

## ***Physical Activity Guidelines Advisory Committee Meeting 5***

***Sponsored by the U.S. Department of Health and Human Services (HHS)***

October 17-20, 2017

### ***Meeting Attendees***

**Physical Activity Guidelines Advisory Committee:** Abby King, PhD (Co-Chair); Kenneth Powell, MD, MPH, (Co-Chair); David Buchner, MD, MPH; Wayne Campbell, PhD; Loretta DiPietro, PhD, MPH; Kirk Erickson, PhD; Charles Hillman, PhD; John Jakicic, PhD; Kathleen Janz, EdD; Peter Katzmarzyk, PhD; William Kraus, MD; Richard Macko, MD; David Marquez, PhD; Anne McTiernan, MD, PhD (in attendance October 17-18); Russell Pate, PhD; Linda Pescatello, PhD; and Melicia Whitt-Glover, PhD

**Co-Executive Secretaries:** Richard Olson, MD, MPH; Katrina Piercy, PhD, RD, ACSM-CEP; Janet Fulton, PhD; Deb Galuska, PhD; Rachel Ballard, MD, MPH; Richard Troiano, PhD

**Federal Staff:** Alison Vaux-Bjerke, MPH; Stephanie George, PhD, MPH, MA; Eric Hyde, MPH; Kyle Sprow, MPH, CSCS

### ***Meeting 5 Summary***

#### ***Day 1 Summary***

***Tuesday, October 17, 2017***

1:00 PM

#### ***Call to Order, Roll Call, and Opening Remarks***

**Dr. Olson, Designated Federal Officer, Office of Disease Prevention and Health Promotion (ODPHP), U.S. Department of Health and Human Services (HHS)** welcomed the public as he called to order the fifth meeting of the 2018 Physical Activity Guidelines Advisory Committee (Committee). He thanked everyone on the Committee for their hard work and asked for a continued push through the end of the process. He noted that the meeting resources, archived videocasts, and public comment database are located at [www.health.gov/paguidelines](http://www.health.gov/paguidelines). He then differentiated between the scientific report – the scientific literature review from the Committee – and the Guidelines – the policy written by the federal government. Dr. Olson reviewed the schedule for the meeting, noting that this is the last public meeting. He emphasized that all evidence grades and conclusion statements need to be finalized and presented before the meeting is adjourned on Friday afternoon.

#### ***Welcome and Introduction of Subcommittee Presentations***

**Dr. Powell, Co-Chair of the Committee** began by reviewing the previous four Committee meetings. Dr. Powell discussed the Meeting 5 goals, underscoring the need to finalize all grades and conclusion statements as well as research needs. He noted that the Sedentary Behavior Subcommittee, Fitness Work Group, and Young Adult Transition Work Group would not be presenting, as all three groups presented their respective material during Meeting 4. Dr. Powell reviewed the evidence grading rubric, noting what qualifies as strong, moderate, limited, or grade not assignable. He outlined the order of presentations and then listed several key topics that the Committee will need to come to a consensus on, including: recommendations for adults, youth, older adults, special populations, sedentary behavior, resistance training, safety, and assembling the evidence. He reminded the Committee that the next and final steps will be to submit the 2018 Physical Activity Guidelines Advisory Committee Scientific Report to the Secretary of Health and Human Services in early 2018.

## ***Subcommittee Presentations***

The subcommittee chairs presented progress updates of their subcommittee's work since the previous public meeting in July, including draft conclusions and evidence grades for the questions in their systematic literature reviews. Following each presentation, the Committee members asked questions and discussed the work of each subcommittee.

**SC 4 Cardiometabolic Health and Weight Management.** Dr. Jakicic opened the Cardiometabolic Health and Weight Management Subcommittee's presentation. He noted that the first question and subquestions were presented during Meeting 4. Dr. Jakicic introduced Dr. Pescatello to present the findings for the overall grade for Question 2 (subquestions a, b, and c were addressed during the July meeting).

- In people with normal blood pressure or prehypertension, what is the relationship between physical activity and blood pressure?

Dr. Pescatello outlined the literature review process, which identified 8 meta-analyses that examined the blood pressure response to physical activity among sedentary adults with either prehypertension or normal blood pressure.

The Cardiometabolic Health and Weight Management Subcommittee presented the following draft conclusion on the relationship between physical activity and blood pressure:

- Strong evidence demonstrates that physical activity reduces blood pressure among adults with prehypertension and normal blood pressure. **PAGAC Grade: Strong**

**SC 4 Question 2 Discussion.** Dr. Marquez asked if leisure-time physical activity was synonymous with recreational physical activity. Dr. Pescatello responded that they are the same. Dr. Kraus was interested in effect modification by race or gender, but this wasn't identified in the evidence presented. Dr. Pescatello noted that in Meeting 4 the subcommittee found insufficient evidence for conclusions on race or gender. Dr. DiPietro asked if 2-5 mmHg change in blood pressure was clinically significant. Dr. Pescatello argued that it is significant at a population level and potentially at the individual level, as that amount of change can be the difference between someone having prehypertension and normal blood pressure. Dr. Campbell asked about how blood pressure was taken, and whether 24-hour blood pressure readings or fasting morning blood pressures were measured? Dr. Pescatello pointed out that these were exercise interventions, so blood pressure was measured before and after the program. She further noted that the literature is very limited regarding ambulatory blood pressure monitoring and hypertension. Dr. Campbell responded by asking if ambulatory blood pressure monitoring considerations have any impact on the breadth of the "Strong" grade. Dr. Pescatello concluded that ambulatory blood pressure monitoring doesn't have a large public health impact and the evidence still supports a "Strong" grade. Dr. Macko inquired about the volume of physical activity needed to provide the dose-response reduction in risk. Dr. Pescatello cited a meta-analysis that concluded for every 10 MET-hour weekly increase in physical activity, the risk of incident hypertension was reduced by ~12%, which she indicated was a very strong dose-response.

**SC 4 Question 3:** Dr. Powell presented the Cardiometabolic Health and Weight Management Subcommittee's third systematic literature review search of systematic reviews and meta-analyses. The search addressed the following question:

- In adults without diabetes, what is the relationship between physical activity and the incidence of type 2 diabetes?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?

- Does the relationship vary based on: frequency, duration, intensity, type (mode), and how physical activity is measured?

The subcommittee ended up with 12 high-quality reviews: 7 meta-analyses, 4 systematic reviews, and 1 pooled analysis. Dr. Powell noted that all 12 reviews reported an inverse relationship between the volume of physical activity and risk of incident type 2 diabetes. He also showed a dose-response curve that was developed from 5 meta-analyses, which shows a clear inverse relationship between MET-hours/week and relative risk of incident type 2 diabetes.

The Cardiometabolic Health and Weight Management Subcommittee assigned the following draft evidence grades for question 3:

- Strong evidence demonstrates an inverse relationship between volume of moderate to vigorous physical activity and incidence of type 2 diabetes. **PAGAC Grade: Strong**
  - Strong evidence demonstrates the existence of an inverse, curvilinear *dose-response* relationship between volume of physical activity and incidence of type 2 diabetes, with a decreasing slope at higher levels of physical activity. **PAGAC Grade: Strong**
  - Moderate evidence indicates that the inverse relationship between volume of physical activity and risk of type 2 diabetes does not vary by weight status. **PAGAC Grade: Moderate**
  - Limited evidence suggests that the relationship between higher volume of physical activity and lower incidence of type 2 diabetes is not influenced by age, sex, or race/ethnicity. **PAGAC Grade: Limited**
  - Insufficient evidence is available to determine if the relationship between physical activity and the incidence of type 2 diabetes varies by socioeconomic status. **PAGAC Grade: Grade not assignable**
  - Insufficient evidence exists to determine whether the relationship between physical activity and the incidence of type 2 diabetes varies by the frequency, intensity, duration, or type of physical activity, or how physical activity is measured. **PAGAC Grade: Grade not assignable**

**SC 4 Question 3 Discussion:** Dr. Kraus asked if the 5 meta-analyses, in which the dose-response curves presented by the subcommittee were derived, had overlapping original articles. While Dr. Powell was uncertain, he noted there must be differences between the meta-analyses or else the dose-response lines would be much more similar. Dr. Kraus pointed out that the asymptote of the effects of physical activity on diabetes is about a 30% reduction, and Dr. Powell agreed. Dr. Campbell inquired on the type of exercise in the meta-analyses; was it aerobic? Dr. Powell responded that most physical activity measures in the literature were leisure-time moderate-to-vigorous intensity physical activity (MVPA). However, he explained the helpfulness in knowing how variations in physical activity type may contribute to decreased incidence of diabetes. Dr. Campbell then asked about the strength of the evidence regarding the effect of weight status on type 2 diabetes (moderate evidence of no effect). Dr. Powell responded that while weight status goes hand in hand with type 2 diabetes incidence, the impact of physical activity on type 2 diabetes does not differ by weight status: the decline is the same. Dr. King asked about how dietary factors were accounted for in the conclusions. Dr. Powell answered that the subcommittee did their best to select studies that had only physical activity interventions/exposures. Dr. Pescatello noted that the subcommittee excluded studies comprised of both physical activity and dietary interventions. Dr. Jakicic asked Dr. King if her comments were about diet and energy intake or macronutrient composition of the diet. Dr. King said both, and Dr. Jakicic agreed, noting the same concerns may apply to blood pressure. Dr. Powell emphasized how the Committee's purpose was to focus on physical activity, not to look at the impact of other factors. Dr. McTiernan inquired about the inclusion of a research recommendation addressing dietary impact on type 2 diabetes. Dr. Powell responded by saying that the research recommendations should be focused on physical activity. He argued that since the subcommittee did not search for diet in the literature, it would be inappropriate to include it as a research recommendation. Dr. Pescatello emphasized the need to clearly illustrate that the report does not include interventions with diet. Dr. Jakicic recommended approaching diet and other crucial factors outside the scope of the PAGAC report in the

beginning, stating that these are not the focus of this document but important covariates. Dr. King also noted that diet and physical activity interventions will be discussed in the promotion subcommittee presentation.

**SC 3 Cancer-Primary Prevention.** During the previous meetings, the Cancer-Primary Prevention Subcommittee presented the analytical framework and systematic literature search conducted to investigate the relationship between physical activity and cancer incidence. Moreover, the subcommittee had previously presented findings on the association between physical activity and cancer incidence for 14 of 16 cancer types. In addition to presenting the findings on the remaining two cancer types, Dr. McTiernan noted that some of their conclusions and evidence grades for previously presented cancers had changed (that information is presented in the table below.)

**SC 3 Question 1:** Dr. McTiernan presented the following:

- What is the relationship between physical activity and specific cancer incidence?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Does the relationship vary by specific cancer subtypes?
  - Is the relationship present in persons at high risk, such as those with familial predisposition to cancer?

The Cancer-Primary Prevention Subcommittee presented the following draft conclusions for specific cancer incidence:

Rectal Cancer (constitutes ~10% of all colorectal cancers)

- Overall relationship: limited evidence suggests that physical activity level does not affect the risk of developing rectal cancer. **PAGAC Grade: Limited**
  - Dose-response: insufficient evidence. **PAGAC Grade: Grade not assignable**
  - No evidence is available on the association between physical activity and risk of rectal cancer by sex, age, race/ethnicity, weight status, high-risk individuals, or cancer subtype. **PAGAC Grade: Grade not assignable**

Renal Cancer (obesity related cancer)

- Overall relationship: strong evidence demonstrates a reduction in risk of developing renal cancer with higher levels of physical activity. **PAGAC Grade: Strong**
  - Dose-response: limited evidence suggests a dose-response relationship exists. **PAGAC Grade: Limited**
  - Sex: limited evidence suggests the effect does not vary by sex. **PAGAC Grade: Limited**
  - No evidence is available on the association between physical activity and risk of renal cancer by age or race/ethnicity. **PAGAC Grade: Grade not assignable**
  - Weight status: decrease risk for people of all BMI categories. **PAGAC Grade: Limited**
  - No evidence is available on the association between physical activity and risk of renal cancer by high-risk persons or cancer subtype. **PAGAC Grade: Grade not assignable**

Breast Cancer (subquestions were not previously presented)

- Overall relationship: strong evidence demonstrates a reduction in risk of developing breast cancer with higher levels of physical activity. **PAGAC Grade: Strong**
  - Dose-response: strong evidence demonstrates a dose-response relationship exists. **PAGAC Grade: Strong**
  - Insufficient evidence is available on the association between physical activity and risk of breast cancer by age. **PAGAC Grade: Grade not assignable**

- Limited evidence suggests the association between physical activity and risk of breast cancer does not vary by race or ethnicity. **PAGAC Grade: Limited**
- Weight status: moderate evidence indicates a decrease risk for people of all BMI categories. **PAGAC Grade: Moderate**
- High-risk persons: Limited evidence suggests a greater risk reduction among those with a family history of breast cancer. **PAGAC Grade: Limited**
- High-risk persons: Limited evidence suggests a lower effect of physical activity in hormone replacement therapy users. **PAGAC Grade: Limited**
- Cancer subtype: Limited evidence suggests a difference in risk reduction by cancer subtype. **PAGAC Grade: Limited**

Colon Cancer (subquestions were not previously presented)

- Overall relationship: strong evidence demonstrates a reduction in risk of developing colon cancer with higher levels of physical activity. **PAGAC Grade: Strong**
  - Dose-response: strong evidence demonstrates a dose-response relationship exists. **PAGAC Grade: Strong**
  - No evidence is available on the association between physical activity and risk of colon cancer by age, race/ethnicity, or high-risk persons. **PAGAC Grade: Grade not assignable**
  - Sex: Strong evidence demonstrates a reduction in risk of developing colon cancer for both men and women. **PAGAC Grade: Strong**
  - Weight Status: moderate evidence indicates a decrease risk for people of all BMI categories. **PAGAC Grade: Moderate**
  - Cancer subtype: the association between physical activity and colon cancer risk was shown regardless of cancer subtype (defined as where the cancer originated in the colon). **PAGAC Grade: Strong**

Dr. McTiernan noted that there was insufficient evidence across all cancer sites that the effect of physical activity is modified by socioeconomic status **PAGAC Grade: Grade not assignable**

The table below reflects the change of grades for cancers addressed in previous meetings.

