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Part A: Executive Summary

Disease prevention and health promotion are high priority features of President George W. Bush's Healthier US initiative and Secretary of Health and Human Services (HHS) Michael O. Leavitt's Prevention Priority. Getting routine medical screenings, making healthy choices and avoiding risks, eating a nutritious diet, and being physically active are major components of chronic disease prevention. On October 27, 2006, Secretary Leavitt announced plans for the development of Federal *Physical Activity Guidelines for Americans* to be issued in 2008. These Federal guidelines will serve as the benchmark and single, authoritative voice for providing science-based guidance on physical activity, fitness, and health for Americans. In preparation for the development by HHS of these guidelines, an important first step was to conduct a comprehensive review and analysis of the scientific literature on physical activity and health published since 1995. This task was assigned to the Physical Activity Guidelines Advisory Committee (PAGAC).

The Physical Activity Guidelines Advisory Committee

Following the announcement by the HHS Secretary of plans to develop physical activity guidelines, nominations for membership on the PAGAC were solicited through the *Federal Register*. PAGAC members were expected to be respected and published experts in the science of physical activity and its role in health promotion and disease prevention; be familiar with the purpose, communication, and application of Federal guidelines; not be employees of the Federal Government; and be free of any commercial conflicts of interest. In February 2007, the Secretary of HHS appointed 13 members to the PAGAC, including a chair and vice-chair. Secretary Leavitt's charge to the PAGAC was to review existing scientific literature to identify where there is sufficient evidence to develop a comprehensive set of specific physical activity recommendations and identify areas where further scientific research is needed. The intent of HHS is to develop physical activity recommendations for all Americans that will be tailored as necessary for specific subgroups of the population. PAGAC was not to prepare guidelines or policy statements. This report is the result of work by the Committee, consultants to the Committee, and HHS support staff. Names and affiliations of PAGAC members, consultants, and HHS support staff are listed at the beginning of this report.

Initially, the PAGAC formed 9 subcommittees, focused on the 9 health outcomes identified by the CDC team assigned to assist the PAGAC: all-cause mortality, cardiorespiratory health, metabolic health, energy balance, musculoskeletal health, functional health, cancer, mental health, and adverse events. PAGAC members then added 2 other subcommittees:

youth and understudied populations (i.e., populations not covered in other chapters — persons with disabilities, women during pregnancy and the postpartum period, and races and ethnicities other than non-Hispanic white). The conclusions in this report represent the consensus of the entire PAGAC.

Report Contents

This report includes 3 major components. The first provides an introduction to the PAGAC process; definition of key terms used in the report; background information on dose response, recent trends in physical activity among Americans, and an overview of physical activity guidelines development in the United States; a summary and integration of the science reviewed by PAGAC; and an explanation of the development and use of the *Physical Activity Guidelines for Americans* Scientific Database. The second component includes 11 sections that review and summarize the scientific literature relating physical activity to individual health outcomes. The third component provides a summary of the PAGAC's collective recommendations for future research. References cited are at the end of each section.

Review of the Science on Physical Activity and Health

One of the PAGAC's major goals was to integrate the scientific information on the relation between physical activity and health and to summarize it in a manner that could be used effectively by HHS personnel to develop the *Physical Activity Guidelines for Americans* and related policy statements. The resulting consensus statements based on the evidence relating physical activity to health are provided in ***Part E: Integration and Summary of the Science*** and the conclusions in each of the chapters in ***Part G: The Science Base***. A number of the key conclusions by the PAGAC, based on their review of the scientific literature, are summarized below.

Overall Benefits of Physical Activity on Health

Very strong scientific evidence based on a wide range of well-conducted studies shows that physically active people have higher levels of health-related fitness, a lower risk profile for developing a number of disabling medical conditions, and lower rates of various chronic diseases than do people who are inactive.

Children and Youth

Strong evidence demonstrates that the physical fitness and health status of children and youth are substantially enhanced by frequent physical activity. Compared to inactive young people, physically active children and youth have higher levels of cardiorespiratory endurance and muscular strength, and well-documented health benefits include reduced

body fatness, more favorable cardiovascular and metabolic disease risk profiles, enhanced bone health, and reduced symptoms of anxiety and depression.

