Safe Routes to School line item and cut nonhighway funds by 30 percent. It was unclear at the time of the workshop what would happen in 2015.

Parks in Communities

A national study of U.S. adolescents (n = 20,745) showed that the greater the number of recreational facilities in a neighborhood, the more active youth are and the less likely they are to be overweight (Gordon-Larsen et al., 2006). People are most active, according to evidence reported by Deborah Cohen of RAND Corporation, on the linear elements of parks, that is, on walking tracks and sidewalks. In terms of a policy bright spot related to the link between parks and physical activity and health, Sallis mentioned the Rails-to-Trails Conservancy, which has increased rail-trails from 250 to more than 21,000 miles.

Concluding Remarks

In conclusion, Sallis noted income disparities in many of the variables he had mentioned or described, with lower-income neighborhoods having, for example, less street lighting, fewer sidewalks, less traffic calming, and fewer marked crosswalks (Gibbs et al., 2012). Additionally, he mentioned a recently published review by himself and colleagues on the impact, or co-benefits, of designing places for active living. Sallis and colleagues (2015) showed that designing a place for active living impacts not just physical health but also mental, social, environmental, and economic health.

RESEARCH TO ACTION: LEVERAGING INFORMATION TECHNOLOGIES FOR POPULATION-WIDE PHYSICAL ACTIVITY PROMOTION[2]

While technology is a major driver of many of society's comforts, conveniences, and advances, it has engineered regular movement and activity out of Americans' daily lives, Abby King began. "Is there a solution in all of this technology?" she asked. Is there a way to harness technology for good in terms of physical activity? Information technology (IT) captures real-time information; delivers personalized, contextually relevant messages and information; and has extraordinary population reach and impact. King noted the explosion of mobile devices worldwide and the growing number of countries, regardless of economic development, with more cell phones than people (UN, 2013). However, King cautioned, while the potential of IT is vast, "It's really a wild west out there." Very little is known about the efficacy of IT programs and which programs may work best for which people. Traditional science is too slow and not agile enough, in King's opinion, to capture current trends in IT innovation. King suggested that one way to harness the potential of IT/mobile devices to promote physical activity is through community-engaged "citizen science," which brings together researchers, public and private organizations, and residents. She considered in detail two different IT domains in which a citizen science approach is being used: the "me" domain and the "we" domain.

The "Me" Domain of IT

The "quantified self" movement—the use of mobile and wireless devices to sense and track one's own physical activity—is an "incredible opportunity," King said. Hundreds of thousands of n = 1 individual experiments are happening across the population at large that involve the personalized "just-in-time" sensing of physical activity and collection of health-related data points throughout the day. These data could be a "game changer" in this field, in King's opinion. Data hubs are emerging in both the public and the private sector that combine and make sense of all these data, creating significant opportunities for partnering with industry in physical activity and other arenas. King encouraged researchers in the public sector to seek out these partnering opportunities.

In addition to quantification and assessment, the "me" power of IT can be harnessed through personalized IT advising—for example, through telehealth, the use of virtual "IT advisors," and smartphone app platforms.

[2] This section summarizes information and opinions presented by Abby C. King, Ph.D., Stanford University School of Medicine, Palo Alto, California.

King pointed out several evidence-based behavioral strategies that can help people change their behavior and are known to work across communication channels: realistic outcome expectations, increased awareness (mindfulness), exploration of personal benefits and costs, personal goal setting, self-monitoring, regular feedback, and social support.

With respect to telehealth by computer, a major question has been whether automated systems can actually replace human advisors in promoting regular physical activity. King remarked that, while making their flight reservations, some workshop participants probably spoke to an agent over the phone, while others probably used an automated interactive voice response system. In an 18-month study, she and her research team found no difference between phone advice delivered by humans and that delivered by a human-sounding automated advisor (King et al., 2007). At the beginning of the study, when asked which they preferred, human or automated, 85 to 90 percent of participants said they needed a human advisor. But in fact, the data show that human and automated advisors were equally effective in improving moderate- to vigorous-intensity physical activity (MVPA). King cautioned that people tend to prefer what they know, even if that may not be the best solution in the long run. She and her research team, in collaboration with Dr. Marcia Stefanick at Stanford and other investigators around the country, are scaling up the automated advice program as part of a trial involving about 40,000 women who have been participating in the National Institutes of Health (NIH) National Heart, Lung, and Blood Institute's (NHLBI's) Women's Health Initiative (WHI).

An important role for personalized technology, King continued, is in preventing the widening of the health disparities gap by helping to address underlying language- and reading-level issues, problems with computer access and skills, and health illiteracy. There has been a movement to develop virtual advisors that can provide tailored interactions through simple verbal and nonverbal conversations. In collaboration with Tim Bickmore and colleagues at Northeastern University, King and her team are testing "Carmen," a culturally adapted bilingual (English, Spanish) advisor with which individuals can interact simply by touching a monitor screen (see Figure 6-2). Carmen was installed in computers at a community center in San Jose, California, where "she showed herself to be an excellent physical activity coach," King said. The virtual advisor was successful in increasing walking minutes, as measured by both pedometry and self-report, in Latino older adults, most of whom had never touched a computer before they started using Carmen (King et al., 2013a). When the investigators asked participants at a 4-month posttest what it was like to work with Carmen, participants reported that Carmen "cared" about them, they "felt close" to Carmen, they "trusted" Carmen, and they were interested in "continuing to work with Carmen." In fact, King said, they did continue

FIGURE 6-2 Participant in the King et al. (2013a) telehealth study receiving physical activity advice from "Carmen," a virtual advisor.
SOURCE: Presented by Abby King on April 15, 2015.

to work with Carmen for another 5 months after the study ended and did not want the researchers to remove Carmen from their community centers.

The next step for virtual advisors, King suggested, is to scale them up and test them in more community settings and with different populations, and to evaluate their longer-term effectiveness. At the time of this workshop, she and her research team were testing Carmen versus human advisors in the Latino community in the San Francisco Bay area. Examples of other potential settings for such virtual advisors, in addition to community centers, include clinics and pharmacies, libraries, worksites, recreational centers, schools, and shopping malls—anywhere people tend to have to wait or congregate, said King.

With respect to smartphone apps, which King noted are increasingly popular and ubiquitous, many have the potential to assess physical activity passively and provide real-time feedback, but few employ other theoretically or empirically based strategies for enhancing motivation and behavior over time. She and her colleagues have been developing smartphone apps to help users walk more and sit less. King and colleagues (2013b) tested

three apps based on different motivational frames (see Figure 6-3). The analytic app, which is based on facts and figures, provides users with data so they can see how they have been doing throughout the day. The affect/play motivational app, in contrast, has no facts or figures, but a bird avatar that tells users how they are doing. If they are doing well, the avatar is chipper and cheery and flying fast. If the user is not doing well, the avatar appears moribund. Finally, the social app provides feedback, but within a group format, with users being part of virtual teams and the feedback being in the form of the user's team versus other teams.

The researchers found that all three apps increased self-reported physical activity (brisk walking) across a smartphone-naïve sample of midlife and older adults, but the social app had the greatest overall impact, relative to a control group, among this age group when an objective measure of physical activity—the smartphone's built-in accelerometer—was employed. Additionally, they found more variability in responses to the analytic and affect apps compared with the social app—some people loved the analytic and affect apps, while others disliked them. Thus for King, the real question is not whether the apps work, but which apps work for whom. With respect to sedentary time, the analytic app appeared to perform the best in decreasing self-reported television sitting time. The social app performed the best overall with respect to sedentary behavior accumulated through-

FIGURE 6-3 Three smartphone apps, each based on a different motivational frame, designed to help users walk more and sit less.
SOURCE: Presented by Abby King on April 15, 2015.

out the day, measured objectively using the phone's built-in accelerometer. These results suggest that different kinds of behaviors may require different kinds of motivational frames.

Looking to the future, King imagined technology that informs and motivates but "gets out of the way" of active living. Right now, she said, people are looking at the world through a screen. She foresees screens disappearing and predicted that people will increasingly be wearing IT, whether it be in the form of iWatches, clothing that "senses" what and how people are doing throughout the day, or Google Glass-–like wearables. That shift, she said, could be "freeing" in terms of physical activity and active living.

The "We" Domain

King described some ways in which the "we" domain of IT empowers citizen scientists to assess and advocate for healthier neighborhoods and social environments. For example, she and her research team have been developing a simple technology, the "Stanford healthy neighborhood discovery tool," to help low-income, underserved residents identify features in their own neighborhoods that facilitate or hinder active living and healthy eating. Residents can use the data to prioritize issues (i.e., based on feasibility and cost), build community partnerships, and advocate for change with community decision makers (Buman et al., 2012). The technology is a very simple electronic tablet that captures barriers to walking and food access. Residents can carry the tablet with them as they walk around their neighborhood and use it to take geocoded photos and narrate problems they see. The resulting information can be assembled into an aggregated view so that policy makers and others can see, on a map, where barriers in the community are located, and can hear about problems (by clicking icons) in residents' own voices.

As part of a "we" domain healthy neighborhood project in east Palo Alto, California, which King described as one of the poorest communities in the San Francisco Bay area, Winter and colleagues (2014) found that residents did a great job using the Stanford healthy neighborhood discovery tool to identify issues with traffic crossings and public transit paths and devise solutions. The residents presented their results to the city council, which in turn used this and related information to allocate about $400,000 for a city-wide environmental analysis, in addition to initiating sidewalk repairs and other improvements to facilitate walking.

The citizen science approach is being used to assess neighborhoods and social environments and advocate for improvements to make them healthier in many ways and in many places worldwide: low-income residents in north San Mateo County, California, for example, learned how to increase their food access; Latino teens and older adults in North Fair Oaks, California,

worked together to improve their neighborhoods for walking; citizens in Mexico formed a coalition to increase neighborhood cohesion and safety; Israeli Arab and Jewish residents in Israel are coming together, some for the first time, to talk about neighborhood barriers and generate collaborative solutions; residents in Bogotá, Colombia, have been evaluating city-wide "open streets" recreational programs (*ciclovía*) (see Chapter 5); and residents of rural upstate New York have been catalyzing positive change in their food and activity environments. The goal, or dream, King said, is to build a network of community-engaged citizen scientists for promoting healthful lifestyles and reducing health inequalities around the world.

In addition to the use of IT in citizen science projects as a way to promote physical activity, King made a call for more research on the spread of physical activity through social networks. Evidence suggests that social networks can be harnessed for change through processes such as homophily, whereby perceived similarities lead people to identify with and associate with each other (Centola, 2011; Hinyard and Kreuter, 2007).

Summary

In summary, King offered some thoughts on what can be done with technology to increase levels of physical activity: harness the power of intersectoral and intergenerational teams to "push the envelope" in the physical activity field and learn IT language, culture, and opportunities; seek opportunities to partner with the private sector, as well as with community organizations; reach all groups to address health disparities; determine which communication channels work for which groups; consider "stealth" interventions, where the focus is not just on health but also on other motives and values; address issues of privacy, anonymity, and informed consent; continue to promote physical activity proactively as complementary and synergistic partners; and tackle challenges not just from the top down, via policy, but also from the bottom up, through citizen science engagement.

Finally, King challenged researchers, organizations, and residents to expand beyond their usual comfort zones and collaborate in leveraging the potential of IT. By doing so, she said, quoting from the Disparity Reducing Advances (DRA) Project of the Institute of Alternative Futures, "we will be better able to meet the challenge of not only anticipating the future, but creating it."

PANEL DISCUSSION

Following Abby King's presentation, she and Sallis participated in a panel discussion with the audience. This section summarizes the discussion.

U.S. Cities Taking a Smart Approach to Active Design

An audience member asked whether any U.S. city is taking a "smart approach" to active design. Sallis cited New York City as an example of a city that has taken some transformative steps, as well as Portland, Oregon. In his home state of Mississippi, he mentioned the city of Hernando, whose mayor, Chip Johnson, has become a national leader as a result of his efforts to make the town healthier. Sallis remarked that he had recently visited Jackson, Mississippi, where the main street was being torn up so that the sidewalks could be widened and a pedestrian-friendly roundabout built.

Harnessing Social Change

An audience member remarked that health departments often talk about policy, but not so much about community engagement or harnessing change in large numbers of people. She mentioned Toni Yancey's work with instant recess (her notion that 10-minute bursts of physical activity can make a difference, which spawned a social movement to get people moving), and wondered whether there are other examples of communities harnessing social change to promote physical activity. Sallis suggested that active applause, whereby audience members stand up when they applaud, might become another physically active social movement.

King added that there are hundreds, if not thousands, of natural experiments going on across the United States. Because researchers and policy makers do not have a good way to harness those natural experiments, she encouraged paying attention to what community-based organizations are doing.

IT for Children

An audience member remarked that much of the IT work discussed by King was focused on older users and asked about the unique challenges of working with children. Might children be more difficult to engage, given competing interests in terms of access to technology?

King agreed that IT is "natural" for children—so much so that the goal with children often is not to engage them but to unplug them so they can actually look at their environment. She speculated that using IT to promote physical activity in children will likely require stealth approaches, an example being the way Dance Dance Revolution (a videogame that gets users up and moving) harnesses play. She suggested that children and adolescents themselves are leading the way for next generations in terms of how to use technologies to promote physical activity and healthy living.

Engaging the IT and Venture Capital Communities

King was asked to comment on ways to engage the IT and venture capital communities. She replied, "Silicon Valley is more ripe than ever for health-related technologies." After being discouraged for a while, they are back to the table, she said. There is a new understanding of the synergies between making sense of all these data and both their own profit margins and their ability to do good in the world.

7

Institutional Strategies for Promoting Physical Activity

OVERVIEW

After considering policy and community strategies for promoting physical activity, workshop participants turned their attention to institutional strategies, in a session moderated by Linda Meyers. The session included presentations by Allison Nihiser and Nico Pronk, followed by a panel discussion with the speakers.

A key finding in the 2012 *Physical Activity Guidelines for Americans Midcourse Report* (HHS, 2012), according to Nihiser, is strong evidence for the importance of a multicomponent approach to promoting school physical activity. An essential part of this approach is physical education, the majority of which is spent keeping students active. Nihiser discussed how the recommendations in that report helped inform and strengthen the Comprehensive School Physical Activity Program of the Centers for Disease Control and Prevention (CDC) and SHAPE America—a national framework for addressing physical activity in schools—and how other national initiatives are helping states implement the report's recommendations. Among other signs of progress, in 2013 CDC provided funding for the first time to all 50 states to support efforts to address physical activity in schools.