**Table 1. Cancer Subcommittee Updated Evidence Grades**

Cancer	PA Parameter	Old Grade	New Grade
Blood & Lymphatics	Sex	Limited	Not assignable
	Cancer subtype	Limited	Not assignable
Brain	Overall	Limited	Not assignable
	Cancer subtype	Not assignable	Limited
Esophagus Squamous	No dose-response effect	Not assignable	Limited
Esophagus Adenocarcinoma	Dose-response present	Not assignable	Limited
Head & Neck*	No effect sex, age, weight, smoking status, cancer subtype	Mixed	Limited
Lung	Smokers	Limited	Moderate
Ovary	Dose-response absent	Not assignable	Limited
Pancreas	Dose-response present	Not assignable	Limited
	Sex	Limited	Not assignable

Prostate	No effect age, weight, smoking status, cancer subtype	Limited	Not assignable
Stomach	Sex	No grade	Not assignable
Thyroid	Overall	Moderate	Limited

\*Originally, the overall conclusion statement for head and neck cancers was stratified by the type and/or location of the cancer. However, given the methodology of the research, the subcommittee felt it was more appropriate to aggregate those findings for the overall conclusion statement. The risk reduction seen for specific head and neck cancers is reflected in the subquestion conclusion statement.

**SC 3 Question 1 Discussion:** Dr. King commented, that as a Committee, a series of overarching research recommendations should be discussed, and the lack of data on socioeconomic status as a potential effect modifier should be highlighted. Among those cancers in which physical activity was strongly associated with a risk reduction, Dr. Kraus inquired about the maximal protective effect of physical activity. While he and Dr. McTiernan agreed the number was hard to accurately assess, especially given the heterogeneity of certain variables across different cancers, they estimated the effect around 10-12%. Dr. Macko noted the disparities of cardiovascular disease and metabolic disorders among different ethnicities, with certain minorities having much higher incidence. He emphasized the need for screening among all populations as well as continued research into biomarkers and mechanisms from which cancer may manifest in these different subpopulations. Dr. Campbell inquired about the practicality, feasibility, and ethical considerations of the last research recommendation presented [conduct randomized controlled clinical trials (RCTs) to determine the effect on physical activity on cancer incidence]. Dr. McTiernan noted the challenges associated with RCTs, but referenced breast cancer prevention studies, which used shorter-term RCTs in individuals at high risk to better understand the effects of physical activity on cancer incidence. Moreover, she emphasized the need of such studies to compare multi-component interventions to interventions that focus solely on physical activity.

**Break**

**SC 5 Exposure.** Although the subcommittee had previously presented questions 1 and 2, Dr. Kraus noted semantic changes made to the conclusions statements. Moreover, the respective subquestions had not been explicitly discussed at prior meetings. The following questions were presented:

**SC 5 Question 1**

- What is the relationship between physical activity and all-cause mortality?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, or socioeconomic status?

The Exposure Subcommittee presented the following draft conclusions for question 1:

- Strong evidence demonstrates a significant relationship between greater amounts of physical activity and decreased incidence of all-cause mortality. **PAGAC Grade: Strong**
  - Strong evidence demonstrates a significant dose-response relationship between physical activity and all-cause mortality. **PAGAC Grade: Strong**
  - Strong evidence demonstrates that these relationships do not vary by age, gender, race, and BMI. **PAGAC Grade: Strong**
  - Insufficient evidence is available to determine whether these relationships vary by ethnicity and SES. **PAGAC Grade: Grade not assignable**

**SC 5 Question 2**

- What is the relationship between physical activity and cardiovascular disease (CVD) mortality?

- Is there a dose-response relationship? If yes, what is the shape of the relationship?
- Does the relationship vary by age, sex, race/ethnicity, or socioeconomic status (SES)?

The Exposure Subcommittee presented the following draft conclusions for question 2:

- Strong evidence demonstrates a significant relationship between greater amounts of physical activity and cardiovascular disease mortality. **PAGAC Grade: Strong**
  - Strong evidence demonstrates a significant dose-response relationship between physical activity and cardiovascular disease mortality. **PAGAC Grade: Strong**
  - Strong evidence demonstrates that these relationships do not vary by age, gender, race, and BMI. **PAGAC Grade: Strong**
  - Insufficient evidence is available to determine whether these relationships vary by ethnicity and SES. **PAGAC Grade: Grade not assignable**

### SC 5 Question 3

- What is the relationship between physical activity and cardiovascular disease incidence?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?

The Exposure Subcommittee presented the following draft conclusions for Question 3 (overall conclusion statement was presented at Meeting 4, but subquestions were not addressed):

- Strong evidence demonstrates a significant relationship between greater amounts of physical activity and decreased incidence of CVD, stroke, and heart failure (HF). **PAGAC Grade: Strong**
  - Strong evidence demonstrates a significant dose-response relationship between physical activity and CVD, HF and stroke. **PAGAC Grade: Strong**
  - Insufficient evidence is available to determine whether these relationships vary by age, gender, race, ethnicity, SES, BMI. **PAGAC Grade: Grade Not Assignable**

As Dr. Kraus wrapped up his presentation, he noted that there are some data that point to the existence of an obesity paradox in individuals with heart failure, but no one has investigated how BMI may modify the relationship between physical activity and heart failure.

**SC 5 Question 1, 2, and 3 Discussion.** Dr. Marquez inquired about the lack of data on SES as a variable. He and Dr. Kraus agreed that: 1) it may be reported, but not analyzed, 2) not reported at all, and/or 3) there is no variability in the sample. Dr. King cited the need for consistent language throughout the report and consensus was reached that physical activity measured through a device would be referred to as “device-based” and not “objective.” Dr. Powell inquired about the standard diagnostic criteria for heart failure. Dr. Kraus explained that most of the studies looked at *reduced ejection fraction heart failure* (with enrollment criteria of an ejection fraction below the a certain threshold) however, he acknowledged the blossoming of heart failure with *preserved ejection fraction* in which patients present with typical heart failure symptoms, but have an ejection fraction in the normal range. He noted the growing use of biomarkers to diagnosis heart failure, but these were not used in the analyzed studies. Dr. Macko emphasized the need to accurately assess a plethora of moderators, specifically blood pressure, on the incidence of heart failure. Dr. DiPietro inquired about the different dose-response curves for men and women regarding heart failure. Dr. Kraus did not believe that there was a biological difference, but that study selection may dictate why the curves are different (and with the wide error bars, the curves are likely more homogenous than they first appear). Dr. Pescatello and Dr. Kraus emphasized the need for common language when discussing the different types of heart disease, both in the report and in the larger body of scientific literature. Agreement was reached that coronary artery disease, stroke, and heart failure comprises cardiovascular disease. Dr. Pate asked about the greater risk reduction with higher levels of physical activity for cardiovascular disease mortality compared to cardiovascular disease incidence. Dr. Kraus responded that approximately half of cardiovascular disease presents as sudden death, and the majority of

those individuals are not resuscitated. Dr. Pescatello noted the difference in evidence grades for race and ethnicity for questions 1 and 2. Dr. Kraus acknowledged that the data was robust enough to tease apart those variables. Dr. Erickson inquired about data on the age in which participants became physically active, and how that affects the relationship with cardiovascular disease incidence. Dr. Kraus was unaware of any data that would be able to address that relationship. Dr. Campbell inquired about whether detraining was assessed in these studies, to which Dr. Kraus acknowledged it was not.

**SC 5 Exposure Question 4.** Prior to presenting the findings for question four, Dr. Janz addressed the analytical framework and literature review used by the subcommittee. She noted the absence of high-quality reviews that systematically addressed the relationship between steps and health outcomes. Therefore, a *de novo* literature search identified nine original research articles from which the conclusions and evidence grades were drawn. Dr. Janz presented the following:

- What is the relationship between step count per day and (1) mortality (i.e., all-cause or cause-specific) and (2) disease incidence (e.g., coronary heart disease, type 2 diabetes)?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?

The Exposure Subcommittee presented the following draft conclusions for question 4:

- (1) Insufficient evidence is available to determine the relationship between step counts per day and mortality (i.e., all-cause and CVD). No studies were identified that addressed this relationship. **PAGAC Grade: Grade Not Assignable**
- (2) Moderate evidence indicates that step count per day is associated with incidence of cardiovascular disease and risk of type 2 diabetes. **PAGAC Grade: Moderate**
  - Moderate evidence indicates that there is a dose-response relationship between the measure of steps per day and cardiovascular disease events and diabetes risk. **PAGAC Grade: Moderate**
  - Insufficient evidence is available to determine whether the relationship between the measure of steps per day and cardiovascular disease events and diabetes risk is influenced by age, sex, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Grade Not Assignable**

**SC 5 Question 4 Discussion.** Citing the lack of information from which the subcommittee had to draw conclusions, Dr. Katzmarzyk inquired about the “moderate” grade assigned for the relationship between steps per day and incidence of cardiovascular disease and diabetes. Dr. King agreed, and after much debate regarding the size and strength of the literature, the subcommittee agreed to reevaluate the evidence and if needed, re-present the conclusion(s) and evidence grade(s) on Friday.

Dr. Pate noted the importance and relevance of using steps counts as a measure of physical activity. He inquired about the existing literature supporting the association between daily step count and other measures of physical activity exposures. Dr. Janz was unfamiliar with such literature, and noted the subcommittee did not directly address this question. Following up with Dr. Pate’s inquiry, Dr. King asked about the NAVIGATOR Study and the use of other physical activity measures (outside of step count). Dr. Kraus mentioned the use of a very imprecise recall survey, but that data had been omitted from the analysis. He also emphasized the need for accelerometry data to measure intensity and walking cadence, which Dr. Hillman had inquired about. Dr. Buchner and Dr. Pate also emphasized the need for accelerometry research to better understand steps counts as a measure of total physical activity. Dr. Buchner also encouraged an additional research recommendation to address step counts in older populations. Similarly, Dr. Macko strongly encouraged a qualifying statement for step counts in special populations, and a research recommendation to expand the use of wearable technology that measure different physiological responses. Dr. Kraus suggested a research recommendation to encourage/mandate that all clinical trials provide pedometers to their enrollees (like the NAVIGATOR Study). Dr. DiPietro agreed, and encouraged the use of accelerometers because of their ability to measure sedentary behavior. Dr. Pate reemphasized the

important distinction between the association of walking as a specific behavior and its association with a constellation of health outcomes compared with walking as a valid indicator of overall physical activity. Dr. Marquez agreed, and also emphasized the popularity of steps in the general population. Lastly, Dr. Buchner emphasized the importance of accurately defining baseline activity, and how it could be important to contribute to a recommendation. Moreover, he highlighted the need to measure gait speed and its correlation to steps.

**SC 5 Exposure Question 5.** Dr. Jakicic presented the analytical framework and systematic review addressing the relationship between bout duration and a variety of health outcomes. Like the previous question, the subcommittee found no high-quality reviews that directly addressed the research question. Therefore, a *de novo* literature search identified 25 papers from which the conclusions and evidence grades were drawn. Dr. Jakicic presented the following:

- What is the relationship between bout duration of aerobic physical activity and health outcomes?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?

The Exposure Subcommittee presented the following draft conclusions for question 5:

- Strong evidence demonstrates that the accumulation of physical activity in bouts with a duration of at least 10 minutes is associated with cardiometabolic health benefits. **PAGAC Grade: Strong**
  - Insufficient evidence is available to determine whether the relationship varies by age, gender, race, ethnicity, SES, BMI. **PAGAC Grade: Grade Not Assignable**
- Moderate evidence indicates that the accumulation of physical activity in bouts with a duration of less than 10 minutes is associated with cardiometabolic health benefits. **PAGAC Grade: Moderate**
  - Insufficient evidence is available to determine whether the relationship varies by age, gender, race, ethnicity, SES, BMI. **PAGAC Grade: Grade Not Assignable**

**SC 5 Question 5 Discussion.** Dr. Katzmarzyk inquired about the term “aerobic,” and if it constituted MVPA. Dr. Jakicic responded that most of the research defined aerobic as MVPA, and very few studies looked at light intensity. Both Dr. Katzmarzyk and Dr. Jakicic agreed that very little, if any, literature was available on bouts of light activity. Dr. Marquez inquired about overlapping literature between bout duration (Question 5) and high-intensity interval training (HITT; Question 6). Dr. Jakicic and Dr. Campbell did not believe any of the articles overlapped. Dr. Marquez commented on the lack of effect modifiers, and the need for rationale to convince researchers to address these gaps. Dr. Pescatello referenced that the Cardiometabolic Health and Weight Management Subcommittee concluded insufficient evidence for frequency, intensity, type, and duration of physical activity and the relationship with blood pressure. She expressed concern and suggested that these findings conflict with the conclusions put forth by the Exposure Subcommittee for Question 5. Dr. Jakicic noted that the evidence was quite different for the two questions. Dr. Pate suggested a more explicit research recommendation for the (continued) use of accelerometers in large prospective studies to better understand and assess bout duration. Dr. King noted the large amount of cross-sectional data, and thus questioned the “moderate” grade. Dr. Kraus and Dr. Jakicic emphasized the conclusion and evidence merely suggest that bouts of any duration are associated with health benefits. Moreover, they both emphasized how the conclusion statement does not suggest that equal health benefits occur at the different bout lengths. Dr. Katzmarzyk inquired about the diversity of cross-sectional studies used to derive the conclusion statement and evidence grades. Dr. Campbell raised caution given the cross-sectional nature of the research and the presumption that the total amount of exercise is the same. He agreed with Dr. Kraus about the arbitrary nature of ten-minute bouts, but emphasized the need to message such findings appropriately to the public. Dr. Hillman agreed with Dr. Campbell and Dr. King that the topic of bout duration is emerging, and there may not be enough evidence to suggest a moderate grade. Dr. Pate discussed the history of the fixed ten-minute bout duration, and how that was derived from structured exercise trials where  $VO_2\text{max}$  was the dependent variable. He noted, when addressing physical activity in the context of public health, the emphasis is focused on a variety of different health outcomes. Dr. Buchner suggested research recommendations on minimum bout length and volume. He

also encouraged citing the *London Transport Worker's Study* for contextual history. He inquired about the relevance of many epidemiological studies that look at total accumulation of MVPA. Dr. Jakicic responded that the subcommittee looked at the research not as total volume, but separated by bout length. Dr. Powell agreed with Dr. Pate that no evidence, in the epidemiological or exercise physiology literature, suggest that bouts of less than 10 minutes do not provide benefit. Dr. Janz was unfamiliar with any accelerometer study that suggested bouts had a greater impact on health outcomes than total accumulated minutes/day of activity. Dr. Jakicic agreed. Dr. King agreed with the historical context, but that the evidence profile presented may not justify a moderate grade. Dr. Macko agreed with assigning an evidence grade of limited. He also inquired about sedentary behavior as a co-variate and its implications with bout duration. Dr. Jakicic noted that many of these studies did not address sedentary behavior, and thus insufficient evidence was available to address this topic. Dr. Powell suggested that the biases normally associated with cross-sectional studies may not impact the conclusion statement given the wording used. He emphasized the lack of significant differences in the association of health benefits with different bout durations. Dr. Erickson suggested a conclusion of insufficient evidence to suggest that bout length matters. Dr. Pate suggested approaching the question from the angle of, *is there evidence to suggest a 10-minute threshold?* Dr. Pescatello worried about the interpretation of the conclusions presented. Dr. Kraus suggested the subcommittee reconvene and address the Committee's concerns with the current conclusion statements and evidence grades and provide an update to the full Committee.

