

Physical Activity Guidelines Advisory Committee Meeting 4

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

July 19-21, 2017

Meeting held at the National Institutes of Health, Building 35
Bethesda, Maryland

Meeting Attendees

Physical Activity Guidelines Advisory Committee: Abby King, PhD (Co-Chair); Ken 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 (joined via conference call); Russell Pate, PhD; Linda Pescatello, PhD; and Melicia Whitt-Glover, PhD

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

Federal Staff: Alison Vaux-Bjerke, MPH and Stephanie George, PhD, MPH, MA

Meeting 4 Summary

Day 1 Summary

Wednesday, July 19, 2017

1:00 PM

Call to Order, Roll Call, and Opening Remarks

Dr. Katrina Piercy, Alternate Designated Federal Officer, Office of Disease Prevention and Health Promotion (ODPHP), U.S. Department of Health and Human Services (HHS) welcomed the Committee members as she called to order the fourth meeting of the 2018 Physical Activity Guidelines Advisory Committee. She pointed out where to access resources from this meeting, and that the videocast will be posted online with chapter bookmarks to easily find each presentation and discussion. All of the Committee members were present except for Dr. McTiernan who called in for part of the meeting. Dr. Piercy also reminded the public of the timeline for the Committee's work, submission of its Scientific Report, and the subsequent development of the second edition of the *Physical Activity Guidelines for Americans*.

Welcome and Introduction of Subcommittee Presentations

Dr. King, Co-Chair of the Committee began with a recap of the Committee's previous public meetings. Dr. King gave an overview of the Meeting 4 agenda, including presentations on subcommittees' questions, presentations on work groups (fitness, pregnancy, and youth transition), discussion of the integration chapter of the Committee's report, and discussion on carrying information forward from the *Physical Activity Guidelines Advisory Committee Report 2008*. Dr. King outlined that each subcommittee presentation will include an update on progress made since the last meeting, including draft conclusions statements and evidence grades for the questions undergoing systematic review. She closed by reminding the group that there will be one final public meeting in October and that the goal for that

meeting is to finalize questions, conclusions, and gain approval of all subcommittee work by the full Committee.

Subcommittee Presentations

Subcommittee members presented progress updates of their subcommittees' work since the previous public meeting in March, including draft conclusions and evidence grades for the questions in their systematic literature review. Following each presentation, the Committee members asked questions and discussed the work of each subcommittee.

Subcommittee Presentations

SC 3 Cancer-Primary Prevention. Dr. McTiernan presented the Cancer-Primary Prevention Subcommittee's first systematic literature search of systematic reviews, meta-analyses, and pooled analyses. She noted that the subcommittee relied on observational studies to answer the question as there has never been a clinical trial testing the effect of physical activity on cancer incidence. She also specified that this subcommittee is focused on cancer incidence in adults. Dr. McTiernan stressed that the strength of the evidence grades are based on consistency across the high number of studies included in the systematic reviews, meta-analyses, and pooled analyses, not the number of existing reviews included in the search itself. She also clarified that "insufficient evidence" does not mean the data don't exist somewhere; they just didn't exist in the meta-analyses and pooled analyses the subcommittee used to answer the question at hand. This search addressed the following question:

1. What is the relationship between physical activity and specific cancer incidence?

Dr. McTiernan reported the draft conclusion statements for 12 additional cancer sites, noting that data for breast and colon/rectal cancer incidence were covered during Meeting 3. Of note is that physical activity did not have an effect on thyroid cancer incidence. Risk reduction for most of the cancer sites was reported as a comparison between highest and lowest levels of physical activity participation, which made it difficult to determine dose-response for some cancer sites.

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

Endometrial cancer (an obesity-related cancer)

- Overall relationship: strong evidence demonstrates a reduction in risk of developing endometrial cancer with higher levels of physical activity **PAGAC Grade: Strong**
- Dose-response: moderate evidence indicates a dose-response relationship exists **PAGAC Grade: Moderate**
- No evidence is available on the association between physical activity and risk of endometrial cancer by age, race/ethnicity, high-risk individuals, or cancer subtype. **PAGAC Grade: Grade not assignable**
- Weight status: moderate evidence indicates a stronger reduction in risk in those with BMI > 25 **PAGAC Grade: Moderate**

Stomach cancer – gastric cardia (obesity-related cancer occurring near the esophagus) and non-cardia (smoking- and H. pylori infection-related cancer occurring in the body of the stomach)

- Overall relationship: strong evidence demonstrates a reduction in risk of developing stomach cancer with higher levels of physical activity **PAGAC Grade: Strong**
- Dose-response: moderate evidence indicates a dose-response relationship exists **PAGAC Grade: Moderate**
- No evidence is available on the association between physical activity and risk of stomach cancer by age, race/ethnicity, weight status, or high-risk individuals. **PAGAC Grade: Grade not assignable**
- Cancer subtype: moderate evidence indicates there is a similar reduction in risk for both gastric cardia and non-cardia incidence **PAGAC Grade: Moderate**

Esophageal cancer - adenocarcinoma (obesity-related) and squamous (smoking-related)

- Overall relationship: strong evidence demonstrates a reduction in risk of developing adenocarcinoma of the esophagus with higher levels of physical activity **PAGAC Grade: Strong**
Dose-response: insufficient evidence **PAGAC Grade: Grade not assignable**
- No evidence is available on the association between physical activity and risk of esophageal cancer by age, race/ethnicity, sex, weight status, or high-risk individuals. **PAGAC Grade: Grade not assignable**
- Cancer subtype: limited evidence suggests a difference in risk reduction by cancer subtype **PAGAC Grade: Limited**

Bladder cancer (smoking-related cancer)

- Overall relationship: strong evidence demonstrates a reduction in risk of developing bladder cancer with higher levels of physical activity **PAGAC Grade: Strong**
- Dose-response: moderate evidence indicates a dose-response relationship exists **PAGAC Grade: Moderate**
- No evidence is available on the association between physical activity and risk of bladder cancer by age, race/ethnicity, weight status, high-risk individuals, or cancer subtype. **PAGAC Grade: Grade not assignable**
- Sex: limited evidence suggests a greater reduction in risk for women than men (men are at higher risk of developing bladder cancer) **PAGAC Grade: Limited**

Lung cancer (smoking-related cancer)

- Overall relationship: moderate evidence indicates a reduction in risk of developing lung cancer with higher levels of physical activity (lower grade due to concern that greater level of smoking correlates with reduced physical activity) **PAGAC Grade: Moderate**
- Dose-response: limited evidence suggests a dose-response relationship exists **PAGAC Grade: Limited**
- Age: limited evidence suggests the effect does not vary by age **PAGAC Grade: Limited**
- No evidence is available on the association between physical activity and risk of lung cancer by race/ethnicity or cancer subtype. **PAGAC Grade: Grade not assignable**
- Sex: limited evidence suggests a greater effect in women than men **PAGAC Grade: Limited**
- Weight status: limited evidence suggests a greater effect in individuals with BMI < 25 **PAGAC Grade: Limited**
- High-risk individuals: limited evidence suggests a greater effect in current/former smokers than in non-smokers **PAGAC Grade: Limited**

Pancreatic cancer (obesity- and potentially diabetes-related cancer)

- Overall relationship: limited evidence suggests a reduction in risk of developing pancreatic cancer with higher levels of physical activity **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 pancreatic cancer by age, race/ethnicity, weight status, high-risk individuals, or cancer subtype. **PAGAC Grade: Grade not assignable**
- Sex: limited evidence suggests the effect does not vary by sex **PAGAC Grade: Limited**

Head and Neck (oral cavity, larynx, pharynx – smoking- or virus-related cancers)

- Overall relationship: limited evidence suggests a reduction in risk of developing head and neck cancer (combined) with higher levels of physical activity **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 head and neck cancer by age, race/ethnicity, weight status, high-risk individuals, or cancer subtype. **PAGAC Grade: Grade not assignable**
- Sex: limited evidence suggests the effect does not vary by sex **PAGAC Grade: Limited**

Brain cancer – glioma and meningioma reviewed

- Overall relationship: limited evidence suggests a reduction in risk of developing glioma or meningioma with higher levels of physical activity **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 brain cancer by age, race/ethnicity, sex, weight status, high-risk individuals, or cancer subtype. **PAGAC Grade: Grade not assignable**

Prostate cancer (screening-dependent)

- Overall relationship: limited evidence suggests a reduction in risk of developing prostate cancer with higher levels of physical activity **PAGAC Grade: Limited**
- Dose-response: insufficient evidence **PAGAC Grade: Grade not assignable**
- Age: limited evidence suggests a greater effect in those under age 65 **PAGAC Grade: Limited**
- Race/Ethnicity: limited evidence suggests a greater effect in blacks than whites **PAGAC Grade: Limited**
- No evidence is available on the association between physical activity and risk of prostate cancer by weight status or high-risk individuals. **PAGAC Grade: Grade not assignable**
- Cancer subtype: limited evidence suggests a greater effect in those with aggressive prostate cancer than non-aggressive prostate cancer **PAGAC Grade: Limited**
- *Note:* this is a slow-growing cancer and research shows that most men in Western countries develop prostate cancer. If screened, prostate cancer is more likely to be found, so in countries with lower screening rates, the cancers that do show up are more likely to be aggressive.