Many workplace physical activity programs are quite effective, but their effectiveness depends on design, according to Pronk. He described how the workplace has been changing such that jobs have become more sedentary, creating a great need for physical activity and movement. He then proposed an organizing framework for the implementation of effective

workplace physical activity programs and elaborated on what researchers have learned about the design characteristics of successful programs. He also emphasized that the culture of an organization is a strong predictor of the degree of success of such programs.

EVIDENCE-BASED AND INNOVATIVE STRATEGIES FOR SCHOOL-BASED PHYSICAL ACTIVITY[1]

A key finding in the *Physical Activity Guidelines for Americans Midcourse Report* (HHS, 2012), according to Nihiser, is that schools are an important setting for increasing levels of physical activity among youth. More important, she stated, the report presents strong evidence for recommending that schools implement a multicomponent approach to school physical activity and ensure that physical education is one component of that approach. The report emphasizes that schools should ensure not only that enough time during the school day is spent on physical education, but also that the majority of physical education class time is spent keeping students active. Additional key findings are that there is enough evidence to recommend implementing active transportation—that is, walking or biking—to and from school, and emerging evidence to recommend activity breaks (i.e., classroom-based physical activity and recess).

The Comprehensive School Physical Activity Program

The multicomponent approach recommended in the *Midcourse* report helped inform and strengthen the recommendation of CDC and SHAPE America that schools develop and implement the Comprehensive School Physical Activity Program (CDC, 2013). This program serves as a national framework for addressing physical activity in schools and improving the quality of physical activity and physical education throughout the school day. According to Nihiser, the program is intended to guide schools' physical activity programming so that students have as many opportunities as possible to be physically active throughout the school day, as well as before and after school, and can achieve the recommended 60 minutes of physical activity daily.

The Comprehensive School Physical Activity Program has five components. The first, and the foundation of the program, is physical education. The others are physical activity during school, physical activity before and after school, staff involvement (i.e., with staff both serving as role models for living healthy lives and helping to implement and energize the program),

[1] This section summarizes information and opinions presented by Allison Nihiser, M.P.H., Centers for Disease Control and Prevention, Atlanta, Georgia.

and family and community engagement (e.g., ensuring that communities are providing additional resources for schools). The process for implementing the program, Nihiser said, involves identifying a champion for physical activity at the school, typically a physical education teacher. That individual then recruits others from the community to lead the school through, first, an assessment of physical activity opportunities throughout the school day, then implementation, and finally evaluation.

Based on national data collected by CDC, in 2012 no state had more than 30 percent of its schools offering the Comprehensive School Physical Activity Program, and only 12 states had 21 to 30 percent of their schools implementing the program. "We really have a lot of work to do in this area," Nihiser said.

States can help by providing support to schools. In 2012, 49 percent of states provided professional development or offered funding for professional development for physical education teachers on the development, implementation, and evaluation of the Comprehensive School Physical Activity Program.

Additionally, Nihiser listed three innovative national initiatives whose goals are to disseminate and implement the Comprehensive School Physical Activity Program and improve the quality of physical activity and physical education in schools: (1) CDC's State Public Health Actions to Prevent and Control Diabetes, Heart Disease, Obesity and Associated Risk Factors and Promote School Health[2]; (2) Let's Move! Active Schools[3]; and (3) the President's Council on Fitness, Sports and Nutrition's Presidential Youth Fitness Program.[4]

As part of the CDC's State Public Health Actions program, Nihiser said, CDC provided funding to all 50 states for the first time in 2013 to address physical activity in schools. All states are funded to address both physical education and recess policies at the state and district levels; 32 states receive additional funding to work with targeted districts on providing professional development and technical assistance for the Comprehensive School Physical Activity Program.

Let's Move! Active Schools is working directly with schools to implement the Comprehensive School Physical Activity Program. According to Nihiser, any school can sign up to be a Let's Move! Active School. The program identifies a physical activity champion at each school and empowers that individual to promote physical activity across the school day. Addi-

[2] See http://www.cdc.gov/chronicdisease/about/state-public-health-actions.htm (accessed September 8, 2015).

[3] See http://www.letsmove.gov (accessed September 8, 2015).

[4] See http://www.pyfp.org (accessed September 8, 2015).

tionally, the program provides a number of free resources, including online tools, professional development, and training.

The purpose of the Presidential Youth Fitness Program is to improve the quality of physical education in schools by improving fitness education. Its three-pronged approach involves, first, schools conducting an assessment using the FITNESSGRAM®. Additionally, schools receive and participate in professional development and training from the program on incorporating fitness education into the curriculum and communicating about the assessment. Finally, schools and students are provided recognition so that they are motivated to continue to improve their levels of fitness. As with Let's Move! Active Schools, any school can sign up to be part of the Presidential Youth Fitness Program.

A key challenge for the Comprehensive School Physical Activity Program, Nihiser said, is ensuring that schools can implement the program. A common component of all three of the above-described national initiatives is professional development and training, with Let's Move! Active Schools and the Presidential Youth Fitness Program providing training directly to a school's physical education teacher or physical activity champion and with the CDC initiative providing training at the state and district levels. Additionally, all three initiatives have comprehensive and rigorous evaluation components. At the time of this workshop, the Presidential Youth Fitness Program had just released its year 1 evaluation results.

Innovative Approaches to School-Based Physical Activity

Nihiser reiterated that physical education is the foundation of the Comprehensive School Physical Activity Program's five-component approach. She stated that there has been a big push across the country to implement the recommendation in the *Midcourse* report to ensure not only that adequate time is provided for physical education in the school day, but also that students are active during physical education classes (HHS, 2012). Likewise, efforts are being made nationwide to transform physical education to incorporate what SHAPE America recently identified as the four essential components of physical education (SHAPE America, 2015):

1. policy and environment (i.e., by ensuring that time, facilities, and other support are available for physical education so that students can engage in it as they do in any other subject);
2. curriculum (i.e., by ensuring that physical education is informed by a curriculum based on national standards);
3. appropriate instruction (i.e., by hiring qualified physical education teachers who can keep students active for the majority of class time); and

4. student assessment (i.e., by ensuring that students are being assessed for whether they are achieving national standards).

In addition to efforts to transform physical education nationwide, another area of innovation, Nihiser observed, is recess in secondary schools. As students age, they tend to engage in less physical activity. Everyone is familiar with the recommendations around recess in elementary school, Nihiser said. But what about using recess in middle and high schools to add more physical activity time to the school day for older youth? Nihiser called for more research in this area. For example, what is appropriate for recess for middle and secondary school students? How should the students be supervised? How can recess for adolescents be promoted? Does recess in middle and secondary school result in increased physical activity? Does it result in the same increase in academic achievement observed in elementary school students? Nihiser noted that SHAPE America would be issuing a policy statement on recess in grades K-12.

With respect to innovative initiatives promoting physical activity before and after school, again, the *Midcourse* report states that there is enough evidence to recommend that schools implement active transport to and from school. Nihiser noted that CDC has been working with the Office of the Surgeon General to examine strategies for promoting walking in a number of settings, including educational settings.

In addition to active transport to and from school, more than 10 million youth across the country engage in after-school programs. The impact achieved by targeting these programs could be great, Nihiser said. She noted the Alliance for a Healthier Generation's Healthy Out-of-School Time Initiative, which gives out-of-school-time providers a science-based framework designed to help create environments where youth are encouraged to eat healthier and move more. The Initiative's healthy eating and physical activity standards for after-school programs have been adopted by a number of organizations.

Free Resources to Implement the Comprehensive School Physical Activity Program

In conclusion, Nihiser highlighted some free resources that schools, districts, and states can tap to support implementation of the Comprehensive School Physical Activity Program, all of which are available online.[5] They include *A Guide for Developing Comprehensive School Physical Activity Programs*, which provides schools with a template and process for program

[5] See http://www.cdc.gov/healthyschools/physicalactivity/cspap.htm (accessed September 8, 2015).

development, implementation, and evaluation; the *School Health Index*, which enables schools to assess their health policies and practices across a range of health topics, including physical activity; *School Health Guidelines to Promote Healthy Eating and Physical Activity*, which includes a number of practices schools can use to implement more opportunities for physical activity throughout the school day; and the *Physical Education Curriculum Analysis Tool*, which allows districts and schools to assess their physical education curriculum and determine whether it is aligned with national standards. Nisiher noted that the *Physical Education Curriculum Analysis Tool* was being updated to reflect SHAPE America's revised national standards.

PHYSICAL ACTIVITY PROMOTION AT THE WORKPLACE: DESIGN MATTERS[6]

The Changing Workplace

The workplace is a "changing place," Nico Pronk began. Technology is changing the energy requirements of jobs, and the resulting sedentary job types create positive energy balances. "This is pervasive throughout the contemporary workplace," Pronk said. Other important shifts in the workplace include changes in the physical locations where people work, with many people working via remote access; an aging and multigenerational workforce, with people working longer before retiring because of financial challenges; and variations in the extent to which media and communication technologies reach different types of workers to promote physical activity.

As an example of how energy requirements in the workplace have changed over time, Pronk cited data from Church and colleagues (2011) showing a dramatic shift in on-the-job energy expenditure over the past 50 years, with jobs requiring moderate energy expenditure decreasing from approximately 50 percent of all jobs in 1960 to approximately 20 percent in 2010 (see Figure 7-1). Over the same time period, the percentages of jobs requiring light or sedentary energy expenditure have increased. This subtle shift over five decades accounts for workers expending roughly 100 fewer calories per day. While that may not sound like much on a daily basis, Pronk said, it accounts for almost 80 percent of the increase in weight among the workforce over the 50-year period. Also over the past three decades, obesity in the workforce has doubled, confirming for Pronk that the changing nature of the workplace has engineered physical activity out of employment (Pronk, 2015).

[6] This section summarizes information and opinions presented by Nico Pronk, Ph.D., HealthPartners, Inc., Minneapolis, Minnesota.

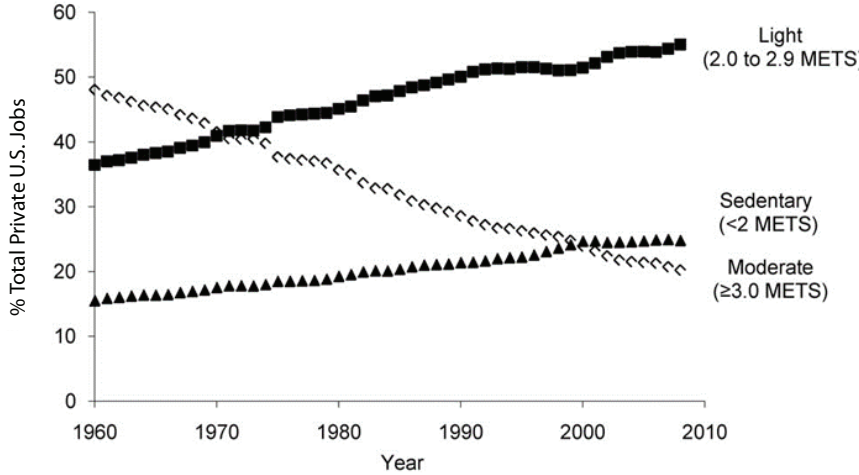

FIGURE 7-1 Change over time in on-the-job energy expenditure in the U.S. private sector, 1960-2010.
NOTE: METS = metabolic equivalents of task.
SOURCE: Presented by Nico Pronk on April 15, 2015 (modified from Church et al., 2011).

Pronk asked, why would employers be interested in physical activity and integrating movement into the workday? He cited several reasons. First, physical activity has been associated with almost 5 percent lower health care costs per active day per week (Pronk et al., 1999). At the same time, low levels of physical activity, or inactivity, have been associated with many negative health outcomes, including overweight and obesity, creating additional health care costs. Anderson and colleagues (2005) found that physical inactivity, overweight, and obesity combined were associated with 23 percent of health plan costs and 27 percent of national health care costs. According to Pronk, these associations between physical activity and health care costs alone suggest that employers should be interested in integrating movement into the workday. However, with the introduction of health care exchanges, Pronk said, that argument may become limited. If so, productivity and work performance will also need to be considered.

In terms of which physical activity interventions provide the greatest return on investment, a systematic review of population-level physical activity interventions (Laine et al., 2014) found that the most cost-efficient programs are those that increase walking and biking. Examples of such programs include community rail-trails ($0.006/metabolic equivalent of task [MET]-h), pedometers ($0.14/MET-h), and school health education ($0.056/MET-h).

Promoting Physical Activity at the Workplace

In Pronk's opinion, while people can be asked to change their behavior to increase their physical activity, or reduce their physical inactivity, it is difficult to do that by oneself and without support. Policy interventions that change either one's physical or psychosocial environment can facilitate individual efforts (Pronk and Kottke, 2013). But even with policy interventions, Pronk cautioned, "people still need to change their behavior as well."

Physical activity can be promoted at the workplace by being built into either the workday or the physical workplace. Ways to build it into the workday include changing the workflow (e.g., identifying natural opportunities to build physical activity or motion into the job itself), implementing physical activity "booster" breaks (e.g., stopping the assembly line for 5 minutes and having everyone on that line participate in some sort of flexing, stretching, or cardiovascular activity), and holding walking meetings. Ways to build physical activity into the physical workplace include encouraging the use of staircases (e.g., using messages or other point-of-decision prompts telling people to use the stairs instead of the elevator), using sit-stand devices (i.e., so that people doing sedentary work can break up the sitting periodically by standing up), and building an activity-friendly campus (e.g., by providing walking paths or bicycles that people can use to ride from one building to another).

In addition to building physical activity into either the workday or the workplace, other ways to promote physical activity among workers include using technology creatively (e.g., using wearable tracking devices such as pedometers so that workers can measure their own physical activity), promoting active commuting (e.g., bicycle-to-work programs that provide incentives for people to buy equipment and clothing), and creating a physical activity–friendly work culture.