**SC 5 Exposure Question 6.** Dr. Campbell highlighted the analytical framework and systematic literature review used for question 6. He presented the following:

- What is the relationship between high intensity interval training and reduction in cardiometabolic risk?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?

The Exposure Subcommittee presented the following draft conclusions:

- Moderate evidence indicates that high-intensity interval training (HIIT) can effectively improve insulin sensitivity, blood pressure, and body composition in adults. These HIIT-induced improvements in cardiometabolic disease risk factors are comparable to those resulting from continuous, moderate-intensity aerobic exercise and are more likely to occur in adults at higher risk for cardiovascular disease and diabetes, compared to healthy adults. **PAGAC Grade: Moderate**
  - Insufficient evidence is available to determine whether a dose-response relationship exists between the quantity of HIIT and several risk factors for cardiovascular disease and diabetes. **PAGAC Grade: Grade not assignable**
  - Insufficient evidence is available to determine whether the effects of HIIT on cardiometabolic risk factors are influenced by age, sex, race/ethnicity, or socioeconomic status. **PAGAC Grade: Grade not assignable**
  - Moderate evidence indicates that weight status influences the effectiveness of HIIT to reduce cardiometabolic disease risk; adults with overweight or obesity are more responsive than adults with normal weight to improve insulin sensitivity, blood pressure, and body composition. **PAGAC Grade: Moderate**

**SC 5 Question 6 Discussion.** Dr. Marquez referenced the literature on the displeasure often reported by individuals who undergo HIIT, especially when compared with more moderate, steady-state aerobic exercise. He inquired if the literature reviewed by the exposure subcommittee had addressed this topic. Dr. Campbell agreed, but noted affect and well-being were not directly addressed by any of the studies. Dr. Hillman suggested that the Brain Health Subcommittee may be better suited to address and comment on affect and HITT. Dr. McTiernan asked about the presence of control groups in the reviewed studies, and whether HITT was seen to produce comparable or superior benefits than steady-state aerobic exercise. Dr. Campbell referenced the

sensitivity analysis that showed the improvements in cardiometabolic disease risk factors are comparable to those resulting from continuous, moderate-intensity aerobic exercise. However, he noted that increases in VO<sub>2</sub>max were greater in those who participated in HITT. Dr. Pescatello suggested that three meta-analyses were not sufficient enough to warrant an overall grade of moderate. Dr. Campbell illustrated that all three meta-analyses showed significant improvements in insulin sensitivity, blood pressure, and body composition. He noted that the parameter estimates and confidence interval were presented at the previous meeting, and that for all three meta-analyses, the results were statistically significant. Dr. McTiernan asked about the number of trials in the meta-analyses, and specifically which studies addressed which health outcomes. Dr. Campbell believed there were 84 original articles that comprised the three meta-analyses, and would need to revisit the evidence portfolio to in order to highlight which studies specifically addressed which outcomes. Dr. Janz inquired about duration, and if the current question helps shape the previous discussion over steps. Dr. Campbell believed that the average HITT exercise session was approximately 20 minutes, but the rest-to-work interval varied substantially. Dr. Jakicic noted the literature for the two questions was very different.

Dr. King requested that the Exposure Subcommittee reconvene and discuss feedback on Questions 4 and 5 and to re-present and discuss them with the Committee on Friday morning.

Note: The Exposure Subcommittee did meet after this public presentation and re-presented some of its conclusion statements on Friday. Please see the Friday notes section for these updates.

### ***Wrap-Up and Close***

**Dr. Piercy, Alternate Designated Federal Officer, ODPHP, HHS** closed the meeting for the day.

#### ***Day 1 Closed***

5:00pm

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### ***Day 2 Summary***

***Wednesday, October 18, 2017***

8:00 AM

#### ***Welcome***

**Dr. King, Co-Chair of the Committee** welcomed the Committee members as she called to order day two of the fifth meeting of the 2018 Physical Activity Guidelines Advisory Committee. She thanked everyone for the good discussion on Day 1.

#### ***Subcommittee and Work Group Presentations***

**SC 9 Youth.** Dr. Pate presented the Youth Subcommittee's Questions 2 and 3 as Question 1 was presented during Meeting 4.

**SC 9 Question 2.** Dr. Pate reported that the subcommittee relied on 29 high-quality systematic reviews and meta-analyses for answering Question 2.

- In children and adolescents, is physical activity related to health outcomes?
  - What is the relationship between physical activity and cardiorespiratory and muscular fitness?
  - What is the relationship between physical activity and adiposity/weight status? Does physical activity prevent or reduce the risk of excessive increases in adiposity/weight?

- What is the relationship between physical activity and cardiometabolic health?
- What is the relationship between physical activity and bone health?
- Are there dose-response relationships? If so, what are the shapes of those relationships?
- Do the relationships vary by age, sex, race/ethnicity, weight status, or socioeconomic status?

The Youth Subcommittee presented the following draft conclusions:

- Strong evidence demonstrates that, in children and adolescents, higher amounts of physical activity are associated with more favorable status for multiple health indicators, including cardiorespiratory and muscular fitness, bone health, and weight status/adiposity. Moderate evidence demonstrates that physical activity is positively associated with cardiometabolic health in children and adolescents. **PAGAC Grade: Strong**
  - Strong evidence demonstrates that increased moderate-to-vigorous physical activity increases cardiorespiratory fitness and increased resistance exercise increases muscular fitness in children and adolescents. **PAGAC Grade: Strong**
  - Strong evidence demonstrates that higher levels of physical activity are associated with smaller increases in weight and adiposity during childhood and adolescence. **PAGAC Grade: Strong**
  - Moderate evidence indicates that physical activity is positively associated with cardiometabolic health in children and adolescents in general; the evidence is strong for plasma triglycerides and insulin. **PAGAC Grade: Moderate**
  - Strong evidence demonstrates that children and youth who are more physically active than their peers have higher bone mass, improved bone structure, and therefore greater bone strength. **PAGAC Grade: Strong**
  - Available evidence is insufficient to determine the dose-response relationship between physical activity and health effects during childhood and adolescence. **PAGAC Grade: Grade not assignable**
  - Available evidence is insufficient to determine whether the relationship between physical activity and health effects in youth is moderated by age, sex, race/ethnicity, weight status, or socioeconomic status. **PAGAC Grade: Grade not assignable**

**SC 9 Question 2 Discussion.** Dr. Campbell asked why, for the overall conclusion statement, there was a “moderate statement” within the strong overall conclusion grading. Dr. Pate responded, that in 3 out of 4 studies that were included, the conclusion was strong for many health indicators, but the studies weren’t necessarily designed to observe the effect on cardiometabolic risk factors. Dr. Campbell advocated for getting rid of the moderate evidence statement to mitigate any confusion. Dr. Pate suggested removing the last sentence from the conclusion statement. Dr. Katzmarzyk suggested streamlining the conclusion statement by excluding mention of all of the health indicators. Dr. King agreed.

**SC 9 Question 3.** Dr. Pate reported that the subcommittee relied on 10 high-quality systematic reviews and meta-analyses for answering the weight status and cardiometabolic subquestions of Question 3. An additional 4 original research articles were found via a *de novo* literature search to answer the bone health subquestions.

- In children and adolescents, is sedentary behavior related to health outcomes?
  - What is the relationship between sedentary behavior and cardiometabolic health?
  - What is the relationship between sedentary behavior and adiposity/weight status?
  - What is the relationship between sedentary behavior and bone health?
  - Are there dose-response relationships? If so, what are the shapes of the relationship?
  - Do the relationships vary by age, sex, race/ethnicity, weight status, or socioeconomic status?

The Youth Subcommittee presented the following draft conclusions:

- Limited evidence suggests that time spent in sedentary behavior is related to health outcomes in children and adolescents. **PAGAC Grade: Limited.**

- Limited evidence suggests that overall time spent in sedentary behavior is related to cardiometabolic health; the evidence is somewhat stronger for television viewing/screen time. **PAGAC Grade: Limited**
- Limited evidence suggests that time spent in sedentary behavior is related to weight status/adiposity in children and adolescents; the evidence is somewhat stronger for television viewing/screen time. **PAGAC Grade: Limited**
- Limited evidence suggests that sedentary behavior is related to bone health. **PAGAC Grade: Limited**
- Insufficient evidence is available to determine whether there is a dose-response relationship between time spent in sedentary behavior and health outcomes in children and adolescents. **PAGAC Grade: Grade not assignable**
- Insufficient evidence is available to determine whether the relationship between sedentary behavior and health outcomes in youth is moderated by age, sex, race/ethnicity, weight status, or socioeconomic status. **PAGAC Grade: Grade not assignable**

**SC 9 Question 3 Discussion.** Dr. Pate clarified that for the first subquestion, much of the work in this area has used television watching or screen time as a surrogate for sedentary behavior, although most agree that television watching encompasses more covariates than just sedentary behavior. Dr. Kraus asked if the data (or lack thereof) stems from the paucity of objective measures of sedentary behavior in youth, and/or parents producing reliable self-reported sedentary behaviors of their children. Dr. Pate suggested that the science isn't quite there to fully answer this question. He again noted that much of the evidence on sedentary behavior in children comes from studies in which they measured TV watching/screen time. Dr. Pate emphasized how the subcommittee found this to be problematic and consequently hindered the ability to develop more concrete conclusions. Dr. Campbell was curious about the length of the prospective studies used for these conclusions. Dr. Janz responded that the lengths were mixed, but some of the studies were very long and included the transition through puberty into adulthood.

**SC 6 Individuals with Chronic Conditions.** Dr. Buchner, the chair of the Individuals with Chronic Conditions Subcommittee, noted that the subcommittee will be meeting later this week to re-examine the wording of some of its conclusions. He also mentioned that Question 1 and 3 will be updated, and the conclusions from Question 2 that were not presented previously will be covered. Questions 4-7 will be presented for the first time. For almost all the questions except osteoarthritis, the subcommittee relied on systematic reviews and meta-analyses. For Questions 5-7, there are no subquestions as the reviews were too limited.

**SC 6 Question 1.** Dr. McTiernan stated that the evidence and overall conclusion statement for Question 1 was presented during previous meetings. She addressed the following subquestions related to breast, colorectal and prostate cancer:

- Among cancer survivors, what is the relationship between physical activity and (1) all-cause mortality, (2) cancer-specific mortality, or (3) risk of cancer recurrence or second primary cancer?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Does the relationship vary based on: frequency, duration, intensity, type (mode), or how physical activity is measured?

The following draft conclusions were presented for subquestions:

#### Breast Cancer

- Moderate evidence indicates that as levels of physical activity increase, risk of breast cancer mortality and all-cause mortality decreases. **PAGAC Grade: Moderate**

- Moderate evidence indicates that physical activity reduces risk for breast cancer specific death in both pre- and postmenopausal women, with menopause as a proxy for age, while high levels of physical activity reduces all-cause mortality in only postmenopausal women. **PAGAC Grade: Moderate**  
Moderate evidence indicates that physical activity reduces risk for all-cause mortality in both normal-weight and overweight/obese women, while it may only reduce breast cancer-specific death risk in overweight/obese survivors. **PAGAC Grade: Moderate**  
There is insufficient evidence to grade whether the relationship between physical activity and breast cancer differs by race/ethnicity or socioeconomic status. **PAGAC Grade: Grade not assignable**
- There is insufficient evidence to analyze whether the frequency, duration, intensity, or type (mode) of physical activity is related to all-cause or cancer-specific mortality among survivors of breast cancer. **PAGAC Grade: Grade not assignable**

### Colorectal Cancer

- There is a dose-response relationship such that higher vs. lower levels of physical activity after the diagnosis of colorectal cancer are associated with a significant HR of 0.68 indicating an approximately 32% reduction in overall mortality, and a significant HR of 0.56 indicating an approximately 44% reduction in colorectal cancer specific mortality. The inverse association for physical activity with reduced all-cause mortality and colorectal cancer specific mortality is consistent across meta-analyses including >6,300 patients across follow-up times ranging 3.8 to 11.9 years after the diagnosis. **PAGAC Grade: Moderate**
- Moderate evidence indicates that the association between physical activity and colorectal cancer mortality does not vary across age groups from middle to older ages. **PAGAC Grade: Moderate**  
Moderate evidence indicates that the association between physical activity and colorectal cancer mortality does not vary between genders. **PAGAC Grade: Moderate**  
There is insufficient evidence to grade whether the relationship between physical activity and colorectal cancer mortality differs by race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Grade not assignable**
- Moderate evidence indicates that moderate to vigorous physical activity of at least 17 MET hours per week is associated with reduced mortality in persons with colorectal cancer. **PAGAC Grade: Moderate**
- There is insufficient evidence to grade whether frequency, duration, intensity, type (mode) of physical activity are associated with mortality in persons with colorectal cancer. **PAGAC Grade: Grade not assignable**

### Prostate Cancer

- No evidence is available on the association between physical activity and prostate cancer survival or recurrence by age, race/ethnicity, socio-economic status, or weight status. **PAGAC Grade: Grade not assignable**
- Limited evidence suggests that increased frequency, duration, and intensity may be associated with decreased risks for overall mortality and prostate cancer specific mortality. **PAGAC Grade: Limited**

**SC 6 Question 1 Discussion.** Dr. Kraus inquired about the effect size and the 44% reduction in colorectal cancer specific mortality when performing at least 17 MET-hours/week. Dr. McTiernan responded that there is a similar effect size for breast cancer, and there's a problem with the adjustment for treatment with all cancers observed; are patients who are going through treatment feeling better and being more physically active, or is it the physical activity alone that is decreasing mortality? Dr. Janz raised concerns that oncologists and those working with cancer survivors are going to see this and not address one of the few modifiable behaviors that can be offered. Dr. McTiernan believed that oncologists are likely unaware of this information, and highlighted that a moderate or strong grade isn't a reflection of the effect size, but rather reflects the strength of the evidence.