Ovarian cancer

- Overall relationship: limited evidence suggests a reduction in risk of developing ovarian cancer with higher levels of physical activity **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 ovarian cancer by age, race/ethnicity, weight status, high-risk individuals, or cancer subtype. **PAGAC Grade: Grade not assignable**

Blood cancers – leukemias, lymphomas, multiple myeloma

- Overall relationship: limited evidence suggests a reduction in risk of developing blood cancers with higher levels of physical activity **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 blood cancers by age, race/ethnicity, weight status, or high-risk individuals. **PAGAC Grade: Grade not assignable**
- Sex: limited evidence suggests the effect varies by sex in certain blood cancer subtypes **PAGAC Grade: Limited**
- Cancer subtype: limited evidence suggests the effect does not vary by blood cancer subtype **PAGAC Grade: Limited**

Thyroid cancer (screening-dependent)

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

Moving forward, the subcommittee plans to review renal cancer, which will be presented in October; ensure consistency of grading across all cancer sites; develop research recommendations; and finalize its conclusions.

Cancer Discussion. Dr. McTiernan commented that the subcommittee’s second question – What is the relationship between sedentary behavior and cancer incidence – is being covered by the Sedentary Behavior Subcommittee. The Cancer-Primary Prevention Subcommittee will support the Sedentary Behavior Subcommittee but will not present a separate write-up or conclusion statement.

During the discussion, Dr. Kraus commented that the dose-response effect reported for bladder cancer may not show a significant effect at all. Dr. McTiernan clarified that the meta-analyses reviewed do not always include p-values for trend, so the observed effect may not be significant. Dr. Powell, however, indicated that this dose-response effect appears to be a shallower version of the all-cause mortality dose-response curve. Dr. Kraus also inquired about the potential confounding of smoking and the effect reported for individuals with lower BMI. Dr. McTiernan agreed, noting that the profound effect of smoking on risk of lung cancer lowered the subcommittee’s level of confidence in the strength of the effect of physical activity on lung cancer incidence.

Dr. Campbell inquired about the quantification and comparability of the “highest” versus “lowest” physical activity levels used as the comparison groups. Dr. McTiernan clarified that, unfortunately, this is one of the limitations of doing a review of reviews, but stated that the lowest categories tended to have more overlap and were more often specified, but that the highest levels can vary greatly. The evidence for a dose-response relationship from included cohorts helped the subcommittee form conclusions for the different cancer sites where this information was available.

Dr. Pate asked if the subcommittee considered physical activity as an exposure during childhood and adolescence and cancer outcomes later in life. Dr. McTiernan explained that this information was not included in the meta-analyses reviewed, and that, frequently, lifetime physical activity behaviors are not assessed in the case-control and cohort studies in this area.

Finally, Dr. Buchner posed the question of the potential of one common subtype of a cancer to dominate the observed effects. Dr. McTiernan noted that this happens in many cases, especially when a review combines all subtypes together.

SC 6 Individuals with Chronic Conditions. Dr. Buchner presented the Individuals with Chronic Conditions Subcommittee’s overview of questions and the specific parts of the questions to be presented. The subcommittee generally relied on evidence from systematic reviews, meta-analyses, pooled analyses, and/or high-quality existing reports to answer its questions. The subcommittee presented updates on the following questions:

1. 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?
 - a. Prostate cancer was presented today
 - b. Breast and colorectal were presented in March
 - c. No other cancers with substantial evidence were identified in the search results

2. Questions 2, 3, and 4 have similar structure: In people with “specific chronic condition”, 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?
 - a. Question 2 = Osteoarthritis (with additional outcome included: (5) pain)
 - b. Question 3 = Hypertension (with additional effect modifier of resting blood pressure level added)
 - c. Question 4 = Type 2 diabetes

SC 6 Question 1. Dr. McTiernan presented the following draft conclusions findings specific to Question 1 (prostate cancer survivors):

- 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**
- 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**
- Limited evidence suggests no association between “highest” vs. “lowest” physical activity level and prostate cancer recurrence or progression. **PAGAC Grade: Limited**
- Limited evidence suggests a greater effect of physical activity on all-cause and prostate-specific mortality with higher amounts of physical activity, with larger effect on all-cause mortality. **PAGAC Grade: Limited**
- 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**

Question 1 Discussion. The Committee did not raise any questions in response to Dr. McTiernan’s presentation.

SC 6 Question 2. Dr. Kraus presented search strategies and draft key findings specific to Question 2 (osteoarthritis). No draft conclusion statements or draft evidence grades were presented for this question as the search is still underway. These will be presented in October.

Question 2 Discussion. After questions from fellow Committee members, Dr. Kraus made some clarifications:

- Comparisons made between effect sizes in studies of analgesics and pain and physical activity and pain have not been made in the same study.
- Most of these are pre-post comparisons, and it is possible that the subcommittee could look at if any interim measurements of pain were made.
- It appears that effects are durable for at least 2-6 months post-intervention.
- There is only one cohort study of osteoarthritis patients; this is a field that has not focused on physical activity in a longitudinal cohort.

SC 6 Question 3. Dr. Pescatello presented the following draft key conclusions for Question 3 (hypertension):

For the outcomes of *co-morbidities, physical function, and health-related quality of life*:

- Insufficient evidence exists to determine whether a relationship exists between physical activity and risk of co-morbid conditions among adults with hypertension. **PAGAC Grade: Grade not assignable**
- Insufficient evidence exists to determine whether a relationship exists between physical activity and physical function among adults with hypertension. **PAGAC Grade: Grade not assignable**
- Insufficient evidence exists to determine whether a relationship exists between physical activity and health-related quality of life among adults with hypertension. **PAGAC Grade: Grade not assignable**

For the outcome of progression:

- Moderate evidence indicates an inverse, dose-response relationship between physical activity and cardiovascular mortality among adults with hypertension. **PAGAC Grade: Moderate**
- Limited evidence suggests the magnitude of the blood pressure response to physical activity varies by resting blood pressure level, with the greatest blood pressure reductions occurring among adults with hypertension that have the highest resting blood pressure levels. **PAGAC Grade: Limited**
- Insufficient evidence exists to determine whether the relationship between physical activity and blood pressure varies by age, sex, race/ethnicity, socio-economic status, and weight status among adults with hypertension. **PAGAC Grade: Grade not assignable**
- Insufficient evidence exists to determine whether the relationship between blood pressure and physical activity varies by frequency, intensity, and duration of physical activity, or how physical activity is measured. **PAGAC Grade: Grade not assignable**
- Moderate evidence indicates the relationship between physical activity and blood pressure does not vary by type (mode) of physical activity among adults with hypertension. **PAGAC Grade: Moderate**

Question 3 Discussion. Dr. Pate asked about medication and hypertensive individuals, and Dr. Pescatello responded that this is often not disclosed, but that typically patients in these clinical trials are stage 1 hypertension and allowed to exercise before being put on meds.

SC 6 Question 4. Dr. Buchner presented search strategies and draft key for Question 4 (Type 2 Diabetes). No draft conclusion statements or draft evidence grades were presented for this question as the search is still underway. These will be presented in October.