Adults and Older Adults

Strong evidence demonstrates that, compared to less active persons, more active men and women have lower rates of all-cause mortality, coronary heart disease, high blood pressure, stroke, type 2 diabetes, metabolic syndrome, colon cancer, breast cancer, and depression. Strong evidence also supports the conclusion that, compared to less active people, physically active adults and older adults exhibit a higher level of cardiorespiratory and muscular fitness, have a healthier body mass and composition, and a biomarker profile that is more favorable for preventing cardiovascular disease and type 2 diabetes and for enhancing bone health. Modest evidence indicates that physically active adults and older adults have better quality sleep and health-related quality of life.

Older Adults

In addition to those benefits listed above, strong evidence indicates that being physically active is associated with higher levels of functional health, a lower risk of falling, and better cognitive function.

Women During Pregnancy and the Postpartum Period

Strong evidence indicates that moderate-intensity physical activity during pregnancy by generally healthy women increases cardiorespiratory and metabolic fitness without increasing the risk of low birth weight, preterm delivery, or early pregnancy loss. Moderate-intensity physical activity during the postpartum period does not appear to adversely affect milk volume or composition or infant growth. Physical activity alone does not produce weight loss in postpartum women except when combined with dietary changes.

Persons With Disabilities

For many physical and cognitive disabilities, scientific evidence for various health and fitness outcomes is still limited due to the lack of research. Moderate to strong evidence indicates that increases in aerobic exercise improve cardiorespiratory fitness in individuals with lower limb loss, multiple sclerosis, stroke, spinal cord injury, and mental illness. Limited data show similar results for people with cerebral palsy, muscular dystrophy, and Alzheimer's disease. Moderate to strong evidence also exists for improvements in walking speed and walking distance in patients with stroke, multiple sclerosis, and intellectual disabilities. Moderately strong evidence indicates that resistance exercise training improves muscular strength in persons with such conditions as stroke, multiple sclerosis, cerebral palsy, spinal cord injury, and intellectual disability. Although evidence of benefit is suggestive for such outcomes as flexibility, atherogenic lipids, bone mineral density, and quality of life, the data are still very limited.

Racial and Ethnic Diversity

Only a limited number of prospective observational or experimental studies investigating the relation between physical activity and health outcomes have had adequate samples of non-Hispanic white men or women and one or more other race/ethnicities to allow a direct comparison of benefits. However, in the few studies where direct comparisons have been made, no meaningful difference appears to exist, and studies conducted in other countries with race-ethnic populations other than non-Hispanic white report similar results. Thus, based on the currently available scientific evidence, the dose of physical activity that provides various favorable health and fitness outcomes appears to be similar for adults of various races and ethnicities.

Persons Who Are Overweight or Obese

Strong evidence shows that physically active adults who are overweight or obese experience a variety of health benefits that are generally similar to those observed in people of optimal body weight (body mass index [BMI] = 18.5-24.9). These benefits include lower rates of all-cause mortality, coronary heart disease, hypertension, stroke, type 2 diabetes, colon cancer, and breast cancer. Some of these benefits appear to be independent of a loss in body weight, while in some cases weight loss in conjunction with an increase in physical activity results in even greater benefits. Because of the health benefits of physical activity that are independent of body weight classification, adults of all sizes and shapes gain health and fitness benefits by being habitually physically active.

Patterns of Physical Activity Associated With Better Health and Fitness

PAGAC members recognized that, when considering the intensity of an activity, it is most appropriate scientifically to express the intensity relative to a person's capacity (relative intensity). However, the PAGAC also recognized that communicating to the public the process of determining relative intensity is difficult and that intensity expressed in absolute terms is a reasonable alternative. Table D.1 and Figure D.1 located in *Part D: Background* provide information on the relation between absolute and relative intensity. Also, the committee concluded that, when classifying activities by intensity using metabolic equivalents (METs), the appropriate classification of moderate-intensity activity is 3.0 to 5.9 rather than 3.0 to 6.0 METs and vigorous intensity is 6.0 or greater METs (Table D.2).

Based on the existing science, it is not possible to be highly precise in selecting a single expression of activity amount that provides improved health because of the diversity in the types of physical activity reported and the conditions under which they are performed, the different questionnaires used to assess these activities, and the various units of measurement used to express the characteristics of the activity. Also, the baseline activity and fitness levels of the population and the targeted health outcomes influence the effective dose. The committee constructed a table to assist in translating the different units of measurements for

the amount of activity performed for a range of activity intensities performed for 150 and 300 minutes per week (2.5 and 5 hours per week) (Table D.3).