She also mentioned that from her experience, oncologists often don't prescribe lifestyle changes (such as physical activity) to their patients. Physical activity programs that cater to cancer survivors are sparse. Dr. Erickson asked whether there was any information on brain cancer in the literature they examined. Dr. McTiernan said that there weren't any systematic reviews or meta-analyses that looked at physical activity in brain cancer survivors. Dr. Whitt-Glover asked about physical activity levels before diagnosis, and if such variables were controlled for. Dr. McTiernan responded that the subcommittee focused on post-diagnosis physical activity levels because this information is for guidelines and the topic specifically is for cancer patients who are already diagnosed.

Note: The Individuals with Chronic Conditions subcommittee met throughout the week and re-presented some of its conclusion statements on Friday. Please see the Friday notes section for these updates.

**SC 6 Question 2.** Dr. Kraus noted that preliminary data on osteoarthritis, specifically physical function, health-related quality of life, and pain, were presented in Meeting 4. Therefore, much of the following presentation will cover the risk of co-morbid conditions and disease progression. Dr. Kraus reiterated that the subcommittee relied on eight systematic reviews and meta-analyses to answer Question 2. Since only one review included information on disease progression, a *de novo* literature review was conducted and produced five original research articles.

- In persons with osteoarthritis, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, (3) health-related quality of life, (4) pain, and (5) disease progression?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Does the relationship vary based on: frequency, duration, intensity, type (mode), or how physical activity is measured?

The Individuals with Chronic Conditions Subcommittee presented the following draft conclusions:

#### Comorbidities

- There is insufficient evidence available to determine whether there is a relationship between greater amounts of physical activity and comorbidities in individuals with osteoarthritis. **PAGAC Grade: Grade not assignable**
- There was insufficient evidence to answer any of the subquestions. **PAGAC Grade: Grade not assignable**

#### Pain and Physical Function

- Strong evidence demonstrates a significant relationship between greater amounts of physical activity and decreased pain and improved physical function in persons with osteoarthritis of the knee and hip. **PAGAC Grade: Strong**
- There is insufficient evidence available to determine whether any of these relationships vary by age, gender, race, ethnicity, SES, or BMI. **PAGAC Grade: Grade not assignable**
- Limited evidence suggests that the mode, intensity, or duration of physical activity is related to improvements in pain and functional capacity in individuals with osteoarthritis of the knee and hip. Differences in exercise frequency and duration appear to influence pain relief in knee osteoarthritis. **PAGAC Grade: Limited**

#### Quality of life

- Moderate evidence indicates a significant relationship between greater amounts of physical activity and improved quality of life in persons with osteoarthritis of the knee and hip. **PAGAC Grade: Moderate**

- There is insufficient evidence available to determine whether any of these relationships vary by age, gender, race, ethnicity, SES, or BMI. **PAGAC Grade: Grade not assignable**

#### Disease Progression

- Moderate evidence indicates that up to the range of 10,000 steps per day, ambulatory physical activity does not accelerate osteoarthritis of the knee. **PAGAC Grade: Moderate**
- Moderate evidence indicates a U-shaped relation between physical activity amount and progression of osteoarthritis, particularly in those with advanced osteoarthritis pathology at baseline. **PAGAC Grade: Moderate**
- There is insufficient evidence available to determine whether any of these relationships vary by age, gender, race, ethnicity, SES, or BMI. **PAGAC Grade: Grade not assignable**

**SC 6 Question 2 Discussion.** Dr. Pate inquired about the strength of the evidence that illustrated comparable benefits provided by aquatic and land-based exercise for individuals with osteoarthritis. Dr. Kraus wasn't comfortable saying that this evidence is strong yet. Dr. Macko noted the differences in osteoarthritis by BMI status and gender, and he asked how these impact the subcommittee's findings. Dr. Kraus explained that there doesn't appear to be data examining physical activity's effect on osteoarthritis by BMI status and/or gender, and exposure/outcome heterogeneity makes it difficult to make definitive conclusions. Dr. Powell asked Dr. Kraus to clarify some of the plots and charts that were included in the presentation. Dr. Janz asked if these studies examined previous physical activity levels and sport participation. Dr. Kraus replied that there was a longitudinal study that found no difference in runners vs. controls on total knee replacement. Dr. Kraus's understanding of the literature was that without a pre-existing injury in the specific joint, physical activity does not lead to osteoarthritis. Dr. Campbell asked if there was more information on the modes of land-based exercise, especially when making the comparison between land-based and aquatic-based modalities. Dr. Kraus responded that the modes were heterogeneous, and that studies comparing different land-based modes were not found in their literature search; this is why the evidence statement is moderate. Dr. Pescatello asked if the 10,000 steps per day in the conclusion statement for osteoarthritis is the "sweet spot" in the U-shaped curve of the association between physical activity and progression of osteoarthritis. Dr. Kraus didn't feel comfortable giving a firm number on the "sweet spot" given the compiled evidence. Dr. Erickson inquired about the overall conclusion statement and grade for quality of life, noting the possibility of diluted positive results. Dr. Kraus stated that the moderate grade was given because of the small sample size for quality of life outcomes.

**SC 6 Question 3.** Dr. Pescatello mentioned that at Meeting 4, the subcommittee presented on the associations between physical activity and hypertension including co-morbid conditions, physical function, health-related quality of life, and cardiovascular disease progression and mortality. She noted that conclusion statements were going to be presented for the fourth part of the overall question: cardiovascular disease progression and mortality. Because blood pressure is considered a proxy measure for the risk of CVD, the subcommittee regarded blood pressure response to physical activity as an indicator of CVD disease progression, and the outcome of CVD mortality as an indicator of longstanding hypertension. The subcommittee relied on 15 systematic reviews and meta-analyses to answer the following question:

- In people with the cardiovascular condition of **hypertension**, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, (3) health-related quality of life, and (4) cardiovascular disease progression and mortality?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, weight status, or resting blood pressure level?
  - Does the relationship [vary] based on: frequency, intensity, time, duration, type (mode), or how physical activity is measured?

The Individuals with Chronic Conditions Subcommittee presented the following draft conclusions:

#### CVD progression and mortality

- Strong evidence demonstrates that physical activity reduces the risk of progression of cardiovascular disease among adults with hypertension. **PAGAC Grade: Strong**
- Strong evidence demonstrates that, among adults with hypertension, physical activity reduces the disease progression indicator of blood pressure. **PAGAC Grade: Strong**
  - Moderate evidence indicates an inverse, dose-response relationship between physical activity and the disease progression indicator of cardiovascular disease mortality among adults with hypertension. **PAGAC Grade: Moderate**
  - Moderate evidence indicates the relationship between physical activity and the disease progression indicator of blood pressure does not vary by traditional type (mode, i.e., aerobic, dynamic resistance, combined) of physical activity. **PAGAC Grade: Moderate.**
    - Limited, but poor-quality, evidence suggests that the relationship between physical activity and the disease progression indicator of blood pressure does not vary by complementary and alternative type (mode, i.e., Baduanjin, Qigong, Tai Chi, Yoga). **PAGAC Grade: Limited**

**SC 6 Question 3 Discussion.** Dr. Campbell pointed out that the Committee has been using a grading system for the quality of the systematic reviews and meta-analyses, but this subcommittee commented on the quality of the individual studies in the conclusion statements. Dr. Pescatello agreed, but noted that their conclusions were similar to a recent American Heart Association position statement on physical activity and hypertension, and more robust evidence about physical activity and blood pressure is needed. Dr. Kraus agreed with the limited evidence grade for alternative exercise modalities as they may provide additional benefits (i.e., stress relief). However, he noted the inability to determine the full scope of the relationship between alternative exercise modalities and blood pressure. Dr. Pate asked how anti-hypertensive medications were handled in these studies. Dr. Pescatello responded that they were often handled very poorly. Dr. Katzmarzyk questioned how the conclusion statements were written; how did the subcommittee conclude that the effect of physical activity did not differ across types of exercise? Dr. Pescatello responded that alternative and traditional types of exercise were not directly compared in the meta-analyses, but a similar reduction in disease progression was seen by both forms of exercise. Dr. Macko recommended describing this important stipulation in the evidence statement. Dr. Jakicic noted that the terms for alternative exercise (yoga, tai chi, etc.) are being used globally, and this needs to be made clear in the chapter write-ups. Dr. Powell asked why these studies were left in the evidence base if they were of such poor quality. Dr. Pescatello emphasized that these alternative types of exercise are becoming more popular, have been commented on by the American Heart Association, and have a growing evidence base, thus their inclusion in the evidence statements seemed appropriate. Dr. Buchner said that the subcommittee will meet again to review these conclusion statements.

**SC 6 Question 4.** Dr. Buchner presented the subcommittee's findings on Question 4, noting that the subcommittee relied on 40 systematic reviews and meta-analyses to answer this question.

- In people with **type 2 diabetes**, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, (3) health-related quality of life, and (4) disease progression?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Does the relationship [vary] based on: frequency, duration, intensity, type (mode), or how physical activity is measured?

The Individuals with Chronic Conditions Subcommittee presented the following draft conclusions:

#### Comorbidities

- Strong evidence demonstrates an inverse association between volume of physical activity and risk of cardiovascular mortality among adults with type 2 diabetes. **PAGAC Grade: Strong**
- Moderate evidence indicates an inverse, curvilinear dose-response relationship between physical activity and cardiovascular mortality among adults with type 2 diabetes. **PAGAC Grade: Moderate**
- Insufficient evidence was available to determine whether the relationship between physical activity and cardiovascular mortality among adults with type 2 diabetes varies with age, sex, race/ethnicity, SES, or weight status. **PAGAC Grade: Grade not assignable**
- Insufficient evidence was available to determine whether the relationship between physical activity and cardiovascular mortality among adults with type 2 diabetes varies with frequency, duration, intensity, or type (mode) of physical activity or how physical activity is measured among people with type 2 diabetes mellitus. **PAGAC Grade: Grade not assignable**

#### Physical Function

- Insufficient evidence was available to determine the relationship between physical activity and physical function in adults with type 2 diabetes. **PAGAC Grade: Grade not assignable**
- There was insufficient evidence to answer any of the subquestions. **PAGAC Grade: Grade not assignable**

#### Quality of Life

- Insufficient evidence was available to determine the relationship between physical activity and health-related quality of life in adults with type 2 diabetes. **PAGAC Grade: Grade not assignable**
- There was insufficient evidence to answer any of the subquestions. **PAGAC Grade: Grade not assignable**

#### Disease Progression

- Insufficient evidence was available to determine the relationship between physical activity and indicators of progression of neuropathy, nephropathy, retinopathy, and foot disorders. **PAGAC Grade: Grade not assignable**
- Strong evidence demonstrates an inverse association between aerobic activity, muscle strengthening activity, and aerobic + muscle strengthening activity and risk of progression among adults with type 2 diabetes, as assessed by overall effects of physical activity on four indicators of risk of progression: body mass index (BMI), lipids, blood pressure, and glycated hemoglobin A1C. **PAGAC Grade: Strong**
- Moderate evidence indicates an inverse dose-response relationship between volume of aerobic activity and risk factors (blood pressure, hemoglobin A1C) for progression among adults with type 2 diabetes. **PAGAC Grade: Moderate**
  - Limited evidence indicates an inverse dose-response relationship between volume of resistance training and risk factors for progression hemoglobin A1C among adults with type 2 diabetes. **PAGAC Grade: Limited.**
- Moderate evidence indicates that effects of physical activity on blood pressure are stronger in hypertensive individuals, and effects of physical activity on hemoglobin A1C are stronger in individuals with higher levels of hemoglobin A1C. **PAGAC Grade: Moderate.**
  - Insufficient evidence was available to determine whether the effects of physical activity on risk factors for progression in adults of type 2 diabetes vary by age, sex, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Grade not assignable.**
- Insufficient evidence was available to determine the relationship between Tai Chi, Qigong, and Yoga exercise with risk factors for progression. **PAGAC Grade: Grade not assignable.**
  - Limited evidence indicates longer periods of exercise have a larger effect on risk factors (hemoglobin A1C, lipids, BMI) for progression among adults with type 2 diabetes. **PAGAC Grade: Limited.**
  - In comparisons of equal volumes of moderate- vs vigorous-intensity aerobic training, limited evidence suggests vigorous intensity activity is somewhat more efficient in reducing one risk factor (hemoglobin A1C) for progression in adults with type 2 diabetes. **PAGAC Grade: Limited**

- Insufficient evidence was available to determine the effects of frequency, bout duration, and method of measuring physical activity on risk factors for progression in adults with type 2 diabetes. **PAGAC Grade: Grade not assignable**

**SC 6 Question 4 Discussion.** Due to time constraints, there was no discussion after Dr. Buchner’s presentation.

**SC 6 Question 5.** Dr. Macko reported that the subcommittee relied on seven systematic reviews and meta-analyses to answer Question 5.

- In people with **multiple sclerosis (MS)**, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, and (3) health-related quality of life?

The Individuals with Chronic Conditions Subcommittee presented the following draft conclusions:

#### Comorbidities

- There is insufficient data to examine the relationship between physical activity and risk of comorbid conditions for persons with MS. **PAGAC Grade: Grade not assignable**

#### Physical Function

- Strong evidence indicates an association between greater amounts of moderate-to-vigorous physical activity and small to moderate improvements in physical function including walking velocity and endurance, strength and aerobic fitness. **PAGAC Grade: Strong**

#### Quality of Life

- Limited evidence shows mixed findings for an association between greater physical activity and health-related quality of life.
- Limited evidence supports a relationship for small-moderate reductions in depressive symptoms and fatigue, which are both related to quality of life in adults with MS. **PAGAC Grade: Limited**

**SC 6 Question 5 Discussion.** Dr. Kraus noted that MS is an episodic disease and inquired about how studies account for the variability of the underlying disease. Dr. Macko responded by saying participants who had an exacerbation incident were removed from these studies. He acknowledged the challenges in making conclusions about disease progression given this variability. Dr. McTiernan asked how medication use was accounted for in the trials. Dr. Macko stated that since 1991-92, people with MS have ubiquitously been placed on medication (given the efficacy of MS drugs). However, he noted that the reviewed studies did not explicitly comment on how medication was controlled for in the trials.