Question 4 Discussion. Dr. Campbell inquired about how the subcommittee will tackle the review of 74 studies so as not to have redundancy when studies are cited often. The subcommittee plans to sort by outcome to examine this.

Moving forward, the subcommittee plans to finish the written evidence summaries for Question 1 (cancer survivors) and Question 3 (hypertension); complete the Question 2 (osteoarthritis) and Question 4 (type 2 diabetes) reviews; and plans to propose a Question 5 (topic TBD, as resources allow).

Break

SC 9 Youth. Dr. Pate presented an update of the Youth Subcommittee’s systematic literature review for the three questions being examined, with a focus on Question 1.

- 1) In children younger than six years of age, what is the relationship between physical activity and health outcomes?
 - a. What is the relationship between physical activity and adiposity/weight status?
 - b. What is the relationship between physical activity and bone health?
 - c. What is the relationship between physical activity and cardiometabolic health?
 - d. Are there dose-response relationships? If yes, what are the shapes of those relationships?
 - e. Do the relationships vary by age, sex, race/ethnicity or socio-economic status?

SC 9 Question 1. Dr. Pate reported that the subcommittee relied on a *de novo* review of original articles to answer Question 1.

The Youth Subcommittee presented the following draft conclusions for the overall question.

- Strong evidence demonstrates that higher amounts of physical activity are associated with more favorable indicators of bone health and with reduced risk for excessive increases in body weight and adiposity in children 3-6 years of age. **PAGAC Grade: Strong**

The following conclusions were presented for sub-questions.

Sub-question	Draft conclusion
a) What is the relationship between physical activity and adiposity/weight status?	Strong evidence demonstrates that higher amounts of physical activity are associated with a reduced risk of excessive increases in body weight and adiposity in children ages 3 to 6 years. PAGAC Grade: Strong
b) What is the relationship between physical activity and bone health?	Strong evidence demonstrates that higher amounts of physical activity are associated with favorable indicators of bone health in children ages 3 to 6 years. PAGAC Grade: Strong

c) What is the relationship between physical activity and cardiometabolic health?	Available evidence is insufficient to determine the effects of physical activity on cardiometabolic risk factors in children ages 3 to 6 years. PAGAC Grade: Grade not assignable
d) Are there dose-response relationships? If yes, what are the shapes of those relationships?	Available evidence is insufficient to determine the dose-response relationship between physical activity and health effects in children ages 3 to 6 years. PAGAC Grade: Grade not assignable
e) Do the relationships vary by age, sex, race/ethnicity or socio-economic status?	Available evidence is insufficient to determine if the relationships vary by age, sex, race/ethnicity or socio-economic status in children ages 3 to 6 years. PAGAC Grade: Grade not assignable

Question 1 Discussion. Dr. King observed that the findings for these young children will align well with the intervention studies in child care settings being examined by her subcommittee. She asked about the context for physical activity measurement in the included studies. Dr. Pate indicated that most of the studies assessed physical activity across the entire day, usually by accelerometry, and assessment was not limited to physical activity within a specific setting.

Dr. Kraus asked how excessive weight gain was defined in the studies. Dr. Pate indicated that most studies compared a mean or average measure of adiposity or weight between those who had low levels of physical activity and those who had high levels. In general, studies did not use a cut-off or standard value for excess weight.

Dr. Pescatello asked about the finding of insufficient evidence between physical activity and cardiometabolic outcomes. Dr. Pate indicated that this reflected a lack of studies.

SC 9 Question 2.

- 2) In children and adolescents, is physical activity related to health outcomes?
- a. What is the relationship between physical activity and cardiorespiratory and muscular fitness?
 - b. 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?
 - c. What is the relationship between physical activity and cardiometabolic health?
 - d. What is the relationship between physical activity and bone health?
 - e. Do the relationships vary based on type and/or intensity of physical activity?
 - f. Are there dose-response relationships? If so, what are the shapes of those relationships?
 - g. Do the relationships vary by age, sex, race/ethnicity or socio-economic status?

Dr. Whitt-Glover provided an update on the cardiorespiratory and muscular fitness subquestion. The group expects to grade the relationship between physical activity and cardiorespiratory fitness in youth as **strong**. Only two of the reviews addressed muscular fitness, so the group may need to go to original research to adequately address this outcome.

Dr. Pate presented the update on the weight status subquestion. The group expects to grade the evidence as **moderate** at this point, but they have not yet finalized their review of the evidence.

Dr. Katzmarzyk provided an update on the cardiometabolic health subquestion. He reported the following draft conclusion statement and grade:

- Moderate evidence indicates that physical activity is positively associated with cardiometabolic health in children and adolescents, especially for plasma triglycerides and insulin. **PAGAC Grade: Moderate**

Dr. Janz reported on the status of the bone health sub-question. The group will likely grade the evidence for the relationship between physical activity and bone health in youth and adolescents as **strong**.

Dr. Pate explained that each of the subgroups will consider the remaining subquestions pertaining to their respective health outcomes. These will be presented in October.

Question 2 Discussion. Dr. Campbell asked about the baseline health status of the children in the included studies. Dr. Pate indicated that the focus was healthy or normal children (i.e., children who started the study without the health outcome which was being studied). However, he did observe that many of the weight studies had been done in overweight children and this information may need to be taken into account as a separate body of literature.

Dr. Bucher observed that the studies in young children primarily used wearable devices to assess physical activity while studies in older children might be using self-report as the assessment method. He wondered how this might affect results. Dr. Pate recognized this as an issue and indicated it might explain differences in study conclusions; this issue will need to be considered when drawing overall conclusions.

SC 9 Question 3.

- 3) In children and adolescents, is sedentary behavior related to health outcomes?
 - a. What is the relationship between sedentary behavior and weight status/adiposity?
 - b. Is there a dose-response relationship? If yes, what is the shape of the relationship?
 - c. Does the relationship vary by age, sex, race/ethnicity, or socio-economic status?
 - d. Is the relationship independent of light, moderate, or vigorous intensity physical activity?

Dr. Pate noted that the literature search to identify systematic reviews and meta-analyses has been completed, and they are starting to review the articles. Based on the number of included papers, the subcommittee may decide to complete a supplemental or *de novo* search for original articles to answer the question. The subcommittee acknowledged that they will need to decide if TV watching will be an acceptable proxy for sedentary behavior in this population.

Question 3 Discussion. Dr. Kraus asked whether sedentary behavior should be considered a modifier for the relationships between physical activity and health outcomes being examined in Question 2. Dr. Pate indicated that this was a good question, but the literature might not be robust enough yet to address it.

Committee Discussion

Plan for pulling forward information from 2008 Physical Activity Guidelines/Physical Activity Guidelines Advisory Committee Scientific Report. Dr. Powell began by noting that the documents produced 10 years ago represent the “best and most current literature and best thinking” on various topics that were considered. He commented that this Committee’s responsibility is to look at the scientific evidence generated in the intervening years and develop a report that outlines science-based advice for its Report that will build upon the information that came out in 2008. Hence, the 2008 Report remains highly relevant to the 2018 Committee’s work and Report. The Committee will need to be

explicit about how its work has expanded, updated, or modified the findings from 10 years ago, and also identify what to carry forward from the 2008 Report. Dr. Powell presented some ideas for how to pull forward information that is still relevant into the 2018 Report.

Proposal Part 1: In the write up for every question, state how the findings expand, update, or modify the material in the 2008 Report. Dr. Powell provided an example from Aging Question 1, expanding upon the evidence from 2008 (risk of falls) in 2018 (risk of injury from a fall). Three Committee members, Dr. Pescatello, Dr. Pate, and Dr. DiPietro, will draft examples of this proposed plan for their question write-ups for the Committee to consider.