Pronk emphasized the role of leadership, at all levels, in changing the cultural norms of an organization with respect to physical activity. While in a corporate setting, leadership at the top level sets the vision, he noted, middle management directors, managers, and supervisors need to be engaged as leaders for the vision to spread. Additionally, frontline leaders need to step up, Pronk said, to "get [the vision] deep into [their] organization." Pronk observed that in many cases, even though the CEO or other top-level leaders have issued a formal message that it is okay to take a physical activity break, a worker who actually takes such a break is frowned upon. He said, "A frown alone can eliminate an entire program."

A take-away message from the literature on promotion of physical activity in the workplace, Pronk continued, is that while it is desirable to focus on physical activity, that focus needs to be part of a company's overall comprehensive multicomponent approach to improving health and

well-being. "These programs need to fit," he said, "with other things that are going on at the workplace." While systematic reviews (e.g., Dugdill et al., 2008) reveal that pedometer programs, active travel (biking or walking to and from work), and workplace coaching can increase daily physical activity, a number of barriers to physical activity exist at multiple levels of influence (Edmunds et al., 2013). Because of these barriers, Pronk said, the design of physical activity intervention programs in the workplace should be based on an ecological or multilevel model, as recommended in the *National Physical Activity Plan* (Pronk, 2009).

A Framework for Designing Physical Activity Interventions in the Workplace

The first step in designing a physical activity intervention in the workplace, Pronk said, is to make sure that physical activity is possible (Pronk, 2009). If workers are confined to an assembly line and the only thing they do is move widgets from one place to the next, or if workers sit in a small cubicle and are on the telephone all day, it may not be possible for them to be active unless some change is made. The next step is to ensure that the intervention is simple. The more complex an intervention is, the less likely it is to be successful. Third, the intervention needs to be socially rewarding. For example, some workers may enjoy the social reward that comes with team-based interventions. Fourth, the intervention needs to be financially rewarding. Fifth, it needs to be personally relevant. If the physical activity does not apply to someone, he or she will not participate. Sixth, the intervention needs to be organizationally relevant so that the business continues to support it. Finally, to be sustainable, the intervention needs to be connected to the community so that when workers go home and then return to work, they engage in the physical activity again.

All of these steps are part of a framework that Pronk (2009) developed for designing physical activity interventions for the workplace (see Figure 7-2). Other components of the framework include level of influence (i.e., individual, interpersonal, or group level; organizational/policy; or environmental/community); customer and user experience; and health, productivity, and return-on-investment outcomes.

Design Principles of Success

To better understand design principles of success, Pronk reviewed 28 scientific and "grey" literature (industry reports, consensus statements) publications on best practices. His search yielded 44 best practices related to successful outcomes (e.g., organizational commitment to a healthy culture, adequate resourcing, meaningful and relevant incentives, wellness

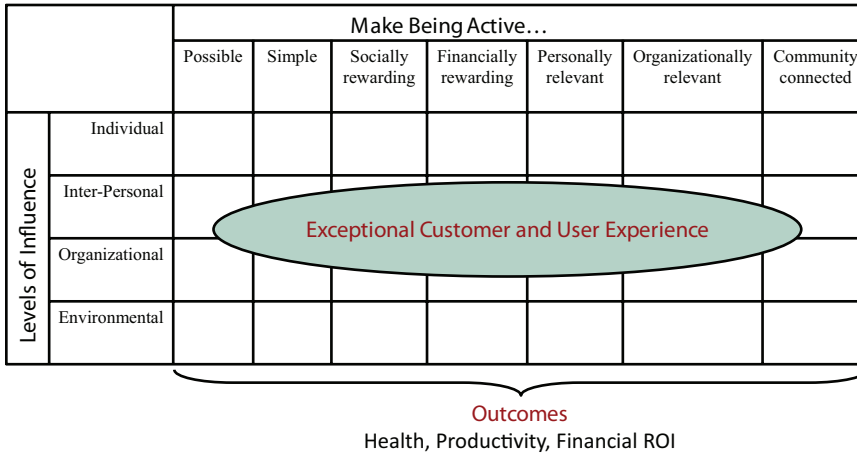

FIGURE 7-2 A translational framework for program design.
NOTE: ROI = return on investment.
SOURCE: Presented by Nico Pronk on April 15, 2015 (reprinted with permission, from Pronk, N. P. 2009. Physical activity promotion in business and industry: Evidence, context, and recommendations for a national plan. *Journal of Physical Activity and Health* 6[Suppl. 2]:S220-S235).

champion networks). Rather than presenting all 44 best practices and saying, "This is what you have to do," Pronk (2014) reorganized them into nine design principles:

1. leadership that sets the vision, assigns accountability, ensures structural support and resources, and sets policy;
2. relevance to needs and interests that optimizes participation and is tied to long-term engagement;
3. partnership with both internal and external stakeholders;
4. comprehensiveness, as defined in *Healthy People 2010*;
5. implementation, which involves having a planned, coordinated, and fully executed work plan;
6. engagement, including the promotion of respect and trust and of co-ownership, the leveraging of company culture, and the use of incentives that optimize intrinsic motivation;
7. a formal communication strategy that is linked to goals and objectives and the use of multiple delivery channels and modes;
8. data-driven monitoring and learning; and
9. compliance with regulatory standards and requirements.

A Case Study

As a quick case study of a physical activity intervention promoted as part of an overall program for employee well-being, Pronk described an example from IBM (Pronk et al., 2014). IBM created an online physical activity resource, the Virtual Fitness Center (VFC), to serve as an interactive behavior change tool with goal setting, activity logging, team-based campaigns, progress reports, feedback loops, and other features. In the first year, approximately 16,000 employees (12.5 percent) participated. In the second to fourth years, when incentives were added, more than 80,000 employees (63 percent) participated. In terms of outcomes among users, physical activity–related risks decreased by 52 percent. Health perception, life satisfaction, smoking, body weight, and overall risk status improved. Although average annual health care costs among VFC users increased by $291 per year from 2003 to 2005, they increased by $360 per year among nonusers. Additionally, VFC users had significantly lower inpatient hospital costs, heart disease–related costs, and costs to treat diabetes. From a business perspective, Pronk said, "these are pretty powerful results."

Conclusions

In conclusion, Pronk emphasized that the workplace is a complex and dynamic environment. Activities that promote physical activity and movement enhance worker performance and support positive business outcomes, and promotion of physical activity should be an integral part of an overall well-being strategy. Not only are organizing frameworks and principles for best-practice program design available, Pronk said, but they also increase the chances of success.

PANEL DISCUSSION

Following Nico Pronk's presentation, he and Nihiser participated in a panel discussion with the audience.

Data on the Comprehensive School Physical Activity Program

An audience member asked Nihiser whether any datasets are now or will be available to help in identifying schools that are implementing the Comprehensive School Physical Activity Program. Nihiser replied that the data she presented showing the percentage of schools in each state that were implementing the program were from 2012 and that data for 2014 would be available later in 2015. The 2012 data points were composite variables based on only some components of the program. The 2014 question-

naire included three additional questions related to assessment, before- and after-school programs, and family engagement. Additionally, according to Nihiser, national school- and classroom-level data from the School Health Policies and Practices Study would be available later in 2015, reflecting responses to a number of questions related to physical activity before, during, and after school.

Nihiser also was asked whether the Comprehensive School Physical Activity Program data can be linked to data from CDC's Youth Risk Behavior Survey as a way to determine if outcome measures of physical activity are related to whether schools have implemented certain policies. Nihiser replied that the two datasets can indeed be linked, and noted that a couple of relevant manuscripts were in preparation.

Physical Activity Versus Physical Education

An audience member remarked that, based on her experience working with people from schools across the country, many people do not understand the difference between physical education and physical activity. She clarified that physical education, as defined by SHAPE America, provides students with a sequential K-12 standards-based program of curricula and instruction designed to develop motor skills, knowledge, and behaviors for active living, physical fitness, sportsmanship, self-efficacy, and emotional intelligence. "That is what physical education is," she said. "Physical activity is how we practice that." She encouraged more discussion on the difference between the two when debating policy.

Training the Next Generation of Physical Educators

An audience member asked about efforts to train the next generation of physical educators. Nihiser replied that CDC is providing training-of-trainers on the Comprehensive School Physical Activity Program. For this purpose, CDC is using the *Guide for Developing Comprehensive School Physical Activity Programs*, a publication she had mentioned during her presentation, and has developed a 1-day workshop that is currently being marketed to state health department grantees. Additionally, CDC has been working with the American Cancer Society, which every few years provides all-day trainings-of-trainers for university staff on CDC tools and resources related to school health. In 2014, for example, Nihiser conducted a training of 20 university staff on CDC's *School Health Guidelines to Promote Healthy Eating and Physical Activity.*

Interventions to Reduce Uninterrupted Sitting Time at Work

When asked whether there are any data on interventions to reduce uninterrupted sitting time at work, Pronk replied that an "emerging" set of cross-sectional studies is associating prolonged sitting time with poor health outcomes. Additionally, a small set of intervention studies has begun to examine permissive activity workstation designs, whereby a sedentary worker can either stand up in place, walk in place, or pedal in place to break up uninterrupted sitting time. In Pronk's opinion, results from the small set of studies completed thus far are promising, but more remains to be learned. For example, some studies examine the use of sit-stand devices by themselves. But when those devices are couched in a workplace-specific context—for example, in the context of training or supervisor or manager support—outcomes can be enhanced and the devices used for longer periods of time. In Pronk's opinion, researchers need to learn more about how to optimize these interventions.

8

Implementation of Strategies That Promote Physical Activity

OVERVIEW

Although many interventions to promote physical activity are known to be effective in specific populations and contexts, the challenge, in Bill Kohl's opinion, is to determine whether those same interventions are translatable in other scenarios and, more important, whether they are scalable and sustainable. Often when interventions are rolled out, he said, they lose their resources or champions and disappear. The challenge, he suggested, is to move from intervention to true systems change. In the final session of the workshop, three panelists discussed programs that Kohl views as being not only effective at promoting physical activity but also translatable, scalable, and sustainable.

First, Linda Fondren described the origins and activities of Shape Up Sisters, a gym she founded in Vicksburg, Mississippi, and the efforts of the nonprofit Shape Up Mississippi. Then, Sean Hinkle described DC SCORES, an after-school program for youth in Washington, DC. Finally, Marisa Molina described Everybody Active/*Todos Activos*, a Centers for Disease Control and Prevention (CDC)-funded exercise and healthy lifestyle intervention designed to promote physical activity among Latinos in San Diego, California.

The panelists' descriptions of their programs triggered a lively discussion with the audience. Several major themes emerged, with all three panelists agreeing on the important role of social support (i.e., in keeping participants coming back), leadership (i.e., having a champion, or champi-

ons, to help expand the program), and partnerships (e.g., with the public health sector and with schools).

This chapter summarizes the introductory remarks of the session, the three panelists' descriptions of their programs, and the discussion that followed. It ends with a summary of workshop closing remarks by Russell Pate.

INTRODUCTORY REMARKS[1]

Many strategies for promoting physical activity have proven effective, while others appear promising or are just emerging, and all of these strategies have helped to identify what works and where resources should be directed, Bill Kohl began. But, he said, "Nothing is moving." Occupation-related physical activity is declining (Church et al., 2011); leisure time physical inactivity is probably increasing, according to some data; transport-related physical activity has remained the same; and, while difficult to measure according to Kohl, household and other related physical activity has remained the same as well. In sum, he described the situation as "static" and "stagnant," suggesting that "more of the same is not enough." He believes that to move forward, "We have to think a little differently, look a little bit to the side."

Rather than individual, one-on-one changes, Kohl called for changes at the population level. Not only should interventions be effective (with data showing that they work in specific populations and scenarios) and translatable (into other scenarios), but more important, in his opinion, they should also be scalable. Instead of affecting just three third-grade classrooms, for example, can a classroom-based physical activity program affect all third-grade classrooms in an entire school district or state or even across the country? Finally, in addition to being scalable, interventions should be sustainable, suggested Kohl. Often, he observed, when interventions found to be effective are rolled out, resources and champions disappear.

Physical activity is a complex behavior, Kohl continued. Managing that complexity requires, in his opinion, systems-level thinking, not just cause-and-effect thinking. Borrowing from business thinking (Sterman, 2000), Kohl suggested that researchers studying physical activity consider not just the goals, actions, and results that can be seen "above" the surface, but also the competing interests, actions of others, unintended consequences, and other public health phenomena "underneath" the surface.

When studying ways to promote physical activity, Kohl explained, researchers typically apply a behavior change theory to the problem,

[1] This section summarizes introductory remarks made by Harold W. (Bill) Kohl III, Ph.D., University of Texas Health Science Center at Houston and University of Texas at Austin.

conduct the intervention, see a behavior change, publish those findings, and move on to the next project. Similarly with policy or environmental approaches to promoting physical activity, an intervention is proposed and tested, results are published, researchers are promoted, and everyone moves on to the next grant proposal. "This is not a systems approach," Kohl said. He encouraged researchers to think more broadly about strategies for implementation and to consider systematic changes across multiple sectors, including the education, health, planning and built environment, transportation, workplace, and sports and recreation sectors (Kohl et al., 2012). He noted that "systems variables," such as how people adapt to interventions and whether effects are delayed, often are missing from studies. For example, most National Institutes of Health (NIH) grants extend over 5 years, which means that delayed changes that may not show up for 6 or 7 years are missed.

Kohl suggested that the three panelists in this session would be describing strategies that are not only effective but also scalable and sustainable, and that can contribute to a systems-level approach to promoting physical activity.

SHAPE UP SISTERS[2]

"Those who live fit live better and longer," Linda Fondren began. Her sister was at a very unhealthy weight as a consequence of a lack of physical activity. Months after her sister's death at age 54, Fondren opened a gym in Vicksburg, Mississippi, called Shape Up Sisters, and founded a nonprofit called Shape Up Mississippi. She did not want other women to "have that same fate."

By opening Shape Up Sisters, Fondren was creating a social environment where women could receive continual support and encouragement to "come back in." Many women in the gym have met their best friends there, she said, while others lacked social lives before attending. The social support offered by the gym is what makes it sustainable, in Fondren's opinion. "They have a place they can come back to for that encouragement and that support," she said.