**SC 6 Question 6.** Dr. Macko reported that the subcommittee relied on 13 systematic reviews and meta-analyses to answer Question 6.

- In people with a **spinal cord injury**, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, and (3) health-related quality of life?

The Individuals with Chronic Conditions Subcommittee presented the following draft conclusions:

#### Comorbidities

- There is limited but consistent evidence that increased physical activity is related to clinically significant reductions in shoulder pain, and improved vascular function in paralyzed limbs in persons with spinal cord injury. **PAGAC Grade: Limited**

### Physical Function

- There is moderate strength evidence for a relationship between greater physical activity and small to moderate positive effect sizes on walking function, muscular strength, and upper extremity function for persons with spinal cord injury. **PAGAC Grade: Moderate**

### Quality of Life

- There is limited evidence for a positive relationship between physical activity and health-related quality of life for persons with spinal cord injury. **PAGAC Grade: Limited**

**SC 6 Question 6 Discussion.** No questions were asked during Question 6 discussion.

**SC Question 7.** Dr. Macko reported that the subcommittee relied on four systematic reviews and meta-analyses to answer Question 7.

- In people with **intellectual disabilities**, what is the relationship between physical activity and (1) risk of co-morbid conditions, (2) physical function, and (3) health-related quality of life?

The Individuals with Chronic Conditions Subcommittee presented the following draft conclusions:

### Comorbidities

- There is insufficient evidence to analyze the relationship between physical activity and risk of comorbid conditions for persons with intellectual disabilities. **PAGAC Grade: Grade not assignable**

### Physical Function

- There is limited evidence for a relationship between physical activity and small effect size improvements on selected physical function outcomes in adults and children with intellectual disabilities. **PAGAC Grade: Limited**

### Quality of Life

- There is insufficient data to analyze the relationship between physical activity and health related quality of life for persons with intellectual disabilities. **PAGAC Grade: Grade not assignable**

**SC 6 Question 7 Discussion.** No questions were asked during Question 7 discussion.

**Note:** The Individuals with Chronic Conditions subcommittee met throughout the week and re-presented some of its conclusion statements on Friday. Please see the Friday notes section for these updates.

**Pregnancy Work Group.** Dr. DiPietro presented the Pregnancy Work Group's questions. The analytical framework and systematic literature search for Question 1 were addressed in previous meetings.

**Pregnancy WG Question 1.** Dr. DiPietro presented the following:

- What is the relationship between physical activity and weight gain during pregnancy and weight loss during postpartum (up to one year)?
  - What dose of physical activity is associated with the reported quantitative benefit or risk?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, race/ethnicity, socioeconomic status, or weight status?

At the previous meeting, the pregnancy work group presented the findings on the relationship between physical activity and gestational weight gain. Therefore, the following presentation addressed the relationship between physical activity and weight loss during the postpartum period.

The pregnancy work group presented the following draft conclusions:

- Insufficient evidence is available to determine if there is a relationship between physical activity and weight loss during the postpartum period. **PAGAC Grade: Grade not assignable**
  - Insufficient evidence is available to determine what dose of physical activity is effective for weight loss during postpartum. **PAGAC Grade: Grade not assignable**
  - Insufficient evidence is available to determine whether there is a dose-response relationship between physical activity and weight loss during postpartum. **PAGAC Grade: Grade not assignable**
  - Insufficient evidence is available to determine whether the relationship between physical activity and weight loss during post-partum varies by age, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Grade not assignable**

**Pregnancy WG Question 2.** Dr. DiPietro reviewed the analytical framework and systematic literature search for Question 2. It was noted that the work group's conclusions and evidence grades were based on the findings of fifteen systematic reviews and meta-analyses.

- What is the relationship between physical activity and the incidence of gestational diabetes mellitus (GDM)?
  - What dose of physical activity is associated with the reported quantitative benefit or risk?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, race/ethnicity, socioeconomic status, or weight status?

The pregnancy work group presented the following draft conclusions:

- Strong evidence demonstrates a significant inverse relationship between leisure-time physical activity and risk of GDM. **PAGAC Grade: Strong**
  - Limited evidence suggests that a dose of physical activity similar to the 2008 U.S. Physical Activity Guidelines (150-180 min/week of moderate-intensity activity) is associated with a lower risk of GDM. **PAGAC Grade: Limited**
  - Limited evidence suggests that there is a dose-response relationship between physical activity and GDM. **PAGAC Grade: Limited**
  - Insufficient evidence is available to determine whether the relationship between physical activity and GDM varies by age, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Grade not assignable**

**Pregnancy WG Questions 1 & 2 Discussion.** Dr. Kraus and Dr. Pate both inquired about the grade of limited for the first subquestion of Question 2. Dr. DiPietro and Dr. Powell agreed the grade was likely conservative, but explained that the authors often did not explicitly describe the dose of physical activity in which subjects participated. Dr. DiPietro also noted the strong dose response curve for pre-pregnancy, but not postpartum. Dr. Janz inquired about the rationale used by the work group in developing the second subquestion. Dr. Powell emphasized the importance of assessing the risk reduction associated with different volumes of physical activity. He was confident that leisure-time physical activity was associated with a reduced risk of GDM (noted by the strong grade for the overall question), but that volume of physical activity need for that risk reduction remained unclear. Dr. King agreed with Dr. Janz, and suggested operationalizing the language to exclude referencing Guidelines, but to keep the recommendation of 150-180 minutes. Dr. Macko encouraged the expansion of the

third conclusion statement to address the differences in risk reduction during pre-pregnancy and pregnancy. Dr. Campbell inquired about the dose-response of 5 hours/week and 30% risk reduction for gestational diabetes. Dr. DiPietro noted that dose-response relationship was derived from a regression calculation. Dr. Powell explained there was a 30% reduction for the first five hours of physical activity. An additional 30% risk reduction is achieved for the next five hours from the level previously achieved. Dr. McTiernan inquired about the recruitment process of the studies, specifically the studies that addressed pre-pregnancy. Dr. DiPietro noted that some of the trials recruited women who were “thinking” about getting pregnant, but she would need to look back at the literature to comment on the specific recruitment process. Dr. Macko inquired about women with diabetes. Dr. DiPietro explained that was outside the domains of the question.

**Pregnancy WG Question 3** Dr. DiPietro noted that rate of preeclampsia in women in North America is relatively low because of screening; however, mortality rates are very high given the severity of the disorder. She reviewed the analytical framework and systematic literature search for Question 3. Dr. DiPietro presented the following:

- What is the relationship between physical activity and the incidence of preeclampsia and eclampsia?
  - What dose of physical activity is associated with the reported quantitative benefit or risk?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, race/ethnicity, socioeconomic status, or weight status?

The pregnancy work group presented the following draft conclusions:

- Limited evidence suggests that physical activity performed pre-pregnancy or during early pregnancy lowers the risk of pre-eclampsia. **PAGAC Grade: Limited**
  - Limited evidence suggests that 3-4 h/week of MVPA performed before or in early pregnancy is associated with a lower risk of preeclampsia. **PAGAC Grade: Limited**
  - Limited evidence suggests that there is an inverse dose-response relationship between physical activity and risk of preeclampsia. **PAGAC Grade: Limited**
  - Insufficient evidence is available to determine whether the relationship between physical activity and preeclampsia varies by age, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Grade not assignable**

**Pregnancy WG Question 3 Discussion.** Dr. Pescatello commented on the U-shaped curve for the relationship of pre-pregnancy physical activity and preeclampsia. She inquired about the possibility of detrimental effects for those who engage in more than five hours/week of physical activity. Dr. DiPietro noted there were no explicit comments regarding leisure-time physical activity, she cited literature on occupational physical activity and its relationship with complicated pregnancies. Dr. Pescatello and Dr. DiPietro agreed on the importance of emphasizing this finding in the report. Dr. Pate commented on the lack of credence attached to high volumes of physical activity and negative health outcomes, and the need address such findings in the report. Dr. Katzmarzyk noted the graph does not indicate an increase in risk. Dr. DiPietro agreed, and noted the wide confidence intervals which illustrate the instability in the sample.

**Pregnancy WG Question 4** Dr. DiPietro reviewed the analytical framework and systematic literature search for Question 4. She presented the following:

- What is the relationship between physical activity and (1) affect, (2) anxiety, and (3) depression during pregnancy and postpartum (up to one year)?
  - What dose of physical activity is associated with the reported quantitative benefit or risk?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, race/ethnicity, socioeconomic status, or weight status?

The pregnancy work group presented the following draft conclusions:

Affect

- Insufficient evidence is available to determine the relationship between physical activity and affect during pregnancy and the postpartum period. **PAGAC Grade not assignable**

Antenatal Anxiety

- Limited evidence suggests that physical activity decreases symptoms of anxiety during pregnancy. **PAGAC Grade: Limited**
- Insufficient evidence is available to evaluate any of the subquestions. **PAGAC Grade: Grade not assignable**

Postpartum Anxiety

- Insufficient evidence is available to determine the relationship between physical activity and postpartum anxiety. **PAGAC Grade: Grade not assignable**

Antenatal Depression

- Limited evidence suggests that physical activity reduces symptoms of depression during pregnancy. **PAGAC Grade: Limited**
- Insufficient evidence is available to evaluate the subquestions. **PAGAC GRADE: Grade not assignable**

Post-partum Depression

- Strong evidence demonstrates an inverse relationship between physical activity and risk of postpartum depression. **PAGAC Grade: Strong**
- Insufficient evidence is available to evaluate the subquestions. **PAGAC Grade: Grade not assignable**

**Pregnancy WG Question 4 Discussion.** Dr. Powell noted that the work group did searches to include quality of life and sleep, but were unable to find information on these outcomes. Therefore, they will also be included in the research recommendations. Dr. Macko referenced a paper that addressed sleep and quality of life, and agreed with Dr. Powell’s comment to include a research recommendation specifically addressing these outcomes. Dr. King inquired about an additional conclusion statement to address the effects of physical activity on reducing depression. However, since the work group did not include a specific search for this relationship (the findings were part of a larger meta-analysis), it could not be added as a conclusion statement. Dr. Jakicic commented on the broader scope of yoga, and the need for research recommendations on teasing apart the mechanisms by which alternative modes of exercise may contribute to positive health outcomes.

***Wrap-Up and Close***

**Dr. King** closed the public session, and announced that tomorrow’s public session would begin at 8am ET.

***Day 2 Closed***

11:55am

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***Day 3 Summary***

***Thursday, October 19, 2017***

8:00am

## Welcome

Dr. Powell, Co-Chair of the Committee, welcomed the Committee and outlined the public meeting agenda for the day.

### Subcommittee Presentations

**SC 1 Aging.** Dr. DiPietro noted that Question 1 was presented at a previous meeting. Additionally, she outlined the subcommittee's revisions to Questions 2 and 3. She emphasized that the chronic diseases selected for Question 3 were based on the robust nature of the literature and the distribution of these diseases among the older population. Dr. Buchner reviewed the analytical framework and systematic literature search for Question 2:

- What is the relationship between physical activity and physical function among the general aging population?
  - General Aging
  - Physical Activity Types
    - Single component (e.g., strength training, yoga)
    - Dual-task (e.g., walking while counting backwards)
  - Impairments
    - Healthy aging
    - Visual Impairment
    - Cognitive Impairment
    - Physical Impairment
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - What types of physical activity are effective for improving or maintaining physical function?
  - What impairments modify the relationship between physical activity and physical function among the general aging population?

The Aging Subcommittee presented the following draft conclusions for Question 2:

- Strong evidence demonstrates that physical activity improves physical function and attenuates age-related loss of physical function in the general aging population. **PAGAC GRADE: Strong**
  - Strong evidence demonstrates an *inverse dose-response relationship* between volume of aerobic physical activity and risk of physical functional limitations in the general population of older adults. **PAGAC Grade: Strong**
  - Limited evidence suggests an *inverse dose-response* relationship of volume of muscle-strengthening and frequency of balance activities with risk of physical function limitations in the general population of older adults. **PAGAC Grade: Limited**
  - Limited evidence suggests that the relationship between physical activity and physical function does not vary by age, sex, or weight status in the general population of older adults. **PAGAC Grade: Limited**
  - Insufficient evidence is available to determine if the relationship between physical activity and physical function varies by race/ethnicity and socioeconomic status in the general population of older adults. **PAGAC Grade: Not assignable**
  - Strong evidence demonstrates that aerobic, muscle-strengthening, and multicomponent physical activity improve physical function in the general aging population. **PAGAC Grade: Strong**
  - Moderate evidence indicates that activities that improve balance improve physical function in the general aging population. **PAGAC Grade: Moderate**

- Limited evidence suggests that activities of Tai Chi improve physical function in the general aging population **PAGAC Grade: Limited**
- Insufficient evidence is available to determine the effects of flexibility activity, qigong, or yoga exercise on physical function in the general aging population. **PAGAC Grade: Grade not assignable**
- Limited evidence suggest that dance training improves physical function among the general aging population. **PAGAC Grade: Limited**
- Limited evidence suggests that active video gaming improves some domains of physical function among the general aging population. **PAGAC Grade: Limited**
- Limited evidence suggests that physical activity training or dual-task training modestly improves measures of physical function under dual-task conditions in the general aging population. **PAGAC Grade: Limited**
- Limited evidence suggests that physical activity has a stronger effect on physical function in older adults with limitations in physical function, compared to relatively healthy older adults **PAGAC Grade: Limited**
- Insufficient evidence is available to determine whether visual impairments or cognitive impairments modify the relationship between physical activity and physical function among the general aging population. **PAGAC Grade: Not assignable**

Dr. Buchner noted that the *LIFE* study was not part of the evidence portfolio, as it did not appear in the literature search. He acknowledged that evidence provided by the literature review is consistent with findings from the *LIFE* study.