Proposal Part 2: The co-chairs will identify major conclusions in the 2008 Report that are not being addressed by the 2018 Committee. The co-chairs will assign these conclusions to the most appropriate subcommittee for review. The Committee discussed how this might look and considered the following:

- The importance of including comments on these topics and conclusions, underscoring their public health importance, but that the Committee did not feel their review would change the conclusion statement
- The indication that the Committee agrees that the conclusion drawn in 2008 is valid, but does not imply that it has reviewed the new literature over the past 10 years with the same rigor as the main 2018 questions
- Acknowledgement that the Committee should be considerate of bringing a statement forward that another group has found conflicting evidence for in the intervening years
- The agreement to look carefully at the subcommittees' topics and clearly identify the topic areas that fall into this category, with the knowledge that during the Committee's first public meeting the 2018 topics were chosen specifically with a focus on areas in which the Committee was confident there would be new information

Proposal Part 3: The 2018 Report should comment on the consistency of its findings with the summary chapter of 2008 *Physical Activity Guidelines for Americans*. These comments are particularly relevant for the integration chapter. Examining how they relate to both the 2008 PAGAC Report AND the 2008 Guidelines will help the federal partners in writing the next edition of the Guidelines.

Wrap-Up and Close

Dr. Powell closed Day 1 of the meeting.

Day 1 Closed

4:45 PM

Day 2 Summary

Thursday, July 20, 2017

8:00 AM

Welcome

Dr. Katrina Piercy, Alternate Designated Federal Officer, ODPHP, HHS, welcomed the Committee members as she called to order day two of the fourth meeting of the 2018 Physical Activity Guidelines Advisory Committee.

Dr. Powell, Co-Chair of the Committee, thanked everyone for the good discussion on Day 1 and asked the Committee to be brief in their presentations for any conclusions or question updates that are still in progress to allow for more time discussion as a Committee on the conclusions that are more final.

Subcommittee Presentations

SC 5 Exposure. Dr. Kraus gave an overview of how the subcommittee has divided up its work. Questions 1 and 2 were presented at the last meeting and will not be discussed at this meeting.

SC 5 Question 3.

Dr. Kraus then proceeded to present the status of question 3. The literature reviewed included one systematic review and nine meta-analyses, one of which included 3.6M individuals. He showed several dose-response graphs from some of the papers.

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

The Exposure Subcommittee presented the following draft conclusion for Question 3:

- There is strong evidence that greater amounts of physical activity are associated with decreased risks for CVD, stroke, and heart failure. **PAGAC Grade: Strong**

Evaluation of the subquestions on dose and subpopulations for Question 3 remains to be completed.

Question 3 Discussion. Dr. Pescatello asked about recommended units for exposure. The examples used MET-minutes /week in thousands. Dr. Kraus advocates an energy-based exposure of MET-hours/week. Dr. Powell asked whether the heart failure results were adjusted for total volume of physical activity. Dr. Kraus responded that this needs to be confirmed. Dr. Pate asked whether any of the reviews looked at change in physical activity over time. Dr. Kraus responded that the reviews only included cohort studies with baseline measures. Dr. Kraus acknowledged that total volume of physical activity over the time of the intervention may be the most relevant exposure, but this is hard to determine. Dr. Powell raised the issue of setting a target amount of physical activity. He noted that the 2008 Advisory Committee used all-cause mortality and cardiovascular disease mortality as starting point for discussion. Dr. Powell asked when the 2018 Committee would be ready to have conversation about target. Dr. Kraus noted that the target from 2008 is 10 MET-hours/week and the 2018 Committee needs to deliberate if this should be changed or not. Dr. Kraus does not see a reason from current evidence to alter that value. Dr. Kraus referred the same question to Dr. Pate for youth who responded that the Youth Subcommittee is just starting to look at dose-response curves for four outcomes and will be able to comment once that review is done. Dr. Kraus also noted the challenge of coordinating multiple systematic reviews and meta-analyses to arrive at a target. Dr. DiPietro asked whether results are in the context of a sedentary lifestyle. In response, Dr. Kraus noted that the examined cohorts began ~20 years ago, so the short answer is “no.” This issue of how they interact will be covered by the Sedentary Behavior Subcommittee.

SC 5 Question 4. Dr. Kraus gave an update on the progress in examining Question 4. This search is using a combination of systematic reviews, meta-analyses, and original research. The exposure will be limited to device measures (pedometers) because self-report is not reliable.

- 4) 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)?
 - a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
 - b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?

Question 4 Discussion. There was no discussion on this question.

SC 5 Question 5. Dr. Kraus gave an update on the search progress for Question 5 (bout duration). Because there was only one relevant systematic review, the subcommittee searched original research conducted since 1990.

- 5) What is the relationship between bout duration of continuous aerobic physical activity and cardiorespiratory fitness and health outcomes?
 - a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
 - b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?

Question 5 Discussion. Dr. Pescatello asked Dr. Jakicic, the lead subcommittee member for this question, whether the blood pressure bout results could be cross-referenced with the Cardiometabolic Health and Weight Management Subcommittee. Dr. Jakicic noted that the other search is limited to systematic reviews while the Exposure Subcommittee is considering individual studies. Dr. Buchner asked whether intensity was being considered as well as bout duration. Drs. Kraus and Jakicic noted that some studies may include this information, but it is too early to tell. Dr. Pate commented that one can look at bouts of varying duration or can look at bouts vs. accumulated physical activity. He noted that early epidemiologic evidence was based on accumulated activity and asked if it would be possible to compare bouts to accumulated activity. Dr. Jakicic observed that some studies with accelerometry may allow this evaluation. Dr. DiPietro asked, regarding the accumulated activity question, whether frequency (e.g., weekend warrior) would be examined. Dr. Kraus indicated that this would not be considered since there is insufficient literature on that issue. Dr. Buchner noted that there may be a body of literature on stair climbing, which is an example of short bouts of relatively high intensity, but the search terms would not capture this. He agreed to share a review on this topic with the subcommittee. Dr. Hillman asked about the age range for this question. The subcommittee limited their search to adults. Dr. Hillman raised the issue of whether high intensity training could be examined by the Youth Subcommittee. Dr. Katzmarzyk raised the issue of reverse causation in cross-sectional studies that are included. Dr. Kraus replied that this is a concern that will be examined carefully and discussed at the next meeting.

SC 5 Question 6. Dr. Campbell presented progress on the search related to high-intensity interval training (HIIT). Three relevant systematic reviews were included.

- 6) What is the relationship between high intensity interval training and reduction in cardiometabolic risk?

- a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
- b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?

The Exposure Subcommittee presented the following draft conclusions for Question 6:

- Moderate evidence indicates that high-intensity interval training can effectively improve cardiorespiratory fitness in adults with varied body weight and health status and improve insulin sensitivity, blood pressure, and body composition in adults with overweight/obesity status and/or at high risk for cardiovascular disease and diabetes, especially with training durations ≥ 12 weeks. **PAGAC Grade: Moderate**
- Limited evidence suggests that dose-response relationships do not exist between the quantity of HIIT and several risk factors for cardiovascular disease and diabetes. **PAGAC Grade: Limited**
- Insufficient evidence is available to determine whether the effects of high-intensity interval training on cardiometabolic risk factors are influenced by age, sex, race/ethnicity, or socio-economic status. **PAGAC Grade: Grade not assignable**
- There is moderate evidence that weight status influences the effectiveness of high-intensity interval training 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**

Question 6 Discussion. Dr. Kraus suggested adding a research recommendation to look at duration of effect after discontinuation of interval training. Dr. Pate noted that you can look at whether interval training produces outcomes or whether it produces different effects from more typical modes and asked if this can be evaluated. Dr. Campbell responded that the cardiovascular fitness response is superior with HIIT in studies that compared it to continuous moderate exercise, but no other major differences were evident. Dr. Pate suggested that this is important to note. Dr. Macko asked about adverse events, particularly among older adults. Dr. Campbell noted that there was not much age stratification in the reviews, and not many older adults were included. Assessment of risk was not a primary outcome, but one review reported on incidence of reportable injuries, most of which were musculoskeletal. This review stated that no serious events were reported. Dr. DiPietro asked about relative intensities in the studies. Dr. Campbell responded that most studies used bouts of four minutes at 85-90% maximum heart rate. When Dr. DiPietro brought up what this would look like for an unfit older adult, Dr. Kraus noted that with relative intensity, this could be achieved with fast walking for some individuals. Dr. DiPietro noted that this was quite achievable for most older adults and that more “bang for the buck” in a given time is a positive.