Obesity affects not just the women who attend Shape Up Sisters, Fondren learned, but their families as well. Many women attending the gym would tell her that they wished their husbands or children would "get off the couch." So she reached out to the wider community; mobilized the support of elected officials, churches, restaurants, other gyms, hospitals, and other individuals and institutions; and founded Shape Up Mississippi.

[2] This section summarizes information and opinions presented by Linda Fondren, community leader and founder of Shape Up Sisters and Shape Up Vicksburg, Vicksburg, Mississippi.

Among other activities, Shape Up Mississippi formed a walking club, and through partnerships with the university and the city of Vicksburg, has been teaching community members how to grow healthy foods (at city-wide community gardens) and be physically active (through trainings conducted by Shape Up Sisters). Through the collective efforts of Shape Up Mississippi and its community partners, Fondren said, the town has collectively lost 15,000 pounds.

In addition to its community work, Shape Up Mississippi conducts trainings in workplaces. Based on her experience, Fondren observed that many companies do not know how to start wellness programs. In addition to teaching about body composition and weight, the number one piece of advice she communicates to them is, "What you do has to be social. . . . People love to interact with each other."

DC SCORES[3]

DC SCORES is a free after-school program serving more than 1,500 low-income youth at 44 elementary and middle schools in Washington, DC. Its goal is to instill self-expression, physical fitness, and a sense of community through what Sean Hinkle described as a unique model combining soccer, poetry, and service learning.

With respect to the "ins and outs" of how DC SCORES operates, Hinkle said, teachers are hired to run the program at schools. At each site, 2 writing coaches and 2 soccer coaches lead teams of 32 students—16 boys and 16 girls. Each week, the teams participate in two 90-minute writing sessions, two 90-minute soccer practices, and an official soccer game on either Thursday or Friday. For the soccer games, a team from one school is bussed to another school so the students can meet youth from other neighborhoods and make new friends. With the sidelines usually filled with parents, administrators, other students, and people from the community, Hinkle said, "It is a wonderful environment."

Hinkle shared findings from a recent evaluation of the program: 78 percent of students participating in DC SCORES improved their body mass index (BMI) percentile, 65 percent increased their aerobic capacity, 100 percent reported feeling confident that they will graduate from high school, 95 percent reported feeling a lot of pride in themselves, and another 95 percent reported feeling as though they are a positive part of their community.

The program started "organically," Hinkle said, in 1994, at Marie Reed Elementary School in the Adams Morgan neighborhood of Washington, DC. A teacher started playing soccer with students after school. Then

[3] This section summarizes information and opinions presented by Sean Hinkle, program director, DC SCORES, Washington, DC.

one day it rained, and the teacher moved the students inside and started writing with them. That dual focus picked up, Hinkle said, gained momentum, and spread to other schools. In 1999, DC SCORES grew into America SCORES, which now serves 8,000 youth in 14 cities.

EVERYBODY ACTIVE/*TODOS ACTIVOS*[4]

Everybody Active/*Todos Activos* was an exercise and healthy lifestyle intervention study in south San Diego, California, funded by the CDC Prevention Research Centers Program. The primary aim of the study, according to Marisa Molina, was to create a sustainable community program that would promote physical activity among Latinos living in south San Diego along the United States–Mexico border.

The study was funded for two 5-year funding cycles. In the first funding cycle, 35 volunteer community health workers were trained to provide free exercise classes in schools, recreation centers, community centers, apartment complexes, and parks. Most of the group exercise programs involved Zumba or dance aerobic classes. Results from the first funding cycle showed significant decreases in blood pressure, waist circumference, and symptoms of depression.

In the second funding cycle, a healthy lifestyle program was added to the group exercise class. Thirty-two community health instructors were trained to teach the exercise class and healthy lifestyle program. Additionally, three community coordinators were hired from local agencies to support the community health workers. Preliminary results from the second funding cycle suggest that participants experienced improvements in blood pressure, waist circumference, BMI, fitness, and flexibility. Additionally, participants reported consuming less fat and drinking fewer sugary drinks (over a period of 6 months to 1 year). Most notably, in Molina's opinion, during the peak of the program, 47 free exercise classes were being offered weekly throughout south San Diego. On average, there were 22 participants per class, with some classes averaging 60-100, and more than 2,500 people registered to participate in the program (i.e., not including the 450 participants already enrolled in the study).

Now that the funded study activities have ended, 27 classes, both free and paid, continue to be offered to the community by the program's community partners. Because of the training they received through Everybody Active/*Todos Activos*, many of the community health workers went on to find jobs with the program's community partners. One of the program's community health workers opened a dance studio, Molina said, offering

[4] This section summarizes information and opinions presented by Marisa Molina, M.P.H., Institute for Behavioral and Community Health, San Diego, California.

17 classes per week, including some free classes for the community. Molina noted that the woman who opened the dance studio was not a dance or exercise instructor before being trained by the program. Clearly, Molina said, the program had a tremendous impact not only on class participants but also on the community health workers providing the classes. That the classes are still being offered to the community reflects the program's sustainability, in her opinion.

The Institute for Behavioral and Community Health is expanding and will be testing the program in other types of organizations, according to Molina. In 2013, it piloted a small study in collaboration with the County of San Diego Health and Human Services Agency to test the model within the context of the Welfare-to-Work program. Although the number of participants was small, with only 19 women taking part in the study, results indicate improvements in health, in participation in Welfare-to-Work activities, and in employment outcomes. The Institute is seeking funding to disseminate the intervention model to other health departments and Welfare-to-Work programs.

A lesson learned from all the work accomplished thus far, Molina observed, is the added social benefit of group exercise classes. The original intent of Everybody Active/*Todos Activos* was to promote active transportation and the use of community parks. But researchers found that participants preferred exercising in groups and indoors. Everybody Active/*Todos Activos* expanded over the years, Molina said, not through marketing, but through word of mouth.

PANEL DISCUSSION

The three presentations prompted a lively discussion with the audience, with Fondren, Hinkle, and Molina fielding a broad range of questions about the success and sustainability of their respective programs.

The Important Role of Social Support

When asked why she thought social support was such an important part of Shape Up Sisters, Fondren said, "It is fun. . . . It is a feel good thing." Most people, in her experience, lack a clear understanding of health. They think about health in terms of sickness, but "it means so much more than that," she said. Getting people to participate requires talking to them about what health really means—the ability to have choices and "just to be a part of life." Then they get motivated, Fondren said. "I think physical activity should be like wearing a seatbelt," she added. "If you don't wear one, you don't feel safe."

Embedding Physical Activity into the Culture

An audience member asked the speakers what evidence exists to indicate that physical activity among the programs' constituents has increased outside of the context of the programs.

DC SCORES starts at a young age—third grade—Hinkle replied. The program has strategically clustered its schools so that when children leave elementary school, they will likely be continuing in a middle school that also offers the program. While DC SCORES has no formal evidence indicating that youth continue seeking additional physical activity opportunities after they leave middle school, Hinkle knows that participants, especially girls, go on to populate, and sometimes even create, high school soccer teams.

Molina replied that, while the community health workers encouraged participants in Everybody Active/*Todos Activos* to exercise outside of the classroom, it is difficult to know what physical activity actually took place outside of the program and whether total physical activity was increasing over time as a result of program participation.

Fondren pointed to the success of the walking club that grew out of Shape Up Mississippi and the collective loss of 15,000 pounds among participants as indicators of the spread of physical activity in the community. Additionally, Shape Up Mississippi partnered with the city of Vicksburg to install a quarter-mile walking track in one of the city's parks so that parents can walk while watching their children play. Another quarter-mile track is being planned in another park. Fondren also mentioned the walking trails through downtown Vicksburg, with interpreters offering directions and information about the city. Finally, Shape Up Mississippi partnered with the Vicksburg National Military Park, a civil war park, to allow free walks through the park four times per year. All of these various programs get people moving and, in Fondren's opinion, make the Shape Up efforts sustainable.

The panelists were asked whether, when people in their programs lose weight or improve their metabolic profiles, it is because the programs are helping people who were inactive become active, or because the programs are attracting already active people?

More than 80 percent of participants in Everybody Active/*Todos Activos*, Molina replied, were overweight or obese when they entered the program. Many were stay-at-home moms who failed to meet the national physical activity guidelines at baseline. Most of Molina's community work, including that with Shape Up Sisters/Shape Up Mississippi, is with underserved African American communities. Often when she recruits people for the Shape Up Sisters 6-week nutrition and exercise program, they ask, "Why?" She told the audience about approaching a woman who was sitting

in her front yard on a lawn chair, which was about to collapse beneath her. When Molina told the woman about the program, the woman wanted to know why she needed it and how much it cost. Molina had to keep going back to the woman until, eventually, she decided to show up with her child in tow. "She was still apprehensive," Molina said, "but she showed up. She showed up because we did not give up." "We have to keep going with the 'I won't,'" Molina said, "until we get 'I might.' Then we can move them on to 'I will.'"

DC SCORES has free enrollment, Hinkle said. Some students who decide to participate are interested in soccer, some in poetry, and others in service learning. Others enter the program because their parents have enrolled them. The program also has a fair number of children referred by counselors or other school administrators who think the children would benefit from participating. Hinkle told the audience about a student who joined the program in the third grade upon referral by his counselor. The child was struggling with his weight. On the first soccer game day, he was embarrassed to run around the field, so he did not play, nor did he want to play the next week either. But in the third week, he saw a child on the other team who looked just like him and who was playing and enjoying himself, so he jumped onto the field, and he has played soccer every day since then. So children come to DC SCORES in many different ways, said Hinkle.

External Funding and Sustainability

An audience member asked how Everybody Active/*Todos Activos* and DC SCORES sustain themselves, given that they are dependent on external funding. Molina replied that it will be interesting to see how the Everybody Active/*Todos Activos* program continues now that its funding period has ended. Many schools and recreation centers have adopted the community health workers trained and certified (e.g., Zumba certified) through the program. Some of the schools have offered to pay for liability insurance for the instructors. Some of the recreation centers are charging a small fee, such as $2 per class, with half the money going to the instructor and the other half to the center for maintenance.

For Hinkle, sustainability is a challenge. Because the DC SCORES program has been in some schools since 1995, it is ingrained in the culture of those schools, and the schools bring the program to the table for discussions about government and other funding opportunities. Over the last few years, however, the organization has been trying to gain more long-term individual donors and multiyear grants to allow for longer-term projection.

Working with Schools

When Allison Nihiser asked how receptive schools are to offering the DC SCORES program, Hinkle replied that the organization has a wait list of about 12 schools. Resources are the greatest barrier. For example, neither the city nor the school system provides buses for student transportation, so DC SCORES must cover those costs itself because game days are an integral part of the program. DC SCORES needs be sure it can offer a complete program and provide students with its full experience before entering a school.

Nihiser also asked whether there were any barriers to expanding Everybody Active/*Todos Activos* into schools. Molina replied that administration buy-in is an important factor. She described the relationship with schools as a partnership, with community health workers working alongside school custodial staff, and said it is leadership that makes that possible. Schools with principals who have real interest and motivation with respect to providing community programs to their students and parents are easy to work with, she said. Schools without a supportive administrator, in which priorities are elsewhere, are more difficult. Molina emphasized that schools do not incur a cost in offering the program. In some of the lower-income schools, where resources were limited, Everybody Active/*Todos Activos* provided such things as soap and toilet paper.

Partnering with the Health Care Sector

An audience member asked whether any of the programs had worked with health care providers or with the health care sector, and if so, how that partnership started and what role it plays in the program. Shape Up Sisters works with physicians' offices in Vicksburg, Fondren said, with many female patients being referred to the program by one physician in particular. Most of these women cannot afford to pay, so Fondren opens the gym to them on Saturdays for free. The referred women are shown what to do and can work out with "fitness motivators" so they do not have to work out alone.

Everybody Active/*Todos Activos* worked with the San Ysidro Health Center in San Diego, Molina said. In fact, the health center was one of three local agencies selected to help with supervision during the second funding cycle. In addition to supervising some of the program's community health workers, the center helped distribute exercise calendars so that visitors to the center could see when Everybody Active/*Todos Activos* classes were being offered. There was some cross-promotion as well, with Everybody Active/*Todos Activos* promoting San Ysidro Health Center's health education and cooking classes. Additionally, Everybody Active/*Todos Activos* and the San Diego Prevention Research Center conducted a training with

medical residents at the health center on physical activity, in which the residents learned about identifying risk factors indicating that a person is ready and able to participate in exercise. Molina was not sure how effective that training was in terms of bringing people into the Everybody Active/*Todos Activos* program. Although the program received a few referrals, it may not have been a primary priority for many of the doctors.

Another audience member asked the panelists how their programs could benefit from support, whether technical, funding, or infrastructure support, from their state health departments. Hinkle replied that DC SCORES needs help certifying its coaches in cardiopulmonary resuscitation (CPR) and first aid. Not only is the certification expensive, but most of the coaches are teachers, which makes scheduling difficult. Molina agreed that, for Everybody Active/*Todos Activos* to expand, support to help with training will be very important. The community health workers need a hub where they can find that support, she said.

Shape Up Mississippi is already working with the state health department in a couple of different ways, according to Fondren. The program is part of the Mayor's Health Council, which Shape Up Mississippi helped to found, and the council conducts health screenings at community events hosted by Shape Up. Hinkle added that just the presence of the state health department at an event being hosted by DC SCORES is important.

Economic Benefits of Promoting Physical Activity

An audience member asked the panelists whether their or similar programs have demonstrated economic benefits—for example, in the form of people moving to a new community because it has these types of programs. Fondren described Vicksburg as a tourist town. People want to do more than go to the casinos when they visit the city, she said; they want to visit the community. Creating walking trails draws tourists. The bridge crossing the Mississippi River, in Fondren's opinion, could be a major driver of economic development. She is working with elected officials to turn the bridge, which is no longer used, into a pedestrian park.

Another audience member observed that the 100 percent self-efficacy for graduating from high school mentioned by Hinkle during his presentation (i.e., that 100 percent of DC SCORES participants are confident they will graduate from high school) in and of itself reveals substantial economic benefits for the individual student, the student's family, and the community. Hinkle agreed, especially given that the high school graduation rate in Washington, DC, is around 50 to 60 percent. "For the kids to have that much confidence is tremendous," he said. He reiterated that DC SCORES is about giving youth opportunities to succeed in as many ways as possible.