**SC 1 Question 2 Discussion.** Dr. Powell asked Dr. Buchner to expand on muscle strengthening. Dr. Buchner discussed the use of different modalities, specifically cuffs, bands, calisthenics, and power training (the ability to contract muscles at faster speed than traditional strength training) to improve balance and other functional outcomes. Dr. Janz inquired about plyometrics in older adults, but Dr. Buchner did not find any literature on the topic. Dr. Hillman inquired about dual-task training, and suggested changing the grade to not assignable. Dr. Erickson acknowledged gaps in the literature, but cited a few well conducted studies supporting the grade of limited. Dr. Pescatello agreed with Dr. Hillman, and suggested a qualifier such as “small, but modest.” Dr. King expressed her frustrations regarding the inability of systematic searches to capture all the evidence. She emphasized the need to illustrate the strengths and limitations of the systematic review process in the report. Dr. Kraus asked if the subcommittee had any reason to suggest changing the current strength training recommendation from two days/week. Dr. Buchner said they did not find any evidence to suggest changing it. Dr. Campbell and Dr. Katzmarzyk questioned the use of the word “prevent,” as aging is a natural process. They suggested changing the language to “reduced risk” or “attenuation.”

**SC 1 Question 3.** Dr. DiPietro reviewed the analytical framework and systematic literature search for Question 3 prior to presenting the following:

- What is the relationship between physical activity and physical function in older people with selected chronic conditions?
  - Cardiovascular Disease
  - Chronic Obstructive Pulmonary Disease
  - Cognitive Impairment
  - Frailty
  - Osteoporosis/Osteopenia
  - Parkinson’s Disease
  - Post-Hip Fracture
  - Stroke
  - Visual impairments

The Aging Subcommittee presented the following draft conclusions:

- Limited evidence suggests that physical activities such as resistance training and complementary/alternative exercise (tai chi, qigong, baduanjin) improve physical function among older people with cardiovascular disease. **PAGAC Grade: Limited**
- Limited evidence suggests that for individuals with cognitive impairment, physical activity programs improve physical function including measures of activities of daily living. **PAGAC Grade: Limited**
- Limited evidence suggests tai chi and qigong might improve one aspect of physical function – walking ability--in older adults with COPD. **PAGAC Grade: Limited**
- Strong evidence demonstrates that physical activity improves measures of physical function in older people with frailty. **PAGAC Grade: Strong**
- Moderate evidence indicates that, for community dwelling older adults who sustain a hip fracture, extended exercise programs improve physical function. **PAGAC Grade: Moderate**
- Limited evidence suggests that muscle strengthening and agility (balance) exercises improves physical function in older people who are at risk for fragility fractures due to osteoporosis or osteopenia. **PAGAC Grade: Limited**
- Strong evidence demonstrates a relationship between greater physical activity and a number of physical function outcomes including walking, balance, strength, and disease specific (UPDRS) motor scores for individuals with Parkinson’s Disease. **PAGAC Grade: Strong**
- Moderate evidence suggests that mobility-oriented physical activity improves walking function for individuals after a stroke. **PAGAC Grade: Moderate**
- Insufficient evidence is available to determine the effect of physical activity on physical function in older adults with visual impairment. **PAGAC Grade: Grade Not assignable**

**SC 1 Question 3 Discussion.** Dr. Janz inquired about the “artificial” setting that exercise interventions create, and the possibility of confounding by increased social capital. Dr. DiPietro acknowledged that some studies were performed in-home. However, she noted the difficulties in maintaining adequate adherence with such study designs. To address Dr. Janz’s concern, Dr. DiPietro cited the need for long prospective studies to better understand the progression of disease. Moreover, Dr. Erickson emphasized the importance of prospective studies to provide a better understanding of biomarkers, specifically gene environment interactions. Dr. Campbell inquired about the transition to “older adulthood,” and when the transition takes place. Dr. DiPietro acknowledged this as a grey area, and referenced menopause as a traditional turning point for women. Dr. Buchner explained that much of the literature defines older adults as 65 and over, but emphasized individual variability in biological age. Dr. Pescatello and Dr. Pate both questioned the use of relative vs absolute intensity, and Dr. Pate questioned the use of the term “aerobic.” Dr. Powell decided that these discussions should continue in smaller groups, and be revisited on Friday during the *Key Topics and Integration* discussion.

**SC 7 Promotion of Physical Activity.** Dr. King presented the results of the Promotion of Physical Activity Subcommittee’s first systematic literature search of systematic reviews and meta-analyses. This search addressed the following two questions:

- What types of physical activity interventions are effective for physical activity change at different levels of impact? (levels include: individual, built/neighborhood environment and policy/legislation; community settings; information technology)
  - Does the effectiveness vary by age, sex, race/ethnicity, or socioeconomic status?
- What interventions are effective for reducing sedentary behavior?

Dr. King again reported the findings for the first question based on the Social Ecological Framework (levels of impact: individual, community, environment/policy, and communication technology). Regarding Question 1, Dr. King explained that the subcommittee focused on identifying areas for which sufficient evidence exists to assign an evidence grade. She then noted that the Community and Individual level grades presented at Meeting 4 will be updated, but would mainly be focusing on the Built Environment and Policy/Legislation level interventions.

**SC 7 Question 1 Updates.** The Promotion of Physical Activity Subcommittee presented the following updated draft conclusion statements for the Community level:

#### Schools

- Multi-component interventions
  - Strong evidence that interventions that impact multiple components of schools are effective for increasing physical activity during school hours in primary school-aged and adolescent youth.  
**PAGAC Grade: Strong**
- Physical education class interventions
  - Strong evidence that interventions that revise the structure of physical education (PE) classes are effective for increasing in-class physical activity in primary school-aged and adolescent youth.  
**PAGAC Grade: Strong**

The Promotion of Physical Activity Subcommittee presented the following updated draft conclusion statements for the Individual level:

#### Older adults

- Strong evidence that physical activity interventions that target older adults have a small, positive effect on physical activity when compared with minimal or no-treatment controls, particularly over time periods of 6-12 months. **PAGAC Grade: Strong**
- Theory-based behavioral interventions
  - Strong evidence that theory-based interventions and behavior change techniques are effective for increasing physical activity levels in general adult populations compared with interventions that are not theory-based. **PAGAC Grade: Strong**

Dr. King noted that for the Question 1 subquestion, there is insufficient evidence to assign a grade for effect modification by age, sex, race/ethnicity, or socioeconomic status for all levels. **PAGAC Grade: Grade not assignable**

The Subcommittee defined the Built Environment and Policy level interventions similar to that in the Community Guide from CDC. Environmental and policy level interventions broadly include those features of a locale that relate directly to the built environment (e.g., access to parks, trails, recreational facilities; pedestrian or bicycling infrastructure), or laws, local ordinances, organizational policies, and institutional practices that can impact physical activity levels. Evidence for this level comes largely from observational studies. The Promotion of Physical Activity subcommittee relied on 13 systematic reviews and meta-analyses to answer the Built Environment and Policy level question.

**SC 7 Question 1.** The Promotion of Physical Activity Subcommittee presented the following draft conclusion statements for the Built Environment and Policy level:

- Point of Decision prompts
  - Strong evidence that interventions that target point of decision prompts to use stairs vs. escalators or elevators are effective in increasing short term stair use among adults. **PAGAC Grade: Strong**

- Access
  - Moderate evidence that having access to indoor and/or outdoor recreation facilities or outlets, including parks, trails, and natural or green spaces, is positively associated with physical activity among adults and children. **PAGAC Grade: Moderate**
- Supports: Walking and cycling for transport
  - Moderate evidence that built environment characteristics and infrastructure that support active transport to destinations (e.g., safe routes to school programs, street connectivity, a mix of connected residential, commercial, and public land uses) are positively associated with walking and cycling for transport among children, adults, and older adults. **PAGAC Grade: Moderate**
- Supports: Recreational physical activity
  - Moderate evidence that community design and characteristics that support PA, such as having safe and readily usable walking and biking infrastructure and other favorable built environment elements are positively associated with recreational forms of physical activity among children and adults. **PAGAC Grade: Moderate**

**SC 7 Question 1 Discussion.** Dr. DiPietro mentioned that many of the interventions are active and include some element of behavior change. She asked if the subcommittee considered any passive interventions (i.e., elevators/escalators being turned off). Dr. King responded saying passive environmental interventions do show a lot of promise for improving physical activity through “mindless” individual decisions. She emphasized that we cannot always change the environment, but it is important to implement changes that make it easier for people to be active. Dr. Kraus mentioned that literature for this area is often located in places we don’t look and consequently often don’t deal with data in the same ways. He inquired about what they mean by the word “contextual” here. Dr. King clarified that it pertains to our surroundings; the context of where we live - whether there are crosswalks, sidewalks, street lamps, etc. Dr. Kraus then asked about the methodology and relationship to the large variation of effect sizes seen in the evidence. Dr. King responded saying that the systematic reviews present quantifiable information, but do not have the color commentary of what’s driving the variability. Dr. Whitt-Glover added that the subcommittee couldn’t determine how the results may differ by demographic groups, especially when it comes to safety. She noted that the variability of interventions by context is important to consider. Dr. Pate noted the lack of systematic reviews on policy interventions, but suggested that there were original research articles on this topic. Dr. King agreed with Dr. Pate’s point, but responded that subcommittee decided at the beginning to review systematic reviews, meta-analyses, and pooled analysis only.

**SC 7 Question 2.** The Promotion of Physical Activity Subcommittee relied on 17 systematic reviews, meta-analyses, and pooled analyses to answer Question 2 (8 for youth, 5 for adults, and 4 for worksite settings).

- What interventions are effective for reducing sedentary behavior?

The subcommittee presented the following draft conclusion statements for Question 2:

- Youth
  - Moderate evidence that interventions targeting youth (ages 3-15 yrs.), primarily through reductions in TV viewing and other screen-time behaviors in community & school settings, have small but consistent effects on reducing sedentary behavior. **PAGAC Grade: Moderate**
- Adults
  - Limited evidence that sedentary behavior interventions targeting decreases in overall sedentary time in general adult populations are effective. **PAGAC Grade: Limited**
- Worksites

- Moderate evidence that interventions targeting sedentary behavior in worksites—particularly among office workers who perform their job duties primarily while seated—have moderate to large short-term effects in reducing sedentary behavior. **PAGAC Grade: Moderate**

**SC 7 Question 2 Discussion.** Dr. Kraus inquired about the methodology behind the interventions and how they increased physical activity and/or decreased sedentary time. Dr. King noted the variability in studies. She explained that some interventions merely provided suggestions, while others took a more prescriptive approach. Dr. Kraus noted that workplace interventions are either individual or environmental, and he asked about workplace interventions encouraging employees to stand more. Dr. King replied that education and motivational support were individual interventions. Policy level (workstations) are the environmental interventions which seem to work well. Dr. Pate observed that the conclusions fall into two categories: intervention-specific or category-based, such as older persons or worksite. He asked about which kinds of interventions are effective for each category and how they should be described. Dr. King noted that was why the subcommittee split the findings into groups. She noted that for schools, much of the evidence was about screen time. For worksites, the evidence is mostly centered on desk-type and walkability. The evidence is more mixed for adults. She agreed with Dr. Pate about the need for specificity and that the subcommittee will make the distinction regarding the intervention type in the report. Dr. Buchner suggested a technical correction for the worksite conclusion statement, changing the language to “reducing occupational sedentary behavior.” Dr. King agreed and said that the subcommittee will edit the conclusion statement accordingly. Dr. Marquez also pointed out the timely nature of this topic, and that two-rigorous randomized controlled trials were recently published and the evidence base is growing.

### **Break**

**SC 2 Brain Health.** Dr. Erickson presented the results for the Brain Health Subcommittee’s first systematic literature search of systematic reviews and meta-analyses. Although Question 1 was presented in Meeting 4, the subcommittee had not presented an overall conclusion statement. Dr. Erickson presented the following:

- What is the relationship between physical activity and cognition?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Does the relationship exist across the lifespan?
  - Does the relationship vary for individuals with normal to impaired cognitive function (i.e., dementia)?
  - What is the relationship between physical activity and biomarkers of brain health?

The Brain Health Subcommittee presented the following draft conclusion statement for Question 1:

- Moderate evidence indicates a consistent association between greater amounts of physical activity and cognition across the lifespan and in populations with impaired cognitive function. **PAGAC Grade: Moderate**

Modifications were made to the draft conclusions for some subquestions.

- Does the relationship exist across the lifespan?
  - Young adults (just long-term)
    - Insufficient evidence is available to determine if long-term physical activity improves cognitive function. **PAGAC Grade: Grade Not Assignable**
  - Acute (across the lifespan)
    - Strong evidence demonstrates that acute bouts of moderate-intensity exercise transiently improves cognition (i.e., executive function). **PAGAC Grade: Strong**
- Does the relationship vary for individuals with normal to impaired cognitive function (i.e., dementia)?

- Strong evidence demonstrates that greater amounts of physical activity is associated with a reduced risk of developing dementia. **PAGAC Grade: Strong**
- Moderate evidence indicates that physical activity improves cognitive function in individuals with dementia. **PAGAC Grade: Moderate**
- Moderate evidence indicates that physical activity improves cognitive function in individuals with conditions that affect cognitive function (e.g., ADHD). **PAGAC Grade: Moderate**

**SC 2 Question 1 Discussion.** Dr. Jakicic mentioned that most of the compiled evidence is from structured exercise studies (not physical activity per se). Dr. Erickson agreed and noted the subcommittee would discuss how to edit the conclusion statement. Dr. Hillman noted that there are some large prospective studies that examine physical activity and cognitive decline in the elderly, but these studies weren't captured in the literature review because the search only included systematic reviews. Dr. Pescatello mentioned the variability in FITT (frequency, intensity, time, type) of the exercise interventions and the authors' lack of disclosure of this information which strongly contributes to the inability to identify a dose-response relationship. Given the highly variable effect sizes, Dr. Katzmarzyk inquired about the conclusion regarding acute effects of physical activity on cognitive function. Dr. Hillman responded, saying that the association of physical activities effect on cognitive function is well understood, and that the question should be around activity type, duration, frequency, intensity, and the duration/timing of effects on cognition. Dr. Pate asked about the importance of examining the acute effects of physical activity on cognitive function, as no other subcommittee made this distinction. Dr. Erickson responded that people are looking for how they can perform better cognitively and that acute bouts of exercise do that. Dr. King asked about the intensity in which people are exercising to receive these acute effects. Dr. Erickson replied that peak is generally at moderate intensity. Dr. Hillman agreed, and mentioned that there is an agreement that moderate-intensity is ideal for testing cognitive benefits. Dr. Pescatello asked about transient effects of physical activity and what details will be in the report. Dr. Erickson replied that the effects are much less than 24 hours, and are closer to 10-20 minutes post-exercise. However, he noted that the length of the time cognitive effects occur after physical activity is still being debated.