Dr. Pescatello asked Dr. Campbell to comment on baseline blood pressure and magnitude of blood pressure reductions. Dr. Campbell thought reductions were on the order of 3-6 mmHg, but will clarify. Some studies were in those with metabolic syndrome, so these individuals may have had elevated blood pressure. Dr. Janz asked about difference between high-intensity interval training and sprint training. And what would a spinning class be? High-intensity interval training was defined as bouts of high intensity exercise (80-90% of max) for durations of four minutes interspersed with low intensity recovery or rest, repeated several times. This could be on a treadmill, cycle ergometer, mostly in lab settings, but some included swimming or outdoor running. Sprint is generally high intensity structured activity, e.g., 30 seconds at maximum effort. Dr. Kraus noted that sprint training tends to be anaerobic, whereas HIIT is not. Dr. Pate reiterated the importance of “bang for buck” greater return for given time, but noted that this requires direct comparison of two approaches controlling for total volume of physical activity. Dr. Jakicic echoed this sentiment and underscored the need to control for total energy

expenditure of physical activity. Dr. Campbell noted that not all of the literature controlled for total energy expenditure. Dr. Jakicic emphasized that this is an important area, but if systematic reviews do not address issues that are in individual articles, the subcommittee may need to return to the articles to evaluate. He also asked about availability of studies that look at choosing high intensity in free-living vs. lab-based studies, such as climbing stairs at a higher speed.

Dr. Powell brought up the issue of progression in the programs to build up to high intensity. Dr. Campbell does not recall this detail as a factor, but this may be important to address to reduce risk of adverse events. This may require going back to the primary articles. Dr. Powell also asked why these articles do not apply to the bouts question. Dr. Jakicic suggested that there is a philosophical difference in the two approaches, with bouts being separated by more time than the recovery period in high-intensity interval training. Dr. Kraus asked Dr. King to comment on the promotion side for interval training as a viable alternative. Dr. King noted that from a messaging perspective, bouts are episodic physical activity, a term more familiar to the public. She also suggested that the term 'episodic' should be added to the search. Dr. Pate noted that historically, endorsement of accumulated physical activity in bouts was in the context of a prolonged exercise paradigm. Now, the context is quite different, and the Committee may not need to focus as much on a precise definition of bouts. Dr. Buchner asked whether it is important to note that the bout duration is based on absolute intensity, even though heart rate may remain elevated during recovery. Members indicated this was not necessarily true. Dr. Jakicic noted the Exposure Subcommittee question about bouts was mostly about duration, which is different than interval training and that it would be helpful to discuss the cross-over between the two. Dr. King commented that bouts and HIIT are in the same family under the FITT concept (frequency, intensity, time, type), so they should be discussed in a related way. Dr. Pate noted that one could look at many variances between any number of specific types of physical activity, but the issue is whether or not there is anything that fundamentally alters health outcomes beyond energy output. Dr. Kraus noted that this goes back to the need to put it on an energy expenditure basis. Dr. Janz added that a focus on expenditure may be fine for metabolic outcomes, but obscure differences such as recruitment of fast-twitch fibers matter more for musculoskeletal outcomes like sarcopenia. Dr. King suggested putting Dr. Pate's comment into a research recommendation.

SC 2 Brain Health. Drs. Erickson (cognition) and Marquez (quality of life) presented the results for the Brain Health Subcommittee's first set of systematic literature searches of systematic reviews, meta-analyses, and pooled analyses. The searches addressed the following questions:

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

SC 2 Question 1. Dr. Erickson noted that an extensive body of research has been published over the last decade with the literature search identifying 32 systematic reviews and meta-analyses covering 13 different cognitive outcomes and populations. Most papers summarized randomized controlled trials and a few (e.g., dementia topic area) focused on prospective observational studies.

modifiable risk factor for dementia. Dr. Hillman commented that one of the issues in children is that we do not know the long term durability of cognition improvement is with physical activity.

SC 2 Question 2. Dr. Marquez reported on the results for the second question on the relationship between physical activity and quality-of-life. He noted that the review focused on people of all ages, including healthy people and people with psychiatric disorders or cognitive impairment, and only focused on self-reported quality-of-life. He noted that quality-of-life in people with other chronic conditions is being covered by other subcommittees.

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

The Brain Health Subcommittee presented the following draft conclusions and draft key findings about the relationship of physical activity and self-reported quality of life. The subcommittee is still reviewing details of articles for making more final assessments and conclusions.

- Strong evidence suggests that the physical component of health-related quality-of-life improves as a result of participation in physical activity when compared with minimal or no-treatment controls for adults and older adults, but not frail older adults or those with Alzheimer’s disease dementia. **PAGAC Grade: Strong**
 - No evidence that the mental domain of HR-QOL improves as a result of participation in physical activity in adults, older and frail adults, and in Alzheimer’s disease populations
- Strong evidence suggests that physical, social, and environmental, but not mental, components of quality-of-life improve as a result of participation in physical activity in individuals with schizophrenia. **PAGAC Grade: Strong**
- Evidence related to global quality-of-life cannot yet be determined

Dr. Marquez noted that the literature for this area is very large and heterogeneous. The majority of the papers included in this review were systematic reviews, not meta-analyses, and therefore did not provide estimates for a summary of effect size across studies. This limited the ability to define exact effect sizes. He explained that for older adults the observed effect sizes were small-to-moderate and more related to improvements in *physical* function with no significant improvements for *mental health* function. Additionally, the subcommittee found that improvements were more likely to be found for community dwelling older adults with no improvements observed for frail or institutionalized older adults. For middle-aged adults, effect sizes were null-to-small for overall quality-of-life, but a few subdomains showed improvement (physical health and psychological well-being) and some subdomains did not improve (social relations and level of independence). For some disease conditions, such as schizophrenia, effect sizes were moderate and similar for different types of physical activity. For other conditions, such as dementia, effect sizes could not be easily estimated from the reviews. For youth, a grade was not assignable due to too few studies and the small sample sizes within those studies. The Brain Health Subcommittee has not yet evaluated other potential moderators in detail, such as age, sex, race/ethnicity, or socioeconomic status.

Question 2 Discussion. Discussion with the full committee was curtailed due to time. Dr. Marquez confirmed that the majority of the reviews focused on randomized controlled trials.

Break

SC 4 Cardiometabolic Health and Weight Management. Dr. Jakicic presented the outcomes of the Cardiometabolic Health and Weight Management Subcommittee's first systematic literature review search of original research. This search addressed the following question:

1. What is the relationship between physical activity and prevention of weight gain?
 - a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
 - b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
 - c. Does the relationship vary based on levels of sedentary, light, moderate, or vigorous physical activity?
 - d. Is this relationship influenced by diet (e.g., energy intake) or eating behavior?

Dr. Jakicic briefly reviewed the literature review process which identified 33 original articles to address the subcommittee's main question and sub-questions. For sub-question d, Dr. Jakicic noted that overall diet was not covered adequately in the literature they reviewed. He recommended that they remove sub-question d and rely on the *Dietary Guidelines for Americans* for nutrition expertise.

The Cardiometabolic Health and Weight Management Subcommittee assigned the following draft evidence grades for its conclusions of the prevention of weight gain outcome.

- Strong evidence demonstrates a relationship between greater amounts of physical activity and attenuated weight gain in adults, with some evidence to support that this relationship is most pronounced when physical activity exposure is above 150 minutes per week. **PAGAC Grade: Strong**
- Limited evidence suggests a dose-response relationship between physical activity and the risk of weight gain in adults, with greater amounts of physical activity associated with lower risk of weight gain. **PAGAC Grade: Limited**
- Limited and inconsistent evidence suggests that the relationship between greater amounts of physical activity and attenuated weight gain in adults varies by age. **PAGAC Grade: Limited**
- Moderate evidence indicates that the relationship between greater amounts of physical activity and attenuated weight gain in adults does not appear to vary by sex. **PAGAC Grade: Moderate**
- Strong evidence demonstrates that the significant relationship between greater time spent in physical activity and attenuated weight gain in adults is observed with moderate-to-vigorous physical activity. **PAGAC Grade: Strong**
- Insufficient evidence is available to determine an association between light intensity activity and attenuated weight gain in adults. **PAGAC Grade: Grade not assignable**
- Insufficient evidence is available to determine whether the relationship between greater amounts of physical activity and attenuated weight gain in adults varies by race/ethnicity. **PAGAC Grade: Grade not assignable**
- Insufficient evidence is available to determine whether the relationship between greater amounts of physical activity and attenuated weight gain in adults varies by socio-economic status. **PAGAC Grade: Grade not assignable**
- Insufficient evidence is available to determine whether the relationship between greater amounts of physical activity and attenuated weight gain in adults varies by initial weight status. **PAGAC Grade: Grade not assignable**

Question 1 Discussion. Dr. Kraus asked about the type of studies included. Dr. Jakicic noted they focused on cohort studies to allow time for weight gain to occur rather than interventional studies. He followed up asking about estimates of energy expenditure, and Dr. Jakicic clarified that studies reported it differently and that MET-minute level details are in the question write-up.