Children and Youth

Few studies have provided data on the dose response for various health and fitness outcomes in children and youth. However, substantial data indicate that important health and fitness benefits can be expected to accrue to most children and youth who participate daily in 60 or more minutes of moderate to vigorous physical activity. Certain specific types of physical activity should be included in an overall physical activity pattern in order for children and youth to gain comprehensive health benefits. These include regular participation in each of the following types of physical activity on 3 or more days per week: resistance exercise to enhance muscular strength in the large muscle groups of the trunk and limbs, vigorous aerobic exercise to improve cardiorespiratory fitness and cardiovascular and metabolic disease risk factors, and weight-loading activities to promote bone health. Experiences consistent with these goals involve participation in physical activities that are developmentally appropriate, that minimize the potential risks of overtraining and injuries, and that provide children and youth with opportunities for enjoyable participation in a wide range of specific forms of physical activity.

Adults and Older Adults

Data from a large number of studies evaluating a wide variety of benefits in diverse populations generally support 30 to 60 minutes per day of moderate to vigorous intensity physical activity on 5 or more days of the week. For a number of benefits, such as lower risk for all-cause mortality, coronary heart disease, stroke, hypertension, and type 2 diabetes in adults and older adults, lower risk is consistently observed at 2.5 hours per week (equivalent to 30 minutes per day, 5 days per week) of moderate to vigorous intensity activity. The amount of moderate to vigorous intensity activity most consistently associated with significantly lower rates of colon and breast cancer and the prevention of unhealthy weight gain or significant weight loss by physical activity alone is in the range of 3 to 5 hours per week.

It is possible to combine aerobic activities of different types and intensities into a single measure of amount of activity. For many studies, the amount of moderate and vigorous intensity activity associated with significantly lower rates of disease or improvements in biomarkers and fitness is in the range of 500 to 1,000 MET-minutes per week. An adult can achieve a target of 500 MET-minutes per week by walking at about 3.0 miles per hour for approximately 150 minutes per week (7.5 miles), walking faster at 4.0 miles per hour for 100 minutes (6.6 miles), or jogging or running at 6 miles per hour for about 50 minutes per week (5.0 miles). To achieve 1,000 MET-minutes per week, these amounts of activity would need to be doubled. For an explanation of the use of METs and MET-minutes for calculating the amount of activity see *Part D: Background*, especially Table D.2 and its associated text.

Resistance or muscle-strengthening exercises are important for maintaining muscle and bone health, and these exercises enhance functional status and contribute to a reduction of falls in older adults. Most of the evidence supports a resistance activity program with the following characteristics: progressive muscle strengthening exercises that target all major muscle groups performed on 2 or more days per week. To enhance muscle strength, 8 to 12 repetitions of each exercise should be performed to volitional fatigue. One set is effective; however, limited evidence suggests that 2 or 3 sets may be more effective.

Older Adults

If a person has a low exercise capacity (physical fitness), the intensity and amount of activity needed to achieve many health-related and fitness benefits are less than for someone who has a higher level of activity and fitness. Because the exercise capacity of adults tends to decrease as they age, older adults generally have lower exercise capacities than younger persons. Thus, they need a physical activity plan that is of lower absolute intensity and amount (but similar in relative intensity and amount) than is appropriate for more fit people, especially when they have been sedentary and are starting an activity program.

Older Adults at Risk of Falls

For older adults at risk of falling, strong evidence exists that regular physical activity is safe and reduces falls by about 30%. Most evidence supports a program of exercise with the following characteristics: 3 times per week of balance training and moderate-intensity muscle-strengthening activities for 30 minutes per session, with additional encouragement to participate in moderate-intensity walking activities 2 or more times per week for 30 minutes per session. Some evidence, albeit less consistent, suggests that tai chi exercises also reduce falls. There is no evidence that planned physical activity reduces falls in adults and older adults who are not at risk of falls.

Persons With Disabilities

For a majority of the studies reviewed involving persons with disabilities, the exercise regimen followed was that currently recommended for the general public — aerobic exercise of 30 to 60 minutes, 3 to 5 days per week at moderate intensity, and resistance training with 1 or 2 sets of 8 to 12 repetitions using appropriate muscle groups 2 to 3 times per week. Although other activity regimens might be effective, they have not been adequately evaluated.