**SC 2 Question 2.** Dr. Marquez reviewed the analytical framework and search strategy before presenting the following:

- What is the relationship between physical activity and quality-of-life?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?

The Brain Health Subcommittee presented the following draft conclusion statements for Question 2:

- Strong evidence demonstrates that physical activity improves quality of life in adults and older adults. **PAGAC Grade: Strong**

The following draft conclusions were presented for subquestions

- Dose-response. Insufficient data available. **PAGAC Grade: Grade not assignable**
- Demographics. Insufficient data available. **PAGAC Grade: Grade not assignable**

**SC 2 Question 2 Discussion.** Dr. King was surprised by the lack of evidence on the relationship between physical activity and quality of life. She asked if the term "well-being" was included in the search strategy. When Dr. Erickson indicated that it was not included, Dr. King voiced concern as much of the early literature used the term "well-being" instead of quality of life. Dr. Marquez indicated that they removed "well-being" because it is conceptualized very broadly in the literature and the group decided to focus in on "quality of life" and "health-related quality of life" instead. Dr. King suggested that the subcommittee be very explicit and concrete in the Committee's report about the decision to omit "well-being," as the subcommittee is omitting a large portion of relevant literature. Given Dr. King's comments, Dr. Janz inquired about the research recommendation that calls

for more global quality of life research. Dr. Marquez replied that in reference to the research question asked, more global quality of life studies are needed. Dr. Macko mentioned that the subcommittee restricted themselves to the Short Form-36 as a measure of quality of life, but acknowledged the gaps with such an approach. Dr. King suggested the Committee continuously remind the reader of the definition of quality of life used by the subcommittee throughout the report, where appropriate. Dr. Buchner argued that short term studies won't capture change in quality of life. Dr. Pescatello pointed out that the older adults group (all > 50 years) and adults group (18-65 years) overlap. She suggested changing the conclusion statement to "adults of all ages," and Dr. Marquez agreed.

**SC 2 Question 3.** Dr. Erickson reported the results for subcommittee's third question which addressed the relationship between physical activity and affect, anxiety, and depression. The Brain Health Subcommittee relied on 54 systematic reviews, meta-analyses, and pooled analyses for answering this question

- What is the relationship between physical activity and (1) affect, (2) anxiety, and (3) depressed mood and depression?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Does the relationship exist across a continuum of mood and affective disorders (i.e., depression)?
  - What is the relationship between physical activity and brain structure and function?

The Brain Health Subcommittee presented the following draft conclusion statements for Question 3:

#### Affect

- Strong evidence demonstrates that increasing intensity of physical activity reduces pleasure during exercise. **PAGAC Grade: Strong**

#### Anxiety

- For the general population, strong evidence demonstrates reduced state anxiety following acute bouts of exercise, and reduced trait anxiety following weeks/months of regular exercise. Exercise (both acute and chronic) alleviates anxiety symptoms in individuals with anxiety disorders and/or clinical symptoms of anxiety. **PAGAC Grade: Strong**

#### Depression and Depressed Mood

- Strong evidence demonstrates that greater amounts of physical activity reduces the risk for depression. Engaging in physical activity is an effective treatment for depression across the lifespan and is as effective as other available treatment methods. **PAGAC Grade: Strong**

The following draft conclusions were presented for subquestions:

- Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Strong evidence demonstrates an acute dose-response of activity intensity such that more intense activities increase displeasure during (but not after) activity. **PAGAC Grade: Strong**
  - Limited evidence suggests a dose response effect of intensity on anxiety symptoms. **PAGAC Grade: Limited**
  - Moderate evidence indicates a dose-response effect of activity on depression/depressive symptoms. **PAGAC Grade: Moderate**
- Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Moderate evidence indicates that effects of physical activity on anxiety and depression is greater for females than males. **PAGAC Grade: Moderate**
  - Insufficient evidence to determine whether age, race, SES, or weight status modify the relationship. **PAGAC Grade: Grade not assignable**

- Does the relationship exist across a continuum of mood and affective disorders (i.e., depression)?
  - Strong evidence demonstrates that physical activity reduces anxiety and depression in individuals with major depression and anxiety disorders. **PAGAC Grade: Strong**
- What is the relationship between physical activity and brain structure and function?
  - Insufficient amount of evidence available. **PAGAC Grade: Grade not assignable**

**SC 2 Question 3 Discussion.** Dr. Kraus asked how the anaerobic threshold was determined for the studies examining physical activity and affect. He mentioned that with ventilatory threshold, often the subject may be attached to a metabolic cart, and that alone could account for decreased affect. Dr. Erickson acknowledged Dr. Kraus's point. He stated that most of the studies used lactate threshold. Dr. Pate pointed out that affect and anxiety are important considerations, as a physical activity program can greatly affect these factors. He then asked if Dr. Erickson could comment on different physical activity modalities and their association with anxiety. Dr. Erickson replied that most studies used only treadmill based activities, and thus, he could not comment on varying relationship with different modalities. Dr. Pate was discouraged by the conclusions on affect as it appears that high intensity exercise has a negative effect. He inquired about activities below the lactate threshold. Dr. Erickson replied that below the lactate threshold is "slightly less pleasant" than self-selected exercise. Dr. Jakicic noted that the affect of participants who are attempting a type of physical activity for the first time, is not good and their anxiety is high; he suggested a research recommendation to address how these factors change over time. Dr. Erickson pointed out that the research recommendations indeed include a time course component. Dr. King pointed out that the effects on affect were mainly acute (during the bout). She inquired about the chronic effects on overall mood, as chronic physical activity participation can positively influence long-term affect. Dr. Erickson mentioned that most of that evidence is in depression/depressive mood and anxiety, not specifically in affect which is mostly observed in an acute fashion in these studies. Dr. King suggesting incorporating that information into the write-up. She also suggested a research recommendation on the impact of sedentary behaviors and sedentary time on risk for depression. Dr. Campbell noticed a couple instances where reviews of reviews and meta-analyses of meta-analyses were included. He asked for clarification on how the subcommittee handled those types of articles and if there was duplication of information. Dr. Erickson said that the subcommittee reviewed these articles to see how the analysis was performed and if the overall effect sizes were consistent across the many meta-analyses used. For the subquestion about the continuum of mood and affective disorders, Dr. Powell pointed out that in general, physical activity operates across the range of mood and affective disorders, but the conclusion statement doesn't quite align with the question. Dr. Erickson agreed and said the conclusion statement will be changed accordingly. Dr. Pescatello asked if the subcommittee should be stating the direction of the dose-response, and Dr. Erickson agreed that it's probably not appropriate here. Dr. Kraus then asked Dr. Powell how meta-analyses of meta-analyses are performed. Dr. Powell was unsure, but said that the subcommittee checked to see if the meta-analyses included in the meta-meta-analyses were captured by their literature search and indeed they were.

**SC 2 Question 4.** Dr. Macko reported on the results of the subcommittee's fourth question, which addressed the relationship between physical activity and sleep. The Brain Health subcommittee relied on 15 systematic reviews, meta-analyses, and pooled analyses for answering this question. He presented the following:

- What is the relationship between physical activity and sleep?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Does the relationship exist for individuals with impaired sleep behaviors or disorders? If yes, for which sleep disorders?

The Brain Health Subcommittee presented the following draft conclusion statement for Question 4:

- Strong evidence demonstrates both acute bouts of physical activity and regular physical activity improves sleep outcomes. **PAGAC Grade: Strong**

The following draft conclusions were presented for subquestions.

- Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Moderate evidence indicates more minutes of acute physical activity bouts and regular physical activity improves sleep outcomes. Positive effects independent of intensity and modality. **PAGAC Grade: Moderate**
- Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Moderate evidence indicates that the effects of physical activity on sleep outcomes are preserved across aging and gender, with the exception of sleep onset latency that declines. **PAGAC Grade: Moderate**
  - Insufficient evidence to examine relationships in adolescents, children, and according to race/ethnicity, socioeconomic, or weight status. **PAGAC Grade: Grade not assignable**
- Does the relationship exist for individuals with impaired sleep behaviors or disorders? If yes, for which sleep disorders?
  - Moderate evidence indicates that MVPA improves sleep in individuals that report sleep problems, primarily insomnia, and for obstructive sleep apnea. **PAGAC Grade: Moderate**

**SC 2 Question 4 Discussion.** Dr. Janz recalled Dr. Macko stating that all parameters were significant for the acute and chronic physical activity effects on sleep, however the slide shows the contrary for sleep latency. Dr. Macko believed this was a typo but would go back to the data and correct the mistake. Dr. Janz then mentioned that she believed that sleep latency has a U-shaped association with sleep disorders, and she wanted to know if the studies from the literature search reflected this association. Dr. Macko responded that none of systematic reviews and meta-analyses examined sleep latency and the association with sleep disorders within the general population. Dr. Pescatello asked if the studies teased out  $VO_2$  or level of cardiorespiratory fitness in the relationship with regular physical activity and slow wave sleep. Dr. Macko responded that the studies did not differentiate by  $VO_{2max}$ , they simply looked at the amount of physical activity performed. Dr. King mentioned that people tend to lose slow wave sleep as age increases. Therefore, she suggested that these conclusions may not fully apply to an older population. Dr. King also stated that most of the early research in physical activity and sleep studied healthy and normal weight adults. She asked if there was any sub-analysis looking at people that had legitimate sleep complaints/problems. Dr. Macko said that the Kredlow article found that the effect of physical activity on sleep did not differ by healthy individuals and individuals with generalized sleep problems at baseline. Dr. King suggested commenting on the continuum of individuals with sleep problems from healthy to those clinically diagnosed. Dr. Campbell asked if the robustness of the improvements in sleep being observed with physical activity among people that have disorders is sufficient to result in changing of therapy, machines, etc. Dr. Macko responded saying that there is limited awareness by clinicians that physical activity can reduce the apnea hypopnea index, independent of weight change. Dr. Macko further stated that if a person has sleep apnea and they can safely exercise, it could very well change their sleep apnea indices and therefore the severity of disorder. Dr. Pate inquired about the evidence supporting the notion that individuals with sleep disorders should not exercise in the evening. Dr. Macko replied that exercise performed within 3 hours of bed time has beneficial effects on slow wave sleep and sleep onset latency, but the subcommittee did not fully investigate the relationship between timing of exercise and sleep. Dr. Pescatello recommended a clarification of the conclusion statement regarding aging, gender, and change in sleep onset latency.

### ***Wrap-Up and Close***

**Dr. Powell** thanked everyone for a great morning and closed Day 3.

**Day 4 Summary**

**Friday, October 20, 2017**

8:00am

**Day 4 Summary**

**Dr. Powell, Co-Chair of the Committee**, welcomed everyone and outlined the agenda for the final day of public meetings. He explained that the Exposure and Individuals with Chronic Conditions Subcommittees were going to re-present certain conclusion statements and evidence grades, with subsequent discussion to follow. Then the Committee would address larger topics pertaining to the implications and integration of the health findings relevant to physical activity behaviors.

**SC 5 Question 4.** Dr. Kraus presented the following:

- What is the relationship between step count per day and (1) mortality (i.e., all-cause or cause-specific) and (2) disease incidence (e.g., coronary heart disease, type 2 diabetes)?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, or socioeconomic status?

The Exposure Subcommittee agreed with the overall Committee to modify the strength of the evidence (originally presented as moderate) and presented the following updated draft conclusions:

- Limited evidence suggests that step count per day is associated with incidence of cardiovascular disease and risk of type 2 diabetes. **PAGAC Grade: Limited**
  - Limited evidence suggests there is a dose-response relationship between the measure of steps per day and cardiovascular disease events and diabetes risk. **PAGAC Grade: Limited**
  - Insufficient evidence is available to determine whether the relationship between the measure of steps per day and cardiovascular disease events and diabetes risk is influenced by age, sex, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Grade Not Assignable**

\*The draft conclusion and evidence grades for all-cause mortality did not change\*

**SC 5 Question 4 Discussion:** No discussion followed this presentation

**SC 5 Question 5:** Dr. Jakicic, from the Exposure Subcommittee, presented the following:

- What is the relationship between bout duration of physical activity and health outcomes?

The Exposure Subcommittee electing to keep the grade of moderate, but change the wording of the conclusion statement. The following updated draft conclusion was presented:

- Moderate evidence indicates that bouts of any length of MVPA contribute to the health benefits associated with accumulated volume of physical activity. **PAGAC Grade: Moderate**

**SC 5 Question 5 Discussion:** Brief discussion surrounding the wording of the conclusion statement followed, and Dr. Pate and the rest of the Committee agreed with the update.

**SC 6 Individuals with Chronic Conditions** Dr. Buchner and the Individuals with Chronic Conditions Subcommittee shared the updated draft conclusion statements for parts of Question 1. All final conclusion statements for prostate cancer, and colorectal all-cause mortality questions are shown below:

- Among cancer survivors, what is the relationship between physical activity and (1) all-cause mortality, (2) cancer-specific mortality, or (3) risk of cancer recurrence or second primary cancer?
  - Is there a dose-response relationship? If yes, what is the shape of the relationship?
  - Does the relationship vary by age, sex, race/ethnicity, socioeconomic status, or weight status?
  - Does the relationship vary based on: frequency, duration, intensity, type (mode), or how physical activity is measured?