Next was a discussion of the dose of physical activity to prevent weight gain. Dr. Kraus shared his impression that 60 minutes/day was needed for weight loss and asked if he thought they would be able to address that in the Guidelines. Dr. Jakicic noted other reports recommend more physical activity for prevention of weight gain and that from the studies they reviewed, the range is somewhere between 150 and 300 minutes/week. In the 2008 *Physical Activity Guidelines*, some evidence suggested the threshold was higher than 150 minutes/week, and Dr. Jakicic urged caution on landing on a specific number, but suggested a range may be more accurate. Dr. DiPietro shared that dose may depend on age and that more physical activity may be needed to maintain body weight as you get older. Dr. Pate commented that there is a large amount of individual variability given that people respond differently, and therefore a range of time spent in physical activity is likely necessary to prevent excessive weight gain over time.

Dr. Pate noted this question was on primary prevention for individuals of normal weight and that it was interesting the subcommittee did not find any systematic reviews to answer this question and also that there were not trials. Dr. Jakicic commented that the follow up period ranged from 2-10 years.

Dr. Macho asked about modality, such as resistance training. In response, Dr. Jakicic shared that there was only one study that had resistance training and they did not find an effect; he mentioned that resistance training could be a confounder with changes in body weight.

Dr. Campbell asked if the studies defined excessive weight gain. Dr. Jakicic responded that studies varied based on how they reported it; some specified gaining specific amount of weight, some used BMI and the transition to overweight or obesity threshold, and some reported body weight changes. Since there were multiple different measures, it gives strength to the conclusion, and there will be additional details on this in the Report.

SC 4 Question 2. Dr. Pescatello presented the process and findings of the Cardiometabolic Health and Weight Management Subcommittee's second systematic literature review search of systematic reviews and meta-analyses. This search addressed the following question:

- 2) In people with normal blood pressure or pre-hypertension, what is the relationship between physical activity and blood pressure?
 - a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
 - b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, weight status, or resting blood pressure level?
 - c. Does the relationship vary based on: frequency, duration, intensity, type (mode), and how physical activity is measured?

Dr. Pescatello emphasized the differences with this question and a similar one in the Individuals with Chronic Conditions Subcommittee which looked at individuals who have hypertension. She noted that adults with pre-hypertension are an understudied group.

The Cardiometabolic Health and Weight Management Subcommittee assigned the following draft evidence grades for its conclusions of the hypertension outcome:

- Strong evidence demonstrates an inverse, dose-response relationship between physical activity and incident hypertension among adults with normal blood pressure. **PAGAC Grade: Strong**
- Insufficient evidence exists to determine whether a dose-response relationship exists between physical activity and incident hypertension among adults with prehypertension. **PAGAC Grade: Grade not assignable**
- Conclusion Statement: Strong evidence demonstrates the magnitude of the blood pressure response to physical activity varies by resting blood pressure level, with greater benefits occurring among adults with prehypertension than normal blood pressure. **PAGAC Grade: Strong**
- Insufficient evidence exists to determine whether the relationship between blood pressure and physical activity varies by the frequency, intensity, and duration of physical activity, and how physical activity is measured among adults with normal blood pressure and prehypertension. **PAGAC Grade: Grade not assignable**
- Moderate evidence indicates the relationship between resting blood pressure level and the magnitude of benefit does not vary by type (mode) of physical activity among adults with normal blood pressure and prehypertension. **PAGAC Grade: Moderate**

Question 2 Discussion. Dr. Erickson asked about how blood pressure medication was handled in studies. Dr. Pescatello noted that everyone had normal blood pressure or pre-hypertension, so the assumption was no one was on medications.

Dr. Buchner asked for a clarification about the statement that there is strong evidence of a dose response, but mode does not matter. Dr. Pestcallo felt that the group could make a statement that multiple modalities can result in meaningful reductions in blood pressure. There was some discussion of whether mode was important and a suggestion to make a statement about average time dose of aerobic vs. strength training time vs. combination and the resulting energy expenditure. Dr. Jakicic cautioned about using Dr. Pescatello's comment about "bang for buck," and said that there is a difference for time on task, but not necessarily overall time investment (e.g., to get to/from a place to exercise) comparing various exercise modes. He noted it would be helpful to discuss dynamic resistance training and if it was quantified the same across studies. Dr. Janz asked about a study that used isometric exercises. Dr. Pescatello noted there were methodological weakness and inconsistencies in that meta-analysis of isometric exercises. She did not feel like there were enough well-done studies to conclude if that particular type of exercise can benefit blood pressure.

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

- 3) In adults without diabetes, what is the relationship between physical activity and type 2 diabetes?
 - a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
 - b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
 - c. Does the relationship vary based on: frequency, duration, intensity, type (mode), and how physical activity is measured?

Dr. Jakicic noted they are dealing with prevention of diabetes, not individuals with diabetes, and that this subcommittee is working in synergy with Individuals with Chronic Conditions Subcommittee. The

- Strong evidence demonstrates the existence of a direct, positive dose-response relationship between sedentary behavior and mortality from cardiovascular disease. **PAGAC Grade: Strong**
- Limited evidence suggests that the relationship between sedentary behavior and cardiovascular disease mortality does not vary by age, sex, race/ethnicity, or weight status. **PAGAC Grade: Limited.**
- Available evidence is insufficient to determine whether the relationship between sedentary behavior and mortality from cardiovascular disease varies by socio-economic status. **PAGAC Grade: Grade not assignable**
- Moderate evidence indicates that the relationship between sedentary behavior and mortality from cardiovascular disease varies by levels of moderate-to-vigorous physical activity. **PAGAC Grade: Moderate**
- Insufficient evidence is available that bouts or breaks in sedentary behavior are important factors in the relationship between sedentary behavior and mortality from cardiovascular disease. **PAGAC Grade: Grade not assignable**

Question 2 Discussion. Dr. DiPietro noted that the graph by level of physical activity shows accelerated risk for the low active, high sitting group. She stated that this needs to come through in the report.

SC 8 Question 3. The Sedentary Behavior Subcommittee presented the following draft conclusions for Question 3:

- Limited evidence demonstrates a direct relationship between greater time spent in sedentary behavior and higher mortality rates from cancer. **PAGAC Grade: Limited**
- Limited evidence demonstrates the existence of a direct, positive dose-response relationship between sedentary behavior and mortality from cancer. **PAGAC Grade: Limited**
- Insufficient evidence suggests that the relationship between sedentary behavior and cancer mortality does not vary by age, sex, race/ethnicity or weight status. **PAGAC Grade: Grade not assignable.**
- There is insufficient evidence available to determine if the relationship between sedentary behavior and mortality from cancer varies by socio-economic status. **PAGAC Grade: Grade not assignable**
- Insufficient evidence demonstrates that the relationship between sedentary behavior and mortality from cancer varies by levels of moderate-to-vigorous physical activity. **PAGAC Grade: Grade not assignable**
- There is insufficient evidence available that bouts or breaks in sedentary behavior are important factors in the relationship between sedentary behavior and mortality from cancer. **PAGAC Grade: Grade not assignable**

Question 3 Discussion. Dr. King asked to clarify the distinction between sitting and sedentary behavior. Dr. Katzmarzyk defined the two conditions. Dr. Campbell asked about the fact that there were many meta-analyses that synthesized an overlapping small number of original studies and the addition of newer articles and how they related to overall conclusions. Dr. Katzmarzyk noted that the subcommittee did not rely on the meta-analyses as much as going to the original studies. Dr. King asked about assessment by devices vs. reports and the relative contribution of the measures. Dr. Katzmarzyk explained that few device studies contribute to this outcome, and they show consistent results with self-reports. He also contrasted the findings for sitting and TV watching, which are also similar for these outcomes. Dr. Marquez asked about studies using the ActivPAL monitor that captures posture. Dr.