Persons Achieving Weight Stability

The optimal amount of physical activity needed for weight maintenance (defined as less than 3% change in body weight) over the long-term is unclear. However, the evidence is clear that physical activity provides benefit for weight stability. A great deal of inter-individual variability exists with physical activity and weight stability, and many persons may need more than 150 minutes of moderate-intensity activity per week to maintain their weight at a

stable level. Data from recent well-designed randomized controlled trials lasting up to 12 months indicate that aerobic physical activity performed to achieve 13 to 26 MET-hours per week is associated with approximately a 1% to 3% weight loss (i.e., an amount generally considered to represent weight stability). Thirteen MET-hours per week is approximately equivalent to walking at 4 miles per hour for 150 minutes per week or jogging at 6 miles per hour for 75 minutes per week.

Persons Achieving Weight Loss

A wide range of studies provides evidence of a dose-response relation between physical activity and weight loss. Clear, consistent data show that a large volume of physical activity is needed for weight loss in the absence of concurrent dietary changes. The physical activity equivalent of 26 kilocalories per kilogram of body weight (1,560 MET-minutes) or more per week is needed for weight loss of 5% or greater. Smaller amounts of weight loss are seen with smaller amounts of physical activity. This relatively high volume of physical activity is equivalent to walking about 45 minutes per day at 4 miles per hour or about 70 minutes per day at 3 miles per hour, or jogging 22 minutes per day at 6 miles per hour.

The role of energy intake (diet) must be considered in any discussion of weight control. When calorie intake is carefully controlled at a baseline level, the magnitude of any weight loss is what would be expected given the energy expenditure of the person's physical activity. However, in situations in which people's dietary intake is not controlled, the amount of weight loss due to the increase in physical activity is not commensurate to what would be expected. Therefore, for most people to achieve substantial weight loss (i.e., more than 5% decrease in body weight), a dietary intervention also is needed. The dietary intervention could include either maintenance of baseline caloric intake, or a reduction in caloric intake to accompany the physical activity intervention. The magnitude of change in weight due to physical activity is additive to that associated with caloric restriction.

Persons Achieving Weight Maintenance After Weight Loss

The scientific evidence for the effectiveness of physical activity alone in preventing weight regain following significant weight loss is limited. Available data indicate that to prevent substantial weight regain over 6 months or longer, many adults need to exercise in the range of 60 minutes of walking or 30 minutes of jogging daily (approximately 4.4 kilocalories per kilogram per day of activity energy expenditure). The literature generally supports the concept that "more is better" for long-term weight maintenance following weight loss. Further, the evidence indicates that individuals who are successful at long-term weight maintenance appear to limit caloric intake in addition to maintaining physical activity.

Special Considerations Related to the Pattern of Physical Activity and Health

The following section presents additional findings from the Committee's review of the literature. These findings represent important considerations for developing comprehensive physical activity guidelines for Americans.

Some Physical Activity Is Better Than None

The least active people in the population generally have the highest risk of a variety of negative health outcomes. Although the minimum amount of physical activity needed to decrease this risk is not clear, increasing evidence suggests that participating in no more than 1 hour per week of moderate-intensity physical activity is associated with lower risk of all-cause mortality and the incidence of coronary heart disease. At this lower amount and intensity of activity, the benefits usually are less than that observed with greater amounts of activity, and studies are much less consistent about the nature and magnitude of these benefits. Nevertheless, the dose-response curves for the major health benefits clearly indicate an inverse relation between the dose of activity and rate of disease. Although the minimum amount of activity needed to produce a benefit cannot be stated with certainty, nothing would suggest a threshold below which there are no benefits.

Additional Health Benefits With More Physical Activity

Reasonably strong evidence demonstrates that participating in moderate to vigorous physical activity for more than 150 minutes per week is associated with greater health benefits for a variety of health outcomes, including chronic disease prevention, improvement of various disease biomarkers, and the maintenance of a healthy weight. However, in a number of studies where such a dose response is observed in preventing chronic disease or reducing all-cause mortality, the relation appears to be curvilinear. This means that the absolute increase in benefits becomes less and less for any given increase in the amount of physical activity.

Additional Benefits With Vigorous Physical Activity

Strong evidence indicates that an increase in intensity is associated with greater improvements for some health outcomes compared to those observed with moderate-intensity activity. This is especially true for outcomes related to fitness. However, it should be noted that an increase in intensity was often associated with an increase in volume of activity for many observational and experimental studies, and it is difficult to separate the benefits of each.