### Prostate Cancer

#### All-cause mortality

- Overall: limited evidence indicates an inverse association between “highest” vs. “lowest” levels of physical activity after diagnosis and all-cause mortality among prostate cancer survivors. **PAGAC Grade: Limited**
  - Dose: grade not presented previously. **PAGAC Grade: Limited**
  - Demographics: No evidence is available on the association between physical activity and prostate cancer survival or recurrence by age, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Grade not assignable**
  - Mode: Limited evidence suggests that increased frequency, duration, and intensity may be associated with decreased risks for overall mortality and prostate cancer specific mortality. **PAGAC Grade: Limited**

#### Cancer-specific mortality

- Overall: moderate evidence indicates an inverse association between “highest” vs. “lowest” levels of physical activity after diagnosis and prostate cancer-specific mortality among prostate cancer survivors. **PAGAC Grade: Moderate**
  - Dose: grade not presented previously. **PAGAC Grade: Limited**
  - Demographics: No evidence is available on the association between physical activity and prostate cancer survival or recurrence by age, race/ethnicity, socioeconomic status, or weight status. **PAGAC Grade: Grade not assignable**
    - Mode: Limited evidence suggests that increased frequency, duration, and intensity may be associated with decreased risks for overall mortality and prostate cancer specific mortality. **PAGAC Grade: Limited**

#### Risk of Recurrence/Second Primary Cancer

- Overall: changed from Limited evidence of no association to insufficient evidence. **PAGAC Grade: Grade not assignable**
  - Dose: Grade not presented previously. **PAGAC Grade: Grade not assignable**
  - Demographics: Grade not presented previously. **PAGAC Grade: Grade not assignable**
  - Mode: Grade not presented previously. **PAGAC Grade: Grade not assignable**

### Colorectal Cancer

#### All-cause mortality

- Overall: Physical activity after diagnosis is associated with decreased all-cause and colorectal cancer specific mortality. **PAGAC Grade: Moderate**
  - Dose: Grade not presented previously. **PAGAC Grade: Moderate**
  - Demographics: Grade not presented previously.
    - Age, gender. **PAGAC Grade: Moderate**

- Socioeconomic status, race, and weight. **PAGAC Grade: Grade not assignable**
- Mode: Grade not presented previously. **PAGAC Grade: Grade not assignable**

**SC 6 Question 1 Discussion:** No discussion followed.

**Key Topics/Integration Chapter of the Report.** Dr. Powell provided a summary of the Committee's assignment and emphasized the importance of harmonizing the wide range health benefits associated with different types and amounts of physical activity across the different subcommittees. The Committee discussed the following topics:

### **Adults**

Dr. Powell suggested that the 2008 Guidelines properly described the dose of physical activity associated with substantial health benefits. He noted that engaging in any amount of activity provides some health benefits, and that partaking in a volume of physical activity greater than the Guidelines produces more benefit. Moreover, he commented on the possibility of including a step count as part of the Guidelines. Dr. Pate agreed with the value of having a step count metric as part of the Guidelines, and believed that the existing literature can be used to illustrate an association between steps/day and minutes of MVPA. Furthermore, given the information put forth by the Exposure Subcommittee, Dr. Powell addressed the elimination of the 10-minute threshold criterion for bouts. Dr. Kraus discussed how the current Guidelines do not appropriately address the accumulation of physical activity. He emphasized the need to explicitly state how any dose of physical activity contributes to one's daily accumulated amount of total activity. Dr. Powell transitioned to the association of sedentary behavior and negative health outcomes. He emphasized how types and amounts of physical activity can counter the deleterious effects of sedentary behavior and the need to encourage individuals to meet their health goals.

### **Youth**

Dr. Powell noted the large body of evidence that continues to support the 2008 youth guideline; it was decided that the overall recommendations for children would remain the same. However, given the strong evidence put forth on the importance of physical activity in children of younger ages, Dr. Powell suggested specifically addressing the types of behaviors appropriate for this demographic. Dr. King emphasized the importance and lack of research on the transitional periods across the life course and the appropriate dose of physical activity needed to produce positive health outcomes at different ages. Dr. Campbell and Dr. Pate expressed the need for clarity on the age ranges. Dr. Kraus noted that the Guidelines highlight substantially different doses of physical activity for individuals who may have no biological difference (17-year-old vs. 18-year-old). While Dr. Pate agreed, he emphasized how the report was based on the available evidence. Dr. Janz emphasized the need to explicitly address intensity, especially in the youngest demographic, to illustrate the lack of heterogeneity in Guidelines for kids of different ages. Dr. Powell concluded the conversation by highlighting the lack of evidence on physical activity and life course transitions, suggesting the next Committee may have the necessary research to better address this topic.

### **Older Adults**

Dr. Powell suggested bringing forward the 2008 Guidelines for older adults, with an emphasis on the benefits of multimodal training. Dr. Buchner summarized the findings of strength training in older adults and suggested keeping the previous recommendation. Dr. King inquired about broadening the 2008 Guidelines to include balance training for all older adults. Dr. Buchner and Dr. Kraus noted that all forms of physical activity contribute to balance, but there is an inability to quantify their contributions. Dr. Macko noted that persons with certain chronic conditions may not have an improvement in balance from all physical activities. He discussed the importance of multimodal training on outcomes such as gait velocity and endurance, two variables highly associated inversely with mortality. Lastly, Dr. Macko referenced Dr. Campbell's presentation in which many of the studies used clinical cutoffs for categorizing individuals at elevated risk for falls. Dr. Campbell agreed and emphasized the notion that individuals engage in multimodal physical activities throughout the life course as a

primary way to meet the Guidelines. Dr. DiPietro noted that the Aging Subcommittee had drafted conclusions and research recommendations which explicitly support multimodal training. Dr. King and Dr. Kraus agreed that more research was needed to address life course progression. Dr. Pate suggested incorporating the life course transition and associated questions into the integration chapter. Dr. Jakicic referenced previous discussion on non-traditional exercises and research recommendations on the mechanism by which they contribute to positive health outcomes. Dr. Katzmarzyk read aloud from the 2008 Guidelines and suggested replacing the word “exercises” with “[physical] activities.” Dr. Powell concluded the discussion citing the importance and challenge of using the correct language to convey the Committee’s findings and recommendations.

### **Special populations**

**Pregnancy** – Dr. Powell emphasized the benefits of physical activity for pregnant women and the evidence presented which reinforces and expands the findings from 2008. Moreover, he encouraged the need for the positive benefits to be reinforced in the doctor’s office.

**Special Populations** – Dr. Powell encouraged individuals to strive for the adult guideline and further emphasized the need for muscle-strengthening activities.

### **Safety**

Dr. Powell noted the lack of new information on this topic and suggested bringing forward the information in the 2008 Guidelines.

### **Other comments**

Dr. Katzmarzyk noted how the 2008 Guidelines do not accurately convey the physical activity continuum and the accumulation of health benefits from all doses of physical activity. Moreover, he emphasized that individuals who are highly sedentary may not receive substantial health benefits at 150 minutes/week of moderate physical activity as the 2008 Guidelines suggest. Dr. DiPietro and Dr. Pate agreed. Dr. Pate further encouraged the Guidelines to explicitly reflect relative intensity. Dr. Buchner agreed and briefly discussed the use of the overload principle to illustrate the importance of relative intensity. Additionally, he referenced how exercise trials for older adults only use relative intensity, whereas interventions for other age groups largely use absolutely intensity. He encouraged an emphasis in the 2018 Guidelines on the importance of relative intensity for all demographics. Dr. Jakicic agreed and cautioned the use of categorizing activities as a certain intensity or MET level. Moreover, he highlighted the importance of accumulating health benefits, even at volumes below the 150 minute/week guideline. Dr. Pate agreed and reemphasized the accumulation of health benefits at relative intensities.

Dr. Hillman inquired about the need for an upper range limit. Dr. Marquez suggested that the importance of the top number is to keep people away from a minimum volume and further highlight how more activity results in more health benefits. Dr. Kraus cited literature on all-cause and cardiovascular disease mortality that showed that 70% of the general population receive substantial benefits at 150 minutes/week of moderate intensity and that 70% of the remaining 30% of the population likely get benefits at 300 minutes/week. Moreover, he noted the small, incremental increases beyond that 300 minutes/week. Dr. Campbell inquired about where in that range the negative effects of sedentary behavior begin to be ameliorated. Dr. Kraus illustrated that when one gets to approximately 15 MET hours/week of activity, the strong effects of sedentary time on all-cause mortality begins to be abrogated, regardless of the amount of sedentary time. He noted that most individuals sit 8 hours or more each day, and suggested that about 70% of the general population receive a substantial reduction in the effects of sitting when participating in approximately 15 MET hours/week of physical activity, which is one and a half times the current Guidelines.

Dr. Marquez inquired about the use of METs , and the earlier conversation regarding absolute vs. relative intensity. Dr. Kraus suggested it provides a sense of volume and requested an overarching research recommendation on the contributions of light activity to health outcomes. Dr. Powell suggested there is evidence that light intensity has value for some people. Dr. DiPietro agreed, and emphasized the significance of isothermal modeling papers on illustrating the risk reduction of mortality associated with replacing sedentary behavior with light intensity activities. Dr. Pate agreed with an earlier point presented by Dr. Jakicic on the importance of explicitly expressing the “some is good, more is better” concept. Dr. Janz noted the importance of METs as a metric, especially for scientists and the research community. She commented on the challenges associated with individualizing intensities in exercise trials. Dr. King agreed with Dr. Pate’s previous comment regarding relative intensity and rate of perceived exertion. She emphasized the need to accurately convey its importance in the report.

### ***Break***

Dr. Powell inquired about the use of the term “aerobic” in the report. He noted how the term has been used in a variety of ways with different definitions. He asked for the Committee’s thoughts on the use of the term, and how to best define it. Dr. Pate noted that subcommittees often used the term “aerobic” and/or MVPA in many of their conclusion statements. He argued the need to be consistent throughout the report and suggested that MVPA is more specific and clear. Dr. Janz agreed and noted that most of the evidence is reflective of MVPA instead of aerobic physical activity. Dr. Campbell emphasized the need to frame the conclusions relative to the terminology used in their respective evidence portfolios. Dr. Jakicic agreed and suggested how the Committee’s report provides the opportunity to influence the way individuals think about this field. He emphasized Dr. Campbell’s point and the importance of using terms correctly. Dr. Pate defined aerobic physical activity as activity that is supported by aerobic metabolism, which includes light and sedentary activities. He explained the term MVPA does not include such intensities. Dr. Katzmarzyk suggested that the term aerobic does not accurately define intensity, whereas MVPA explicitly states it. Dr. King explained the need to frame these types of activities into the broader scheme. Dr. Powell suggested that Dr. Campbell’s comment was appropriate when the authors correctly described the activity. He noted that the systematic reviews and meta-analyses described activities in varying ways. Dr. Campbell responded that, when addressing the reviews or primary research, specificity of wording is very important. He emphasized the importance of using the original language, but the need to accurately define and harmonize the terminology used throughout the report. Dr. Powell asked when the Committee felt it appropriate to use the term aerobic. Dr. DiPietro referenced aging and the multicomponent programs that include aerobic, strength, and balance training. She explained how strengthening activities play an important role in diseases such as osteoporosis but that would not come across with the term MVPA. Dr. Pate cautioned the purging of terms, but the need to define the terms and use them consistently. Dr. Jakicic emphasized how the Committee may be able to help mold the field by eliminating the notion that one type of activity is best. He expressed hope that the Committee’s report will highlight how all modalities are important. Furthermore, Dr. Whitt-Glover mentioned the semantic issues with the term “exercise training.”

The next topic of discussion was on the inclusion of specific figures that one or more Committee members had developed. The first figure, “Dose-response associations between sedentary behavior and all-cause mortality”, illustrated the results of 16 meta-analyses. The trend shows an increasing relative hazard ratio for all-cause mortality with increasing sedentary behavior. Dr. Powell asked the Committee for their thoughts on the figure. Dr. DiPietro asked Dr. Katzmarzyk if the Sedentary Behavior Subcommittee could comment on TV viewing. Dr. Katzmarzyk responded saying the Youth Subcommittee could comment more thoroughly on TV viewing, as the Sedentary Behavior Subcommittee did not include TV viewing in its search (because of the surrounding covariates). He did suggest that the risk ratios are very similar between the two exposures. Dr. Kraus emphasized the need to explicitly address, in the integration chapter, how individuals can replace sedentary

behaviors with different activities. Dr. Powell suggested addressing ranges of activities with the associated MVPA dose.

The next figure, “Accruing Health Benefits by Dose of Moderate-to-Vigorous Physical Activity,” illustrated the health benefits associated with different volumes of weekly MVPA. Dr. Jakicic suggested that the figure illustrates the concept of the physical activity continuum, and the idea of accumulating health benefits at different doses of activity. Dr. Jakicic then presented another figure, which highlighted the relationship between sedentary behavior and weekly MVPA. This figure illustrated the need to off-set large quantities of sedentary behavior with high volumes of physical activity. Dr. Kraus shared his desire to transform this graph into a 3-D model, with the inclusion of light intensity on the z-axis. Dr. Katzmarzyk responded that adding contributions from light intensity into the figure would hinder the evidence base, as the figure is based on findings from the Ekelund study. He suggested that light activity is implied by shifting down the y-axis and staying consistent on the x-axis. Dr. King emphasized the importance of the scientific evidence that supports the figure. Dr. Powell inquired about possible changes to the colors. Dr. Kraus pointed out that the evidence is in MET-hours, not in minutes of MVPA. He suggested converting the units. Dr. Erickson suggested that the x-axis could be in minutes /week while the y-axis could be in hours/day. Dr. Campbell mentioned that for public consumption, there needs to be numbers and not just conceptual figures. He suggested two versions; one that is more scientifically rigorous and one that is conceptually based. He also mentioned keeping in mind a colorblind audience. Dr. Jakicic noted that most of the audience may not have an exercise physiology background so suggested keeping the model(s) conceptual. Dr. Powell noted concern with the “Accruing Health Benefits...” figure suggesting that it does not properly illustrate how benefits can be accrued without reaching a specific dose threshold. He suggested the inclusion of a percent or relative risk reduction. Dr. Jakicic emphasized that the figure was conceptual and attempts to highlight when benefits come online. Dr. King stated the need to develop an overview figure that could go into the integration or introduction chapter. Additional figures could be tailored for specific health outcomes relevant to the subcommittees. Dr. Powell mentioned important acute health outcomes (i.e., reduced depression, improved sleep, etc.) that present immediately and suggested the incorporation of these into the figure(s). Dr. Jakicic agreed. Dr. Campbell expressed concern over standardizing the quantification of certain outcomes, as studies maybe based on quintiles, quartiles, etc. that may not allow for harmonization. Similarly, Dr. Erickson acknowledged the appeal of the figure but noted concern over including hazard ratios and association measures because of the heterogeneity of studies. Dr. Jakicic briefly addressed the dichotomy of making the figures mathematically correct vs. conceptual. Dr. King thanked Dr. Jakicic for creating these figures. Dr. Jakicic then led the Committee in a standing ovation, thanking Dr. King and Dr. Powell for their leadership on the 2018 Physical Activity Guidelines Advisory Committee.

### ***Wrap-Up Discussion and Next Steps***

**Dr. Olson** introduced the Acting Assistant Secretary for Health, Dr. Don Wright, who spoke on the importance of the Guidelines and thanked the Committee members for all of their hard work over the past two years.

**Dr. Olson** adjourned the meeting.

***Meeting Adjourned***

2:00 PM