Katzmarzyk noted that only one study used the ActivPAL and that was with all-cause mortality. Dr. Powell pointed out that often TV is included in measures of sitting and the two may not be separable.

SC 8 Question 4. The Sedentary Behavior Subcommittee presented the following draft conclusions for Question 4 by outcome:

Type 2 Diabetes

- Strong evidence demonstrates a significant relationship between greater time spent in sedentary behavior and higher risk of type 2 diabetes. **PAGAC Grade: Strong**
- Limited evidence suggests the existence of a direct, graded dose-response relationship between sedentary behavior and risk of type 2 diabetes. **PAGAC Grade: Limited**
- Insufficient evidence is available to determine whether the relationship between sedentary behavior and type 2 diabetes varies by age, sex/ethnicity, socio-economic status, or weight status. **PAGAC Grade: Grade not assignable**
- Insufficient evidence is available to determine whether the relationship between sedentary behavior and type 2 diabetes varies by level of moderate-to-vigorous physical activity. **PAGAC Grade: Grade not assignable**
- There is insufficient evidence available that bouts or breaks in sedentary behavior are important factors in the relationship between sedentary behavior and incidence of type 2 diabetes. **PAGAC Grade: Grade not assignable**

Weight Status

- Limited evidence suggests a positive relationship between greater time spent in sedentary behavior and higher levels of adiposity and indicators of weight status. **PAGAC Grade: Limited**
- Limited evidence suggests the existence of a direct, graded dose-response relationship between greater sedentary behavior and higher levels of adiposity and indicators of weight status. **PAGAC Grade: Limited**
- Insufficient evidence is available to determine whether the relationship between sedentary behavior and weight status varies by age, sex/ethnicity, socio-economic status, or weight status. **PAGAC Grade: Grade not assignable**
- Insufficient evidence is available to determine whether the relationship between sedentary behavior and weight status varies by level of moderate-to-vigorous physical activity. **PAGAC Grade: Grade not assignable**
- Insufficient evidence is available to determine whether bouts or breaks in sedentary behavior are important factors in the relationship between sedentary behavior and weight status. **PAGAC Grade: Grade not assignable**

Cardiovascular Disease

- Strong evidence demonstrates a significant relationship between greater time spent in sedentary behavior and higher risk of incident cardiovascular disease. **PAGAC Grade: Strong**
- Strong evidence demonstrates the existence of a direct, graded dose-response relationship between sedentary behavior and risk of cardiovascular disease. **PAGAC Grade: Strong**
- Insufficient evidence is available to determine whether the relationship between sedentary behavior and incident cardiovascular disease varies by age, sex/ethnicity, socio-economic status, or weight status. **PAGAC Grade: Grade not assignable**
- Insufficient evidence is available to determine whether the relationship between sedentary behavior and incident cardiovascular disease varies by level of moderate-to-vigorous physical activity. **PAGAC Grade: Grade not assignable**

- There is insufficient evidence available that bouts or breaks in sedentary behavior are important factors in the relationship between sedentary behavior and incidence of cardiovascular disease. **PAGAC Grade: Grade not assignable**

Cancer

- Moderate evidence indicates a significant relationship between greater time spent in sedentary behavior and higher risk of incident cancer, particularly for endometrial, colon and lung cancer. **PAGAC Grade: Moderate**
- Limited evidence suggests the existence of a direct dose-response relationship between sedentary behavior and risk of endometrial, colon and lung cancers. **PAGAC Grade: Limited**
- Insufficient evidence is available to determine whether the relationship between sedentary behavior and cancer varies by age, sex/ethnicity, socio-economic status, or weight status. **PAGAC Grade: Grade not assignable**
- Insufficient evidence is available to determine whether the relationship between sedentary behavior and cancer varies by level of moderate-to-vigorous physical activity. **PAGAC Grade: Grade not assignable**
- There is insufficient evidence available that bouts or breaks in sedentary behavior are important factors in the relationship between sedentary behavior and cancer. **PAGAC Grade: Grade not assignable**

Question 4 Discussion. Dr. Kraus observed that outcomes that have strong relationship with physical activity have a strong association with sedentary behavior as well. This points to some physiology that ties sedentary behavior to physical activity that has not been identified. Dr. DiPietro commented on findings for endometrial and colon cancer, and was surprised that lung cancer was not as strong. Dr. Katzmarzyk noted that he did not see effect modification by smoking status for lung cancer. Dr. DiPietro asked if endometrial and colon cancer were stratified by obesity. Dr. Katzmarzyk replied that stratification was not done in the meta-analyses. Dr. Campbell was curious about weight gain and difference between old and new literature. Dr. Katzmarzyk responded that the systematic reviews from 2011 covered older studies. Newer studies are often more focused on sedentary behavior and may include better measures and larger cohorts, but he cautioned there is also heterogeneity among newer studies in which outcomes were affected. So, that is why the subcommittee went with limited evidence. Dr. Campbell also asked about length of follow-up time and how to articulate the associations by different lengths of follow-up time. Dr. Katzmarzyk responded that most had 2-10 year follow-up. He also mentioned, in regard to weight status, that there could be a reciprocal relationship, noting that 3 of 4 studies examined the relationship in this direction and did find that body weight changes predicted sedentary behavior as well. An important note is that some studies looked at the change in sedentary behavior and change in weight status at only two time points, thereby losing the prospective design and becoming cross-sectional. These issues are addressed in the chapter. Dr. Campbell also asked if weight status at baseline had an effect. Dr. Katzmarzyk noted that this was not examined in the studies but was examined in sub-question b for Question 2. Dr. Janz asked about ability to summarize by hours of sedentary behavior. Dr. Katzmarzyk noted there was much variability in how the exposure was measured and classified, so the subcommittee was not able to summarize them on a common metric.

SC 8 Question 5. The Sedentary Behavior Subcommittee presented the following draft conclusions for Question 5:

- Moderate evidence indicates that the effect of moderate-to-vigorous physical activity on all-cause mortality varies by level of sedentary behavior. **PAGAC Grade: Moderate**

Question 5 Discussion. Dr. Pate noted that the focus of the full Committee is on *physical activity* guidelines, so the subcommittee might want to focus on the current recommended level of 10-15 MET hours/week in its write-up. He observed that at that level, we still see some separation by sitting time. So, to reframe this into a recommendation on physical activity level, higher sitting time requires more physical activity to achieve the same risk reduction. Dr. Powell pointed out that if you look at relative change, higher sedentary time gets better improvement with increased physical activity. Dr. Kraus commented on sedentary behavior as a disease and how much physical activity is needed to counter it. He addressed the physical activity target vs. minimal/optimal/maximal levels of physical activity. He pointed out that most of benefit is achieved at 10-15 MET hours/week. Dr. Campbell asked whether observed change in one is more important than the other (absolute vs. relative risk). He commented that there is a continuum from sedentary to physically active. Dr. Pate suggested that they may want to put sedentary behavior in the context of range of physical activity; sedentary behavior is a moderator in the relationship between physical activity and risk of developing health outcomes. Dr. DiPietro added that if you are a “long sitter,” you need to be at the higher end of recommended range of physical activity. Dr. Jakicic commented that he thinks about it like the physical activity dose for weight control: some benefit at one level, more benefit with more activity. Dr. King added that the Committee needs to be explicit about sedentary behavior, not avoid addressing it. Dr. Buchner pointed out that if you control for moderate-to-vigorous physical activity, sedentary behavior is really a proxy for light intensity physical activity. Dr. Buchner asked if the Exposure Subcommittee is looking at light intensity physical activity. Dr. Kraus responded that with the current evidence light activity is still not understood. Dr. Macko asked about the average duration of sitting. The group discussed how measurement mode affects estimated duration.