Scalability

Kohl asked Hinkle how DC SCORES was able to scale up so successfully from Washington, DC, to the now 14 cities across the country, and he asked all of the panelists to reflect on what they would do if they could scale up their programs and reach a larger population.

Hinkle explained that DC SCORES identified core components and then built a training platform that allowed its coaches to acquire the knowledge necessary to deliver the program in the best way possible. The training platform has been growing, especially as new technologies have become available. With respect to moving the program outside of Washington, DC, and into new communities, Hinkle said that in addition to know-how related to the program, there needs to be someone in the community who wants to bring the program there, as well as funding in place.

Fondren stressed the importance of community role models, that is, people in leadership positions whom underserved people want to follow. "I would like to see many more role models saying, 'Look at me. I did it.' That is what will make someone else do it too," she said.

Everybody Active/*Todos Activos* is planning to create a program package with manuals and training videos that can be given to any organization interested in implementing the program. The cost of actually providing training to help organizations implement the program will probably be the greatest challenge, in Molina's opinion. Outside of that challenge, creating partnerships in the community and leveraging locations will be important.

Is the Emphasis on Losing Weight or on Moving?

An audience member asked the panelists whether the emphasis of their programs was on losing weight, moving, or both.

Hinkle described DC SCORES as a youth development program. It is about youth engagement—youth enjoying themselves and having fun. Physical activity is built into the curriculum, with an attempt to ensure that all sessions include the maximum amount of movement possible. But much of the training of coaches is focused on youth development principles so the coaches can create supportive environments where the youth can thrive. "The soccer takes its own route," Hinkle said.

Everybody Active/*Todos Activos*, Molina said, takes a whole well-being approach, with a focus on many different aspects of health, including healthy eating and emotional health, not just physical activity. That said, exercise is the main component of the intervention, and the greatest amount of time is dedicated to exercise. If a particular community health worker has an interest in weight loss, he or she may verbally share that interest with class participants, but otherwise there is no focus on weight loss.

Shape Up Sisters promotes physical activity. "When you do it, you feel good," Fondren said. In her opinion, there is something about physical activity that makes people want to eat better, do better, and try new things.

CONCLUDING REMARKS

In his concluding remarks, Russell Pate relayed three anecdotes that he believes collectively capture, as he said, "where we are with this challenging issue." The first was a media story about a so-called free range family in Silver Spring, Maryland, that was encouraging its elementary school-aged children to walk to a nearby park by themselves, unsupervised by adults. This behavior eventually resulted in the police picking the children up and citing the parents for child abandonment. The same thing happened again just days before this workshop, and this time when the children were picked up, they were taken to child protective services. Pate did not express his opinion about who was right or wrong in this situation. He did say, however, that regardless of who was right, the situation was sad. It was unfortunate if the police were right, and it was not safe for these children to be walking a few blocks from their home to a park to play. And it was unfortunate if the parents were right—if the neighborhood was safe, and the police were intervening because of a misperception.

Pate's second anecdote was that just a couple of days before the workshop, John Hancock announced that it would be providing financial incentives for its life insurance clients to adopt and maintain a level of physical activity that meets the national guidelines. The company would be providing its clients with Fitbits, uploading the data, and monitoring compliance. If that development catches on and is adopted by other life insurance companies, Pate said, it could have a powerful positive impact on the behavior of millions of people.

The third anecdote was relayed to Pate by a friend who coaches boys' and girls' high school cross-country teams. Girls in the high school were posting pictures of their prom dresses on the Internet, with some girls commenting that they had to go on a diet and lose weight so they could fit into their dresses. The captain of the girls' cross-country team asked her classmates whether, instead of going on a diet, it would be better to run to improve their fitness, lose weight, and fit into their prom dresses. This anecdote struck Pate because not only did this girl have the right idea, but she took the initiative to advance it. Despite policies that operate at a macro level, in the end, Pate believes, there is nothing as powerful as what is taking place in one's immediate social group.

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A

Workshop Agenda

Physical Activity:
Moving Toward Obesity Solutions

APRIL 14-15, 2015

Auditorium, National Academy of Sciences Building
2101 Constitution Ave. NW Washington, DC
Hosted by the Institute of Medicine Roundtable on Obesity Solutions

Workshop Goal: To provide an expert summary of the state of the science regarding the impact of physical activity in the prevention and treatment of overweight and obesity and to highlight innovative strategies for promoting physical activity across segments of the population.

April 14, 2015
Day 1: Physical Activity and Obesity—State of the Science

Day 1 Goal: To provide authoritative summaries of the state of the science regarding the effects of physical activity on development of overweight and obesity in children and adults, and to review current knowledge of the effects of physical activity in individuals with obesity.

9:00 am **Welcome Remarks**
Victor J. Dzau, President, Institute of Medicine

9:05 am **An Introduction to Physical Activity and Its Impact on Health and Weight Status**
Russell Pate, University of South Carolina, Workshop Planning Committee Chair and Roundtable Vice Chair

9:25 am **Keynote: Does Physical Activity Have a Role in Reducing Obesity?**
James Hill, University of Colorado Denver

9:55 am **Physical Activity Disparities: Sociodemographic Dimensions**
Aviva Must, Tufts University

10:15 am Discussion

10:35 am ACTIVE BREAK led by Shape Up Sisters

10:45 am **Physical Activity and Primary Prevention of Obesity in Youth**
Moderator: Howell Wechsler, Alliance for a Healthier Generation, Roundtable Member

Everyday Physical Activity and Its Role in Preventing Obesity
Kathleen Janz, University of Iowa
Physical Activity and Pediatric Obesity Prevention: Putting Science to Work
Shari Barkin, Vanderbilt University School of Medicine
Discussion

11:45 am LUNCH

12:45 pm **Physical Activity and Primary Prevention of Obesity in Adults**
Moderator: Loretta DiPietro, George Washington University, Workshop Planning Committee Member

Physical Activity and Prevention of Weight Gain and Obesity in Adults: An Epidemiological Perspective
Ulf Ekelund, University of Cambridge
Is Exercise an Effective Strategy for Preventing Weight Gain in Adults?
Robert Ross, Queen's University
Discussion

1:45 pm ACTIVE BREAK led by DC SCORES

2:00 pm **Physical Activity–Related and Induced Outcomes with Overweight and Obesity**
Moderator: Cedric Bryant, American Council on Exercise, Roundtable and Workshop Planning Committee Member

- Physical Activity as Part of DPP-Based Community Lifestyle Intervention Efforts
  - Andrea Kriska, University of Pittsburgh
- Physical Activity and Exercise for Obesity in Youth: Refocusing Attention from Weight Loss to Health Gains
  - Gabriel Shaibi, Arizona State University
- Physical Activity: Implications for Weight Loss Maintenance and Related Health Outcomes
  - John Jakicic, University of Pittsburgh, Workshop Planning Committee Member
- Discussion

3:20 pm ADJOURN

April 15, 2015
Day 2: Innovative Strategies for Promotion of Physical Activity

Day 2 Goal: To highlight innovative policy, community, and institutional strategies for promoting physical activity among children and adults.

9:00 am **Promoting Physical Activity: An Introduction**
Russell Pate, University of South Carolina, Workshop Planning Committee Chair and Roundtable Vice Chair

9:15 am **Policy Strategies for Promoting Physical Activity**
Moderator: Ginny Ehrlich, Robert Wood Johnson Foundation, Roundtable Member

- Promoting Physical Activity Through Policy: An Overview
  - Amy Eyler, Washington University in St. Louis
- Physical Activity Policy Implementation and Impact: A Multisectoral Review
  - Jamie Chriqui, University of Illinois at Chicago
- Discussion

10:15 am ACTIVE BREAK led by BOKS

10:30 am **Community Strategies for Promoting Physical Activity**
Moderator: Jim Whitehead, American College of Sports Medicine, Roundtable Member

Blueprint for Active Living Communities
Jim Sallis, University of California, San Diego, Roundtable Member
Research to Action: Leveraging Information Technologies for Population-Wide Physical Activity Promotion
Abby King, Stanford University
Discussion

11:30 am LUNCH

12:30 pm **Institutional Strategies for Promoting Physical Activity**
Moderator: Linda Meyers, American Society for Nutrition, Roundtable Member

Evidence-Based and Innovative Strategies for School-Based Physical Activity
Allison Nihiser, Centers for Disease Control and Prevention
Physical Activity Promotion at the Workplace: Design Matters
Nico Pronk, HealthPartners, Inc., Roundtable Member
Discussion

1:30 pm **Moderated Panel Discussion: Implementation of Strategies That Promote Physical Activity**
Moderator: Harold W. (Bill) Kohl III, University of Texas Health Science Center and University of Texas at Austin, Workshop Planning Committee Member

Panelists:
Linda Fondren, Shape Up Sisters, Vicksburg, MS
Sean Hinkle, DC SCORES, Washington, DC
Marisa Molina, Institute for Behavioral and Community Health, San Diego, CA

2:30 pm ADJOURN

B

Perspectives on Disparities in Physical Activity[1]

[1] These commentaries are reproduced here as submitted by the authors.

PHYSICAL ACTIVITY IN LATINO COMMUNITIES

Rebecca T. Adeigbe, M.S., and Amelie G. Ramirez, Dr.P.H.,
*University of Texas Health Science Center at San Antonio, TX**
April 2015

Latino health is increasingly synonymous with the future of U.S. health, yet the nation's largest and still-growing minority group continues to live in communities with reduced access to health-promoting resources and safe, pedestrian-friendly built environments. Latinos' higher rates of childhood and adult overweight/obesity relative to whites and blacks is often attributed to cultural influences, attitudes, and beliefs; however, community-level attributes are increasingly being associated with higher prevalence of obesity in Latino-predominant communities.

Latino communities across the country tend to have fewer parks, less access to recreational facilities, and unsafe and outdated street-scale infrastructure. Furthermore, Latinos tend to live in communities where crime rates are higher and perceived crime keeps Latinos and their children indoors.[1] Studies also have shown that Latino youth often attend schools with few recreational resources, have few opportunities for active play at and after school, and are less likely to participate in organized sports. Even with state active play policies, many schools struggle with implementation due to competing priorities and lack of resources or policy knowledge.[2]

In the face of these barriers, researchers, policy makers, health officials, and the public have identified families, communities, and schools as key areas to focus on to address Latino obesity. Through the work of programs such as *Salud America! The Robert Wood Johnson Foundation Research Network to Prevent Obesity Among Latino Children*—which works to showcase examples of grassroots-level healthy changes in Latino communities—culturally relevant evidence-based strategies and program have successfully improved built environments and increased activity opportunities in Latino communities.[3]

From a built environment perspective, shared-used agreements have been helpful at increasing accessibility to safe and free public places in Latino communities across the country. For example, large communities in

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The views expressed in this commentary are those of the authors and not necessarily of the authors' organization or of the Institute of Medicine. The commentary is intended to help inform and stimulate discussion. It has not been subjected to the review procedures of the Institute of Medicine and is not a report of the Institute of Medicine or of the National Research Council.

* Participants in the activities of the IOM Roundtable on Obesity Solutions.

California and rural cities, like Alice, TX, have successfully implemented shared use agreements to improve access to schools and playgrounds with the support of passionate parents and community members.[4,5]

In schools, culturally relevant structured school programs have demonstrated success in increasing physical activity among Latino children and their families. The *Míranos!* program in Head Start centers in San Antonio, TX, improved parents', teachers', and children's knowledge of the benefits of healthy eating and physical activity.[6] Utah researchers incorporated active video games in physical education (PE) classes and increased Latino youth activity.[7] Providing Latina teens with the tools needed to advocate for change, city pools in New Britain, CT, were reopened and an out-of-school PE credit recovery program was implemented through the local YWCA.[8]

As strategies for improving physical activity become more innovative, it is critical to make them culturally relevant for Latinos. Despite the many physical activity barriers for Latinos, strategies showing promise for increasing physical activity in Latino communities tend to include community-level systems changes and active programming, but there are areas that can be better understood. As policy makers and public health experts develop strategies to improve the built environment and promote activity, doing so in Latino communities should begin with understanding the intended and desired use for public spaces and physical-activity oriented programs; that way, these efforts may be most effective for helping Latinos be and remain more active.

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PHYSICAL ACTIVITY IN OLDER PEOPLE

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April 2015

Physiological function and resiliency decline with age, even among the most robust sectors of the older adult population. The degree to which this decline is attributable to true biological aging versus aging-related changes in lifestyle factors has been the focus of most research in this area. Nearly three decades ago, Walter Bortz first noted that many of the physiological changes ascribed to aging per se are similar to those induced by enforced inactivity, such as during prolonged bed rest, and he proposed that much of this functional dysregulation could be attenuated or even reversed with regular exercise.[1] Unfortunately, the modern-day lifestyle is characterized by a majority of time spent sedentary throughout the day. Older people may be especially vulnerable to the harmful effects of prolonged sitting due to a loss of physiologic reserve and the fact that they may spend up to 60-70 percent of their waking hours sitting or reclining. This has especially important consequences for aging, as increasing sedentary time may be displacing time spent in health-accruing lower intensity activities, which are the most prevalent physical activities reported among older people.

Physical activity of any intensity has consistently demonstrated a powerful counter effect on every risk factor associated with the prominent chronic diseases of older age.[2] Current activity level is more protective than past activity levels; however, cumulative lifetime patterns may be even more influential for risk reduction, especially for chronic diseases with a long latency period, such as cancer or osteoporosis. Moreover, the volume of physical activity necessary to prevent functional decline and to maintain health may be substantially lower than the amount needed to reverse an existing chronic condition. Thus, physical activity is far more cost-effective at the prevention (rather than curative) end of the public health spectrum, and this concept is emphasized repeatedly in the 2008 federal physical activity guidelines.[3]

Walking remains an important and prominent activity in older age.

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* Participant in the activities of the IOM Roundtable on Obesity Solutions.

Because walking is weight bearing, uses large muscle groups, can be sustained at lower and moderate intensities, and can improve maximal and submaximal physical functioning, its merits should be promoted among older people for meeting the physical activity guidelines of 150 minutes per week.[3] In addition, the American College of Sports Medicine recommends a regular program of resistance, flexibility, and balance training 2 days per week to promote and maintain lean mass and to prevent falls.[2] Finally, the dosing and timing of the exercise bout has recently assumed investigative priority.