Frequency of Physical Activity

Very limited published research has systematically evaluated health or fitness benefits in response to different frequencies of activity sessions per week when the amount of activity

is held reasonably constant. Although the data are limited, the results suggest that for health and fitness benefits, the frequency of activity is much less important than the amount or intensity. Many experimental studies since 1995 have demonstrated beneficial effects of 120 to 150 minutes per week of moderate- or vigorous-intensity activity, usually performed during 3 to 5 sessions per week, so we know that this frequency of activity is effective. Only limited data are available comparing the benefits from just 1 or 2 sessions per week with multiple sessions spread throughout the week with activity amount and intensity held constant.

Accumulation of Physical Activity

The concept of accumulation refers to performing multiple short bouts of physical activity throughout the day. Some scientific evidence of moderate strength suggests that accumulating 30 or more minutes of moderate- to vigorous-intensity aerobic activity throughout the day in bouts of 10 minutes or longer produces improvements in cardiorespiratory fitness. Limited data indicate that accumulated short bouts of 8 to 10 minutes improve selected biomarkers for cardiovascular disease in a manner generally similar to that observed when activity of a similar amount and intensity is performed in a single bout of 30 or more minutes. Data on the effects of accumulating activity involving multiple short bouts for the prevention of major clinical outcomes, such as all-cause mortality, cardiovascular disease, diabetes, and selected cancers, are very limited due to the type of data collected from the questionnaires in most prospective observational studies. In these studies, people are generally asked about the total amount of physical activity performed, and it has not been possible to precisely differentiate between activities conducted in a single, long bout versus those conducted in multiple, short bouts over the day.

Health Benefits of Brisk Walking

Strong evidence shows that a regimen of brisk walking provides a number of health and fitness benefits for adults and older adults, including lower risk of all-cause mortality, cardiovascular disease, and type 2 diabetes. Some evidence is available indicating that walking at faster pace is associated with greater health benefits than walking at a slower pace. Strong evidence also shows that frequent bouts of walking increase cardiorespiratory and metabolic fitness, especially in people who have been performing little activity on a regular basis. Limited to moderate evidence suggests that walking helps to maintain bone density and reduce fractures over time, especially in women, and helps to maintain joint health and functional ability in adults and older adults.

Safety and Adverse Events

Activity-related adverse events such as musculoskeletal injuries are common but are usually mild, especially for moderate intensity activities such as walking. Overall, the health benefits of regular physical activity outweigh the risks. Much of the research that has addressed adverse events during physical activity has evaluated the risk of musculoskeletal

injuries or sudden cardiac death during vigorous physical activity (e.g., jogging, running, competitive sports, military training). Few well-conducted studies are available evaluating risk during moderate-intensity activity intended primarily to improve health. Injury rates are higher for collision and contact sports than for activities with fewer and less forceful contact with other people or objects. Walking for exercise, gardening or yard work, dancing, swimming, and golf are activities with the lowest injury rates. Injuries are more likely to happen when people are more physically active than usual, and the risk is related to the size of the increase. A series of small increments in physical activity, each followed by a period of adaptation, is associated with lower rates of musculoskeletal injuries than is an abrupt increase to the same final level. For sudden cardiac adverse events, intensity appears to be more important than frequency or duration. The protective value of a medical consultation for persons with or without chronic diseases who are interested in increasing their physical activity level is not established.

Research Recommendations

Individual chapters in *Part G: The Science Base* provide a list of recommendations regarding issues that should receive priorities for future research. The PAGAC felt that it would be valuable to collate the major research recommendations into one section, *Part H: Research Recommendations*, and to include some overarching recommendations that pertain to more than one health outcome. For example, it became apparent during the PAGAC's review that various populations are underrepresented in studies on physical activity and health. These populations represent a substantial portion of the population at risk because of their high prevalence of sedentary behavior. They include persons of low socioeconomic status, racial-ethnic minorities, persons with disabilities, and women during pregnancy and the postpartum period. Also, inadequate data are available to answer a number of questions about dose response for a variety of health outcomes, such as the effects of activity intensity, bout duration, or frequency when total amount or volume of activity is held constant. More data are needed to better define both the low and high ends of the dose-response relation for various health outcomes. Additional research on the basic biological mechanisms modified by changes in physical activity will help establish causality for specific clinical outcomes. National surveillance systems also are needed to track trends in total daily activity energy expenditure in various populations throughout the lifespan.