Similar to some pharmacologic treatments, a smaller exercise dose repeated several times per day (particularly when it may be most effective, like after each meal or for breaking up sitting time) may provide greater overall benefits for health than the same dose performed prior to eating or than a single large dose performed once per day. This may be especially so if frailer people are more tolerant of smaller exercise doses and are better able to adhere to multiple frequencies of them on a regular basis.

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PHYSICAL ACTIVITY FOR PEOPLE WITH DISABILITIES: HOW DO WE REACH THOSE WITH THE GREATEST NEED?

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The 25th anniversary of the Americans with Disabilities Act (ADA) this year is an opportune time for researchers, practitioners, and policy makers to begin thinking about addressing the high rates of physical inactivity among people with disabilities. Recent national estimates on rates of physical activity among Americans (2009-2012) found that more than 50 percent of adults with disability are not meeting the U.S. exercise guidelines of 150 minutes per week.[1] Achieving the U.S. recommended guidelines is far more challenging for many people with disabilities, particularly among those who have difficulty walking, are unable to walk due to some form of paralysis (e.g., spinal cord injury), or cannot walk for long periods due to pain and/or balance impairments (e.g., multiple sclerosis, stroke, rheumatoid arthritis, etc.). In general, people with physical disability are more likely to undertake less physical activity during any given day because of high rates of unemployment or underemployment.[2] They may be unable to walk outdoors (the most common form of physical activity in the general population) due to difficult terrain or safety issues. They may be unable to walk for periods long enough to accrue health benefits (i.e., 30 or more minutes).[3] Transportation to and from community fitness facilities, parks, and recreation areas is often difficult to obtain, unavailable, or unaffordable,[4] and many fitness facilities do not have accessible equipment, classes, and programs or trained staff who understand how to adapt programs and services for people with disabilities.[5-8] These barriers are often difficult to overcome for many people with disabilities and, when considered in the aggregate (i.e., most people report several barriers), pose substantial challenges to promoting higher rates of physical activity in this underserved population.

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Reaching the Hardest to Reach

There is an urgent need to establish new models that integrate children and adults with a disability into the corpus of evidence-based programs and emerging new programs in physical activity.[9] For long-term sustainable health improvements to occur, communities should provide people with disabilities with the necessary supports (e.g., transportation, trained staff, accessible information and facilities, universally designed exercise equipment, socially engaging physical activity environments) that will allow them to engage in self-managed physical activity with other community members.

Within this framework, six concurrent steps are recommended. First, from a research perspective, adapted versus reinvented (which is much costlier and less generalizable) evidence-based physical activity strategies and programs established on the general population must be adapted and tested on people with disabilities in real-world settings. Second, disability and non-disability service providers must work together to form inclusive health coalitions that represent the physical activity needs of community members with disabilities. Third, programs that successfully promote inclusion in physical activity across policies, systems, and environments must be captured, translated, and disseminated to other organizations and communities using technology to readily and effectively connect to key stakeholders. Fourth, policies must be established that require staff training in physical activity inclusion for people with disabilities in all sectors (e.g., schools, workplaces, health care facilities, fitness centers). Fifth, health care providers must be trained and encouraged to counsel people with disabilities on appropriate and effective strategies for increasing physical activity. Sixth, university-based exercise science programs must add additional content across the curriculum in disability and physical activity and recommend to students that they obtain an entry-level certification sponsored by the American College of Sports Medicine (Certified Inclusive Fitness Trainer) that will increase their knowledge in accommodating people with disabilities in their programs.

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DISPARITIES IN PHYSICAL ACTIVITY AMONG LOW-INCOME AND RACIAL/ETHNIC MINORITY COMMUNITIES: WHAT CAN WE DO?

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Eliminating disparities related to physical activity (PA) among low-income and racial/ethnic minority communities (hereinafter referred to as "high-priority groups") is a complex, dynamic, and multifaceted challenge that requires complex, dynamic, and multifaceted solutions. First, we need to conduct *more comprehensive and accurate assessments of PA* in order to develop a clearer picture of PA patterns among high-priority groups. To accomplish this goal, self-report assessments of PA should be complemented with more objective and sensitive measures of PA, such as accelerometers, smartphone applications, and wearable technology devices.[1] Self-report assessments also should measure PA across multiple activity domains, including household, transportation, workplace, and recreation/leisure. Sedentary behavior as it relates to PA, weight status, and other health outcomes should be included in these assessments.[2] Furthermore, ecological momentary assessments with repeated and random sampling of PA and sedentary behavior in real time in natural environments should be conducted to minimize recall bias and maximize ecological validity.

Second, given the current social stratifications in Western societies, we need to consider *justice principles*, which include *environmental justice*, *green justice*, and *social justice*. Historically, high-priority groups have been disproportionately affected by injustices in these three areas. In terms of *environmental justice*, high-priority groups tend to live in communities deprived of health-promoting resources; thus, there is an inequality in the availability of PA resources.[3]

In this area, the goal is to develop and promote PA-friendly built environments (e.g., safe and walkable neighborhoods and access to recreation facilities) in all communities, especially those of color and low income.[4,5] In terms of *green justice* (i.e., natural environments), high-priority groups

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generally lack access to parks where they can be active, play, and learn about the environment.[6,7] To help address this inequality, the National Park Foundation launched Every Kid in a Park, an initiative to get all fourth graders and their families to national parks and other federal lands by giving them free admission for a full school year. In this area, the goal is to maximize the opportunities for all communities, particularly those of color and low income, to experience and enjoy the outdoors.[7] In terms of *social justice*, high-priority groups are adversely affected by various social factors, including poverty; inequitable education; lack of housing, jobs, and economic development; income inequalities; and stress associated with discrimination, racism, and poverty.[8] These factors increase social isolation and depression, all of which are associated with decreased PA. In this area, the goal is to eliminate social disadvantages in order to increase PA levels for all communities, with those for high-priority groups increasing at a faster rate.

Third, we need to understand how high-priority groups adapt to and function in the surrounding community. The recently developed *Community Energy Balance Framework* (CEB) can help to achieve this objective.[9] According to CEB, researchers, practitioners, and community organizers working with high-priority groups should contextualize their food- and PA-related sociocultural perspectives by accounting for relevant historical, political, and structural contexts. Importantly, the health consequences of cultural-contextual stressors and accommodating these stressors are emphasized. For intervention development, CEB identifies several factors and elements in three broad domains: cultural-contextual influences, intervention settings and agents, and intervention targets.[9] Also, emerging evidence identifies *social capital* as a correlate of PA patterns in high-priority groups, so PA intervention programs should incorporate social capital indicators into their designs.[10,11]

In conclusion, there is no single, simple strategy for eliminating PA-related disparities among high-priority groups. We need innovative, comprehensive, and multifaceted strategies emanating from community-based participatory approaches and theoretical frameworks.[12,13] The ultimate goal is to have health-promoting environments and the motivation to take full advantage of PA-friendly opportunities for all segments of society.[14]

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INVESTING IN NATIVE COMMUNITY-LED STRATEGIES TO IMPROVE PHYSICAL ACTIVITY

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Native Americans represent approximately 1 percent of the U.S. population, but account for some of the worst health outcomes related to preventable chronic diseases (diabetes, heart disease, cancer, alcoholism) than any other racial or ethnic group. In considering the risk factors for these diseases, Native American people have among the highest rates of obesity, with many children experiencing obesity rates two to three times greater than other racial/ethnic populations. But this was not always the case. Only in the last half of the 20th century have the documented cases of diabetes rates in Native communities increased so drastically.[1]

From a public health perspective, the policies, systems, and environment have had a significant impact on rates of obesity. For example, the environment in many Native communities drastically changed over the past 200 years, shifting from traditional hunting and gathering or farming subsistence cultures to forced relocation and reservations, leading to sedentary lifestyles and dependence on federal government food programs. These drastic generational changes to the environment, culture, and language, and the connection to land and food, have had a direct impact on the health of Native American people.

Native American communities disproportionately lack access to safe places to exercise and for children to play. Families and communities face a variety of barriers to being physically active, such as limited access to parks and recreation facilities, dirt roads with little to no walkable areas, stray dogs, and gang violence. Physical activity has always been an integral part of Native American life and history from running for endurance and speed valued for hunting, to running as a spiritual connection.

Native peoples are well aware of the research that links social determinants of health to the health of a community (level of educational attain-

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ment, poverty, access to health services, etc.). For example, poverty leads to dependence on federal government food programs such as the Food Distribution Program on Indian Reservations or "commodity foods"). In addition, due to the remote nature of many Native communities, access to healthy food choices is a challenge due to the cost of transporting fresh fruits and vegetables and other perishable foods. As a result, food access is typically limited to preserved and packaged foods that can be transported and stored inexpensively. These foods are typically not the healthiest choices, and are not consistent with traditional healthy diets.

Using this lens, we can approach solutions and strategies to address the root causes of obesity. Understanding these social and environmental changes impacting Native people requires an understanding of their history and treatment in this country as well as how this history over hundreds of years has impacted and drastically changed Native communities, their environment, and their health. Understanding this context will help inform strategies and solutions that will shed light on the foundational inequities facing Native people and build on their resiliency and inherent strength.

Despite these significant challenges, there are numerous positive and promising Native-led strategies to increase physical activity in Native communities. For example, some tribes in the Northeast are working to bring back leg wrestling, which in previous times would help create strong, agile men. Also in the Northeast, traditional games like lacrosse are being promoted as part of children's daily physical activity. In the Midwest, canoeing was not only a way to get around a land full of streams and lakes, but it also provided a means for fishing and collecting wild rice, a staple of many Midwestern tribes' diets. In the Southwest, several Pueblo and Navajo chapters are returning to their roots as long-distance runners. Runners played a critical role for the Pueblos, not only for entertainment and keeping their people strong and healthy, but also as an intricate piece of the 1680 Pueblo revolt. Long-distance runners were tasked with sharing communication throughout the Pueblo villages for when and how the revolt would take place.[2] In addition, many Native communities are embracing the concept of food sovereignty and regaining traditional food systems. These efforts need to be evaluated, highlighted, and shared with other Native communities to expand the evidence base of promising practices in obesity prevention and to promote health in Native communities.

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INCREASING MOVEMENT TO PROMOTE HEALTH AND LEARNING IN EARLY CHILDHOOD

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Public support is increasing for the investment in pre-kindergarten (pre-K) education for 3- and 4-year-olds.[1] If physical activity is going to be an integral part of pre-K education, changes are needed in the training of early childhood educators and in the physical environments of pre-K programs. When teachers are trained and motivated to move with children throughout the school day and have the spaces to do so, both children and teachers can benefit. Frequent movement is developmentally appropriate for preschool children, promotes health and learning, and can also improve the physical and mental health of teachers.

The main goal of pre-K and other early childhood education programs, such as Head Start, is to prepare children for elementary school. Efforts to increase young children's physical activity are more likely to be implemented and sustained if they align with that goal. Therefore, movement needs to be promoted on the basis of its benefits for learning, not just for health. Movement can improve academic performance by developing cognitive functions, such as the ability to sustain and shift attention, remember information, and inhibit impulses.[2,3]

Social and emotional learning can also be enhanced when children move together because this develops additional brain functions, such as locating one's body in relation to others and interpreting and responding to non-verbal cues.[4] When teachers move with children, it may enhance teacher–child relationship quality,[5] which can also support learning.[6] Finally, outdoor activity, which is associated with more energy expenditure than indoor activity,[7] may also increase children's cognitive stimulation because outdoor environments are more variable and complicated than indoor environments.[8] Interventions have already been developed that emphasize the links between moving and learning by integrating physical activity into the teaching of academic concepts.[9,10]

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Teachers may also be motivated to support children's physical activity if teachers find that moving with children improves their own physical and mental health. For children to learn well, their teachers must be healthy, and the health of early childhood educators has much room for improvement.[11] The early childhood education program must be viewed as the educators' worksite, and the same level of support must be given to the teachers' health and well-being as to the children's learning. Integrating movement into early learning helps physical activity become part of the culture of learning and health at the school and workplace.

To integrate movement and learning, classroom teachers need training, and preschools require space and equipment that afford safe and enriching movement experiences.[5,12] All of this requires funding. Funding is most likely to follow from changing policy in two areas: (1) requirements for teacher certification and (2) requirements for program certification and quality rating.[13] Degree-conferring programs that credential early childhood educators should require training in several areas: children's gross motor development, the integration of movement experiences into academic learning, children's safety during movement, and the development of the teacher's own movement skills. Technical assistance to existing early childhood educators must address these same topics along with providing guidance about suitable equipment and space for both indoor and outdoor movement experiences. This training may need to come from experts in the physical education of young children. Program certification and quality rating should depend on indoor and outdoor space requirements and the availability of equipment and practices that support physical activity and gross motor development. These costs cannot be shifted onto the teachers, who are already poorly paid,[14] or to the low-income families whose children may benefit most from these changes. As support grows for public pre-K investment, there is an opportunity to position physical activity as part of this investment because movement is necessary for learning and for the health of young children and teachers.

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Acronyms and Abbreviations

ADHD	attention-deficit/hyperactivity disorder
BMI	body mass index
BRFSS	Behavioral Risk Factor Surveillance System
CARDIA	Coronary Artery Risk Development in Young Adults
CDC	Centers for Disease Control and Prevention
CSPAP	Comprehensive School Physical Activity Program
DPP	Diabetes Prevention Program
DPPOS	Diabetes Prevention Program Outcome Study
DRA	Disparity Reducing Advances Project
DSE	diabetes support and education
DXA	dual-energy X-ray absorptiometry
EPIC	European Prospective Investigation into Cancer and Nutrition
FMD	flow-mediated dilation
FSIVGTT	frequently sampled intravenous glucose tolerance test
HbA1c	hemoglobin A1c
HDL	high-density lipoprotein
HHS	U.S. Department of Health and Human Services

ILI	intensive lifestyle intervention
IOM	Institute of Medicine
IT	information technology
LDL	low-density lipoprotein
MAP-21	Moving Ahead for Progress in the 21st Century
MAQ	Modifiable Activity Questionnaire
MET	metabolic equivalent of task
MVPA	moderate- to vigorous-intensity physical activity
NHANES	National Health and Nutrition Examination Survey
NHIS	National Health Interview Survey
NHLBI	National Heart, Lung, and Blood Institute
NIDDK	National Institute of Diabetes and Digestive and Kidney Diseases
NIH	National Institutes of Health
NQLS	Neighborhood Quality of Life Study of Adults
NSCH	National Survey of Children and Health
PE	physical education
SAFETEA-LU	Safe, Affordable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
VFC	Virtual Fitness Center
WHI	Women's Health Initiative
WHO	World Health Organization

D

Speaker Biographical Sketches

Shari Barkin, M.D., M.S.H.S., is William K. Warren Foundation Chair professor of pediatrics, director of pediatric obesity research in the Diabetes Center, and chief of general pediatrics at Vanderbilt University Medical Center. Dr. Barkin was trained as a Robert Wood Johnson clinical scholar in outcomes research and has experience in developing and implementing large randomized controlled trials testing interventions designed to affect large public health issues, such as obesity prevention. Her laboratory studies family-based, community-centered clinical interventions aimed at measurably reducing pediatric obesity during critical windows of childhood. The lab is focused on changing body mass index trajectories in childhood, applying an ecologic model that considers children in the context of their families and families in the context of their communities. Dr. Barkin serves as the principal investigator for the Growing Right Onto Wellness (GROW) Trial, funded by the National Heart, Lung, and Blood Institute (NHLBI) and the National Institute of Child Health and Human Development (NICHD) and part of the Childhood Obesity Prevention and Treatment Research (COPTR) Consortium. She also serves on the Steering Committee for COPTR and on the Board on Children, Youth, and Families of the Division of Behavioral and Social Sciences and Education of the National Academies. She has extensive experience in conducting research examining health from a life span perspective, looking at how early exposures lead to later health outcomes. Dr. Barkin received a bachelor's degree from Duke University and a doctorate in medicine from the University of Cincinnati.

Cedric X. Bryant, Ph.D., FACSM, is chief science officer for the American Council on Exercise (ACE) and represents ACE as a national and international lecturer, writer, and expert source. He has written more than 250 articles or columns in fitness trade magazines, as well as sports medicine and exercise science journals, and authored, co-authored, or edited more than 30 books. During his tenure at ACE, Dr. Bryant has played a primary role in the development and evolution of its educational content and certifications, which have helped set the standards for fitness professionals around the world—more than 90,000 professionals having earned ACE certifications over the past 12 years. He has held positions on the exercise science faculties at several prestigious institutions, including the United States Military Academy at West Point, Pennsylvania State University, and Arizona State University. He earned both his doctorate in physiology and master's degree in exercise science from Pennsylvania State University.

Jamie F. Chriqui, Ph.D., M.H.S., is professor of health policy and administration at the School of Public Health at the University of Illinois at Chicago. She has more than 24 years of public health policy research, analysis, and evaluation experience working in the federal government, in government contracting, and in academia. Dr. Chriqui is considered a national expert on chronic disease policy issues, particularly those related to obesity, diet, and physical activity, as well as tobacco and illicit drug control. She serves on numerous obesity-related advisory boards and panels and previously served as a member of the Institute of Medicine's (IOM's) Committee to Accelerate Progress in Obesity Prevention and Committee to Evaluate Progress in Obesity Prevention. Her research focuses heavily on studying the diffusion of and variability in obesity-related policies at the state and local levels nationwide, and their impact on communities, schools, and individual behaviors and health-related outcomes. Dr. Chriqui earned a bachelor of arts degree in political science from Barnard College, a master of health science degree in health policy from Johns Hopkins University, and a doctorate in policy sciences from the University of Maryland.

Loretta DiPietro, Ph.D., M.P.H., is department chair for the Department of Exercise at George Washington University. She joined the Milken Institute School of Public Health in 2008 following her tenure at Yale University School of Medicine, where she was associate professor of epidemiology and public health and a fellow at the John B. Pierce Laboratory, which studies how biological systems interact with the built environment and influence health. As chair of the Department of Exercise Science, Dr. DiPietro emphasizes the many collaborative research and educational opportunities that students can pursue across the George Washington Medical Center and the entire university. She holds a bachelor of science degree in health

education from Southern Connecticut State University, a master of science degree in health education and exercise science from Southern Connecticut State University, a master of public health degree from Yale University, and a doctor of philosophy degree in epidemiology from Yale University.

Ginny Ehrlich, Ph.D., is director and senior program officer of the Childhood Obesity team at the Robert Wood Johnson Foundation. From 2006 to 2013, she was CEO of the Alliance for a Healthier Generation, and she served more recently as founding CEO of the Clinton Health Matters Initiative, the Clinton Foundation's newest initiative focused on reducing preventable deaths and closing gaps in health equity in the United States. While head of the Alliance for a Healthier Generation, Dr. Ehrlich oversaw the transition of the organization, originally a joint venture of the Clinton Foundation and the American Heart Association (AHA), to an independent nonprofit. She also positioned the Alliance as a national leader in the childhood obesity prevention arena, as evidenced by its distinction as a founding member of First Lady Michelle Obama's Let's Move! initiative. In 2013, she helped start the Clinton Health Matters Initiative, setting the vision, strategy, and blueprint for the organization and building partnerships with more than 50 corporations and nonprofits to support access to health and wellness. From 2006 to 2008, Dr. Ehrlich was founding director of the Healthy Schools Program, now the largest school-based obesity prevention effort in the country, active in more than 18,000 schools in all 50 states. She holds a doctor of education degree in education leadership and a master of science degree in special education, both from the University of Oregon; a master of public health degree from Boston University; and a bachelor of arts degree in community health education from the University of Oregon.

Ulf Ekelund, Ph.D., is a professor of physical activity epidemiology at the Department of Sport Medicine, Norwegian School of Sport Sciences, Oslo, Norway. He is also a senior investigator scientist at the MRC Epidemiology Unit, University of Cambridge, United Kingdom. Dr. Ekelund's main research interests are related to measurement and population levels of physical activity, the role of physical activity in preventing noncommunicable diseases, and the biological basis for physical activity and sedentary behavior across the life course. He obtained his Ph.D. from the Karolinska Institutet, Stockholm, Sweden, in 2002; joined the MRC Epidemiology Unit in January 2003; and assumed his position in Norway in 2012.

Amy A. Eyler, Ph.D., is assistant professor and assistant dean of public health at the Brown School at Washington University in St. Louis. Her main research interests are physical activity, community policy, and environmental interventions. She most recently served as principal investigator for the

Physical Activity Policy Research Network (PAPRN), a national network of researchers studying the influence of policy on population physical activity. Dr. Eyler is past chair of the physical activity section of the American Public Health Association, a member of the American College of Sports Medicine (ACSM), and a certified health education specialist. She holds a master's degree in physical education and adult fitness from Ohio University and a doctorate in public health from Oregon State University.

Linda Fondren is a community leader who transformed her life from poverty and disempowerment to success, and returned to her hometown of Vicksburg, Mississippi, determined to make it a healthier place after Mississippi was deemed the "fattest state" in the nation for several consecutive years. In 2009, she spearheaded "Shape Up Vicksburg," a City Hall–sanctioned weight loss challenge. Ms. Fondren enrolled 2,500 Vicksburg residents in the program, most of whom were taking charge of their health and nutrition for the first time. The challenge resulted in a collective weight loss of more than 15,000 pounds among participants. For her persistent efforts and the impact on her community, Ms. Fondren was chosen a Top Ten CNN Hero of the Year for 2010. She was also selected, among distinguished leaders such as First Lady Michelle Obama, as one of The Grio's 100 History Makers in the Making and named 2011 Woman of the Year for the City of Vicksburg. Her efforts caught the attention of major national media outlets, including *CBS Evening News with Katie Couric*, *NBC Nightly News*, MSNBC, *Dr. Oz*, and CNN. She has been featured in numerous magazines, including *Essence, Glamour*, *Woman's World*, *Shape*, *Success*, *Jet*, and Southwest Airlines' *Inflight Magazine*. Radio interviews include the *Tom Joyner Show* and *Bill Bradley*. In 2014, Ms. Fondren published her first book, *Shape Up Sisters!*, to spread her message and tips to a wider audience. *Shape Up Sisters!* is a practical, inspirational, and accessible guide for everyday women with jobs, families, and real-life obstacles. Ms. Fondren is a certified personal trainer and owns an all-female gym called Shape Up Sisters in Vicksburg.

James O. Hill, Ph.D., is Anschutz professor of pediatrics and medicine at the University of Colorado Denver, director of the Colorado Clinical Nutrition Research Unit, and executive director of the Anschutz Health and Wellness Center. He has spent more than 30 years researching the causes of weight gain, adiposity, and obesity and how these problems can be prevented or treated. He has published more than 500 scientific articles and lectures widely on weight management. Dr. Hill is well known as a co-founder of the National Weight Control Registry, which follows more than 10,000 people who have lost weight and kept it off permanently. He is also co-founder of America on the Move, an initiative focused on making

small lifestyle changes to help improve health and manage weight. He was a member of the expert panel that developed the first National Institutes of Health (NIH) Guidelines for Management of Overweight and Obesity and was chair of the first World Health Organization Consultation on Obesity. He has served as president of the American Society for Nutrition and The Obesity Society. Dr. Hill has spent the past few years translating the science of weight management into science-based intervention programs. He is author of the *Step Diet Book* and *The State of Slim*. Dr. Hill holds a bachelor of science degree from the University of Tennessee and master of science and doctoral degrees in physiological psychology from the University of New Hampshire. He was elected to the IOM in 2014.

Sean Hinkle is program director at DC SCORES. He joined DC SCORES in 2009 after working with Grassroot Soccer in South Africa. There he helped design and implement "11 for Health in Africa," a public health campaign aimed at African youth that combines soccer with 11 different health, social, and life skills messages. The "11 for Health" program has since expanded to eight other countries. While in Africa, Mr. Hinkle also co-founded Ragball International, a soccer-based income-generation and entrepreneurial development program. Prior to his tenure with Grassroot Soccer, he worked at the U.S. Soccer Foundation, where he helped oversee the Passback Program and manage grants. He received his bachelor of science degree from the University of Virginia's Curry School of Education in 2007. At the university, he was also a 4-year member of the varsity men's soccer team.

John M. Jakicic, Ph.D., is a professor in the Department of Health and Physical Activity and director of the Physical Activity and Weight Management Research Center at the University of Pittsburgh. He has also been on the faculty at Brown University, the University of Kansas, and the University of Nebraska–Kearney. He has a national and international reputation as a leading scholar in the area of physical activity and weight control. His work in this area builds on a line of research aimed at determining the appropriate dose of physical activity for long-term body weight regulation. Within this line of research, he studies the interaction between energy expenditure and energy intake and the influence of these factors on body weight regulation. Specifically, his early research was key to the public health recommendation that physical activity can be beneficial when separated into multiple 10-minute sessions per day. Dr. Jakicic is also an expert in the implementation of strategies for improving long-term adherence to physical activity, and in the understanding of behavioral and physiological mechanisms involved in linking physical activity to body weight regulation. In addition, he has been at the forefront of applying technology to physical

activity interventions, including wearable technologies and low-intensity intervention strategies for lifestyle behavior change. Dr. Jakicic has served on various national and international committees developing physical activity guidelines for the prevention and treatment of obesity and other chronic conditions. Thus, he has been influential in the heightened awareness of physical activity as a key lifestyle behavior to improve health. Dr. Jakicic earned his bachelor of science degree in physical education and health and his master of science degree in exercise science from Slippery Rock University of Pennsylvania. He received his doctorate in exercise physiology from the University of Pittsburgh.

Kathleen F. Janz, M.A., Ed.D., is professor of health and human physiology at the University of Iowa and associate director of the University of Iowa Obesity Research and Education Initiative. Her scholarship centers on the epidemiology of physical activity; specifically, she studies the relationship between everyday physical activity and health outcomes, including heart and bone health. This work is a prerequisite for successfully establishing efficacious public health guidelines, for discerning causal factors for physical activity choices, and for intervening to improve physical activity levels. Dr. Janz also maintains a second area of study—objective monitoring of physical activity, including the statistical modeling of movement data. She was one of the first scholars to publish work using objective monitors to examine cardiorespiratory outcomes (1992) and the first to use objective monitors to examine bone outcomes (2001). She recently completed ad hoc service for the U.S. Department of Health and Human Services (HHS), coauthoring the *Physical Activity Guidelines for Americans Midcourse Report* (2013). This report addresses effective strategies for improving physical activity levels for children and adolescents. Dr. Janz is currently a member of the writing committee charged by the National Osteoporosis Foundation with systematically reviewing and updating its statement on lifestyle factors and peak bone health. She is lead author for sections addressing physical activity and exercise as they pertain to bone development and adaptation. Dr. Janz holds a doctor of education degree in community health, exercise physiology and a master of arts degree in exercise physiology, both from the University of Northern Colorado, and a bachelor of science degree in physical and health education from the University of Wisconsin–Stevens Point.

Abby King, Ph.D., is professor of health research and policy and medicine (the division known as the Stanford Prevention Research Center) at Stanford University School of Medicine. A recipient of the Award for Outstanding Scientific Contributions in the Area of Health Psychology from the American Psychological Association, Dr. King has focused her research on the development, evaluation, and dissemination of public health interventions

to reduce chronic disease risk and enhance health. Her current research focuses on expanding the reach and generalizability of evidence-based interventions through the use of state-of-the-art communication technologies, the application of community-based participatory research perspectives to address health disparities among disadvantaged populations, and policy-level approaches to health promotion. Dr. King has served on a number of government task forces in the United States and abroad, including the U.S. Secretary of HHS's Scientific Advisory Committee on National Health Promotion and Disease Prevention Objectives for 2020. She has been the recipient of a number of NIH research grant awards. She is an elected member of the Academy of Behavioral Medicine Research and past president of the Society of Behavioral Medicine. In 2003, she received the Society of Behavioral Medicine's Distinguished Research Mentor Award, and she has twice received the Stanford Prevention Research Center's Outstanding Contributions to Teaching Award. In 2014, Dr. King became 1 of 10 U.S. scientists honored by the Association of American Medical Colleges (AAMC) for outstanding work in support of health equity as part of AAMC's national initiative highlighting evidence-based solutions to health and health care inequities. She obtained her doctorate in clinical psychology from Virginia Polytechnic Institute & State University.

Harold W. (Bill) Kohl III, Ph.D., is professor of epidemiology and kinesiology at the University of Texas Health Science Center at Houston and in the Department of Kinesiology and Health Education at the University of Texas at Austin, College of Education. He is also faculty at the Michael & Susan Dell Center for the Advancement of Healthy Living in Austin. Dr. Kohl is founder and director of the University of Texas Physical Activity Epidemiology Program, where he is responsible for student training, research, and community service related to physical activity and public health. His previous service includes directing physical activity epidemiology and surveillance projects in the Division of Nutrition, Physical Activity, and Obesity at the Centers for Disease Control and Prevention (CDC). Dr. Kohl's research focuses on the specific area of epidemiology related to physical inactivity and obesity, in adults but also in children. He also studies the effect of the built environment on physical activity and is currently researching a planned development that implements "smart growth" techniques designed to support physically active lifestyles. Dr. Kohl served as chair of the IOM's Committee on Physical Activity and Physical Education in the School Environment and was a member of the IOM's Committee on Fitness Measures and Health Outcomes in Youth and Committee on Accelerating Progress in Obesity Prevention. He received a master of science in public health degree from the University of South Carolina School of Public Health in epidemiology and biostatistics and a doctorate from

the University of Texas Health Science Center at Houston School of Public Health in community health studies.

Andrea Kriska, Ph.D., is professor in the Department of Epidemiology in the Graduate School of Public Health. She led the development of the physical activity component of the original Diabetes Prevention Program (DPP) lifestyle intervention curriculum as part of the national DPP Lifestyle Resource Core at the University of Pittsburgh. She continued her involvement in physical activity intervention and assessment in the DPP Outcomes Study, and maintained a similar role in several other multicenter (the STOPP-T2d TODAY trial) and single-site (WOMAN, SAVE, WWF) studies. With a focus on and passion for prevention, Dr. Kriska was principal investigator of a National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) study involving the translation of the DPP's successful behavioral intervention into diverse community settings, ranging from senior centers and worksites to the military. She formerly served as principal investigator of an NIH-funded investigation of activity/inactivity in the DPP using objective monitoring (accelerometry). She was recently funded by NIH to investigate whether the health of sedentary, overweight people can be improved with a program focusing initially on decreasing the amount of time they spend sitting rather than on increasing the amount of time they spend exercising. Dr. Kriska is a faculty member of the Diabetes Prevention Support Center of the University of Pittsburgh, which provides training and support in lifestyle intervention efforts in diverse communities. Much of her research and almost all of her service efforts, including serving on local and national committees and task forces, focus on underserved populations in which prevention efforts are most needed. Dr. Kriska holds a doctorate in epidemiology and a master of science degree in exercise physiology, both from the University of Pittsburgh, and a bachelor of science degree in biology from the University of Dayton.

Linda Meyers, Ph.D., is senior science advisor for the American Society for Nutrition (ASN), where her portfolio includes fostering strategic initiatives to expand the impact and influence of the Society and its foundation. Until June 2013, Dr. Meyers directed the Food and Nutrition Board (FNB) at the IOM, where her portfolio included obesity prevention. She also directed the FNB's international nutrition program from 1982 to 1986. From 1986 to 2001, she served as senior nutrition advisor, deputy director, and acting director in the Office of Disease Prevention and Health Promotion, Office of the Assistant Secretary for Health, HHS. While there, she oversaw the preparation of technical and policy reports, including the 1990, 1995, and 2000 *Dietary Guidelines for Americans*; the U.S. Action Plan on Food

Security; and *Healthy People 2010*. Her research focused on population indicators of nutritional status. Dr. Meyers has received awards for her contributions to public health, including the Secretary's Distinguished Service Award for Healthy People 2010, the Conrad A. Elvehjem Award for Public Service in Nutrition from the ASN, the IOM's Cecil Award, the National Academies Group Distinguished Service awards for *The DRI's Essential Guide* and for the Emmy-nominated *The Weight of the Nation* and *The Weight of the Nation: Kids* film series, and the Surgeon General's Medallion. In April 2013, she was elected a fellow of the ASN. Dr. Meyers holds a bachelor of arts degree in health and physical education from Goshen College in Indiana (1968), a master of science degree in food and nutrition from Colorado State University (1974), and a doctorate in human nutrition from Cornell University (1978).

Marisa Molina, M.P.H., is research core project manager with the San Diego Prevention Research Center (SDPRC) within the Institute for Behavioral and Community Health (IBACH). She has 5 years of public health management experience, working with the SDPRC. As project manager, she led the development of evaluation protocols, the design of the intervention, and community partnerships for implementation. Ms. Molina also maintained the role of communication and dissemination coordinator for the SDPRC, beyond the scope of the main research study. The intervention designed utilized the community health worker (CHW) model to provide free exercise and healthy lifestyle classes to community members in South San Diego County (450 Latina women participated in this research study, which maintained a retention rate of approximately 80 percent at 6 and 12 months postbaseline). During this 5-year project, Ms. Molina led the evaluation team in a comprehensive assessment and designed measurement protocols to create a more efficient process than had been used for previous evaluation strategies within IBACH. The intervention included a 10-session healthy lifestyle course and the development of training manuals for CHWs and for organizations. In the past 2 years of the study, Ms. Molina spearheaded a pilot project with the county of San Diego and a contractor who provided all employment-related training to participants in CalWorks (California's version of Temporary Assistance for Needy Families [TANF]) to utilize the curriculum and model within this setting. While results from this study have not yet been published, preliminary analysis has shown individual-level improvements in health and improved participation and employment outcomes among participants. Ms. Molina holds a bachelor of science degree in molecular biology from the University of California, San Diego, and received her master of public health degree from San Diego State University.

Aviva Must, Ph.D., is Morton A. Madoff professor of public health and chair of the Department of Public Health and Community Medicine at Tufts University School of Medicine. She is a nutritional epidemiologist who has worked in population-based obesity research since 1988. She focuses on the epidemiology of obesity across the life span, with a particular interest in physical and psychosocial health consequences during adolescence and in vulnerable populations. Additional research foci include the development of valid survey measures and surveillance systems for pediatric obesity and proximal modifiable behaviors (nutrition, physical activity, sedentary behavior). Recent efforts have been directed toward developing the descriptive epidemiology and health promotion for children with developmental disabilities. Dr. Must's preventive intervention work includes community-based research projects in preschool and primary school populations. She directs the Clinical and Community Research Core of the Boston Nutrition Obesity Research Center, a cross-institution NIH-funded obesity center, and is co-director of the Healthy Weight Research Network for Children with Autism Spectrum Disorders and Developmental Disabilities, funded by the Maternal and Child Health Bureau of the Health Resources and Services Administration, HHS. Dr. Must holds a doctorate and a master of science degree in nutrition, both from Tufts University, and a bachelor of science degree in biology from New York University.

Allison Nihiser, M.P.H., is health scientist at CDC's School Health Branch. She synthesizes research on school-based physical activity and nutrition to produce strategies and guidelines for schools. Much of her work focuses on school-based body mass index (BMI) measurement programs, physical activity, fitness testing, local school wellness policies, out-of-school time, and technical assistance for grantees and partners on obesity prevention policies and practices in schools. Relatedly, she authored CDC's *School Health Guidelines to Promote Healthy Eating and Physical Activity*, CDC's/Presidential Youth Fitness Program's *Monitoring Student Fitness Levels: Is Physical Fitness Associated with Health in Overweight and Obesity in Youth?*, and *BMI Measurement in Schools*. Ms. Nihiser regularly conducts trainings on the aforementioned *School Health Guidelines* to state and local health department staff, state and local education department staff, and university staff. She has worked at CDC since 2004. She received two bachelor's degrees from Miami University (Ohio), in exercise science and zoology, and obtained a master's degree in public health from Yale University, where she focused on chronic disease epidemiology.

Russell Pate, Ph.D., is professor of exercise science at the Norman J. Arnold School of Public Health, University of South Carolina, Columbia. His research interests and expertise focus on physical activity measure-

ment, determinants, and promotion in children and youth. He also directs a national postgraduate course aimed at developing research competencies related to physical activity and public health. Dr. Pate is involved in the CDC-funded Prevention Research Center at the University of South Carolina. His research includes studies on preschoolers' physical activity levels and how schools can influence these levels, as well as multicenter trials on the promotion of physical activity among middle and high school-age girls. Dr. Pate was a member of the Physical Activity Guidelines Advisory Committee of the HHS and served on the 2005 Dietary Guidelines Advisory Committee. He is a past president of both the ACSM and the National Coalition on Promoting Physical Activity. Dr. Pate has served as a member of several IOM obesity-related committees, including the standing Committee on Childhood Obesity Prevention, and was chair of the Committee on Fitness Measures and Health Outcomes in Youth. He received a doctorate in exercise physiology from the University of Oregon.

Nico Pronk, Ph.D., FACSM, is vice president for health management and chief science officer for HealthPartners, Inc. He is also a senior research investigator at the HealthPartners Institute for Education and Research; adjunct professor of social and behavioral sciences at the Harvard School of Public Health; visiting research professor in environmental health sciences at the University of Minnesota, School of Public Health; member of the Task Force on Community Preventive Services; and founding and past-president of the International Association for Worksite Health Promotion. His research expertise lies in the areas of population health improvement, the role of physical activity in health, and the impact of multiple health behaviors on health outcomes. Dr. Pronk is particularly interested in improving population health in the context of the employer setting; the integration of health promotion with occupational safety and health; and the integration of health promotion, behavioral health, and primary care. He is senior editor of ACSM's *Worksite Health Handbook*, 2nd ed. (2009), and author of the scientific background paper for the U.S. National Physical Activity Plan for Business and Industry. Dr. Pronk received a doctorate in exercise physiology from Texas A&M University and completed postdoctoral studies in behavioral medicine at the University of Pittsburgh Medical Center and the Western Psychiatric Institute and Clinic in Pittsburgh.

Robert Ross, Ph.D., R.Kin., FACSM, FAHA, is a professor in the School of Kinesiology and Health Studies at Queen's University. His research program focuses on the management of obesity and related comorbid conditions. Dr. Ross has published extensively in these and related areas. He is past-president of the Canadian Society for Exercise Physiology, current vice president of the College of Kinesiology in Ontario, and a fellow of

ACSM and AHA, and is this year's recipient of the Honor Award from the Canadian Society of Exercise Physiology. He has delivered more than 300 lectures to medical, scientific, and lay groups worldwide. Dr. Ross obtained a bachelor's degree in physical education from McGill University and master's (1988) and doctoral (1992) degrees in exercise physiology from the Université de Montréal.

James F. Sallis, Ph.D., is distinguished professor of family medicine and public health at the University of California, San Diego, and director of Active Living Research, supported by the Robert Wood Johnson Foundation. Dr. Sallis's primary research interests are promoting physical activity and understanding policy and environmental influences on physical activity, nutrition, and obesity. He has made contributions in the areas of measurement, correlates of physical activity, intervention, and advocacy. Dr. Sallis's health improvement programs have been studied and used in communities, health care settings, schools, universities, and companies. He is the author of more than 600 scientific publications, co-author of several books, and a member of the editorial boards of several journals. He is a frequent consultant to universities, health organizations, and corporations worldwide. Dr. Sallis received his doctorate in clinical psychology from Memphis State University.

Gabriel Shaibi, Ph.D., is associate professor and Southwest Borderlands scholar at Arizona State University, where he holds appointments in the College of Nursing & Health Innovation and School of Nutrition and Health Promotion. In addition to his faculty roles, he serves as research director in the Division of Pediatric Endocrinology and Diabetes at Phoenix Children's Hospital and sits on the editorial board of *Obesity*, the flagship scientific journal of The Obesity Society. Dr. Shaibi's research examines obesity-related health in high-risk and vulnerable populations, with an emphasis on understanding and preventing cardiometabolic diseases in obese youth. His work applies a translational approach that includes basic, clinical, and community research collaborations that have contributed to more than 65 peer-reviewed publications stemming from more than $12 million in grant funding. Dr. Shaibi earned his bachelor's degree in kinesiology from Occidental College and his doctorate in biokinesiology and physical therapy from the University of Southern California.

Howell Wechsler, M.P.H., Ed.D., is CEO of the Alliance for a Healthier Generation, founded by the AHA and the Clinton Foundation in response to the rapid increase in childhood obesity rates over the past three decades. He leads a team of more than 120 professional staff in 39 states and

the District of Columbia taking action to reduce the prevalence of childhood obesity by making it easier for youth to be physically active and eat healthier foods. Before assuming the role of Alliance CEO in 2013, Dr. Wechsler spent 18 years at CDC, joining as a health scientist in 1995 and most recently serving as director of the Division of Adolescent and School Health (DASH) from 2004 to May 2013. He supervised the management of DASH's three surveillance systems and oversaw the division's research and evaluation studies; the development and dissemination of tools to help schools implement evidence-based policies and practices; and the funding of and technical assistance to state and local education agencies and national, nongovernmental organizations. He entered the field of public health during his service as a Peace Corps volunteer in Zaire. Dr. Wechsler earned a doctorate in health education from Teachers College, Columbia University; a master's degree in public health from Columbia University; and a bachelor's degree in journalism from Northwestern University.

James Whitehead is executive vice president of ACSM in Indianapolis, Indiana, a position he has held since 1990. Prior to his appointment at ACSM, he served in executive roles at the American Academy of Otolaryngology-Head and Neck Surgery in Washington, DC, from 1987 to 1990, and also was a principal with an association management firm that specialized in health and science nongovernmental organizations and political candidates at the U.S. federal level. Mr. Whitehead's research and practice focus on innovation within planning processes, as well as health policy and administration. He has published articles in the health, public policy, and organizational literature. Mr. Whitehead has received awards from many professional associations, including the International Academy of Sports Vision, the Association for the Advancement of Applied Sports Psychology, the Council for Better Hearing and Speech, and ACSM. He attended the University of Alabama at Birmingham, receiving degrees in political science (public administration) and history (business and medical history).