SC 1 Aging. Dr. Campbell presented the Aging Subcommittee’s continuing work on their first systematic literature search. This search addressed the following question:

1. What is the relationship between physical activity and risk of injury due to a fall?
 - a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
 - b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
 - c. What type(s) of physical activity are effective for preventing injuries due to a fall?
 - d. What factors (e.g. cognitive impairment or specific disease states) modify the relationship between physical activity and risk of injury due to a fall?

Dr. Campbell reported that the literature searches for Question 1 yielded four systematic reviews or meta-analyses, one government report, and four cohort studies; the search did not include studies on individuals in nursing homes or assisted living facilities, only community dwelling adults older than age 50. Based on the findings from randomized controlled trials, higher levels of physical activity reduce the risk of injurious falls among older adults in community and home settings. The reduction in risk is approximately 32-66% for all injurious falls and 40-66% for falls with fractures.

Dr. Campbell reviewed the Aging Subcommittee’s draft conclusion statement to its main question that was presented at the last meeting in March 2017:

- Participation in multicomponent group or home-based fall prevention physical activity and exercise programs can reduce the risk of injury from falls, including severe falls, those requiring medical care, and fractures among community-dwelling older adults. **PAGAC Grade: Strong**

The key findings for the four sub-questions of Question 1 were discussed. Concerning a dose-response relationship, mostly consistent results from three high-quality prospective cohort studies suggest that moderate-intensity physical activity reduces the risk of fall-related injuries, including bone fractures. However, low amounts of moderate-intensity physical activity and low-intensity walking may be insufficient to affect the risk of fall-related injuries. The subcommittee was interested in the types of fall prevention exercise programs that effectively reduced the risk of injurious falls and bone fractures; most exercise training programs were multi-component that included various combinations of moderate-intensity training for balance, strength, endurance, gait, and physical function, along with recreational activities.

The Aging Subcommittee presented the following draft conclusions for Question 1 sub-questions a – d:

- a. Limited evidence suggests that a dose-response relationship exists between the amount of moderate to high-intensity physical activity or home and group exercise and risk of fall-related injury and bone fracture. However, the small number of studies available and the diverse array of physical activities studied make it difficult to describe the shape of the relationship. **PAGAC Grade: Limited**
- b. Insufficient evidence is available to determine whether the relationship between physical activity and risk of injury and bone fracture due to a fall varies by age, sex, race/ethnicity, socio-economic status, or weight status. **PAGAC Grade: Grade not assignable**
- c. Moderate evidence indicates that the risk of fall-related injury and bone fracture may be reduced using a variety of community-based group and home physical activities. Effective multi-component physical activity regimens generally include combinations of balance, strength, endurance, gait, and physical function training, and recreational activities. **PAGAC Grade: Moderate**
- d. Insufficient evidence is available to determine whether any factors modify the relationship between physical activity and risk of injury due to a fall. **PAGAC Grade: Grade not assignable**

Question 1 Discussion. There were a number of issues discussed by the Committee. Dr. Pescatello asked how well medication use was reported in the trials reviewed. Dr. Campbell responded that it was not well described in the systematic reviews so the effect of medication on falls and fall injuries could not be clarified. Dr. Pate asked if increased physical activity might transiently be associated with an increased risk of fall related injuries but overall is protective of injury from falls; Dr. Buchner responded that that appears to be the case. Dr. Macko asked about the nature of the population in the literature that was reviewed; he particularly was wondering about whether individuals with cognitive decline or mobility problems were included. Dr. Campbell responded that since the studies reviewed only included community dwelling adults, the issue of the effect of cognitive decline on the risk of injury due to falls was not evident. Dr. Janz questioned how the evidence grade of moderate was determined; was it because multi-component regimens were used and therefore the various physical activity components were not able to be teased out? She noted that the heterogeneity of activities captured more neural-interfacing activities, and it may not be bad that many activities fall into the same category.

SC 1 Question 2. Dr. DiPietro presented the Aging Subcommittee’s second systematic literature search for systematic reviews and meta-analyses. This search addressed the following question:

2. What is the relationship between physical activity and physical function?
 - a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
 - b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?

- c. What type(s) of physical activity are effective for improving or maintaining physical function?
- d. Does the relationship vary by level of physical and/or cognitive impairment and by selected chronic conditions (e.g., Alzheimer's, Parkinson's, osteoporosis, coronary heart disease, after hip fracture)?

The subcommittee is looking at physical activity types (single component, dual-task, and multiple component) as well as at various subpopulations (general aging; those with some level of visual, cognitive or physical impairment; or frailty), as well as at several specific disease states. At this stage of the literature search, it appears that there may be 114 systematic reviews that meet inclusion/exclusion criteria.

Question 2 Discussion. Dr. Buchner commented that a frail adult would not have the capacity to do physical activity as a general adult, so the subcommittee will try to understand responses to physical activity based on functional levels in its examination of the literature.

Break

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 questions:

1. What types of physical activity interventions are effective for physical activity change at different levels of impact? (levels include: individual, built/neighborhood environment; community settings; policy and legislative; information technology)
2. What interventions are effective for reducing sedentary behavior?

Dr. King reported the findings for the first question based on the Social Ecological Framework (levels of impact: individual, community, environment/policy, and communication technology). She explained that the Promotion Subcommittee was on a "hunt" for evidence while the other subcommittees have very specific, vetted questions. One global search was completed for the entire physical activity intervention field to encompass all styles of interventions, using systematic reviews, meta-analyses, and government reports. The Promotion Subcommittee made the decision to only focus on intervention areas with sufficient evidence to allow for evidence grading. Dr. King specified that the grade "limited" reflects a dearth of a reasonable number of systematic reviews, meta-analyses, or rigorously controlled trials with clear reporting of evidence. She then proceeded to give the draft conclusions for Question 1 for the following three levels: information technology, community settings, and individual. The remaining levels and Question 2 will be addressed in October.

The Promotion of Physical Activity Subcommittee presented the following draft conclusions for the information technology level:

- Activity Monitors
 - Strong evidence that wearable activity monitors can help increase physical activity in general adult population and in those who have type 2 diabetes. **PAGAC Grade: Strong**
 - Moderate evidence that they can help increase physical activity in adults with overweight or obesity. **PAGAC Grade: Moderate**
 - Limited evidence that they may help increase physical activity in adults with musculoskeletal disorders. **PAGAC Grade: Limited**

A key finding across the Activity Monitors category is that evidence evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently limited or lacking.

- Computer-tailored Print
 - Moderate evidence that it has a small but positive effect in general adult population when compared with minimal or no-treatment controls. **PAGAC Grade: Moderate**
- Interactive Video Games
 - Limited evidence that use in structured community-based programs is effective for increasing physical activity in healthy children. **PAGAC Grade: Limited**
 - Limited evidence that such programs (i.e., “exergames”) are a potentially acceptable and safe approach for use in programs aimed at increasing physical activity in adults ages 60 years and older. **PAGAC Grade: Limited**
- Mobile Phone Applications
 - Moderate evidence that programs involving text-messaging have small to moderate positive physical activity effects in general adult population. **PAGAC Grade: Moderate**
 - Strong evidence that use of smartphone applications (apps) increase regular physical activity in children and adolescents. **PAGAC Grade: Strong**
 - Limited evidence that smartphone apps increase regular physical activity in general adult populations. **PAGAC Grade: Limited**
- Social Media
 - Limited early evidence that programs involving *social media* are effective for increasing PA in adults or youth. **PAGAC Grade: Limited**
- Telephone-assisted
 - Strong evidence that telephone-assisted interventions are an effective and safe means for increasing physical activity in general adult populations, including older adults. **PAGAC Grade: Strong**
- Web-based or Internet Delivered
 - Strong evidence that internet-delivered interventions that include educational components have small but consistently positive effects in increasing physical activity in general adult population, particularly in shorter-term, when compared with interventions that do not include internet-delivered materials. **PAGAC Grade: Strong**
 - Limited, early evidence that these interventions may have some efficacy in increasing short-term physical activity in persons with type 2 diabetes. **PAGAC Grade: Limited**

Question 1 Technology Level Discussion. Dr. Kraus asked for further elaboration on the sustained usability of these types of interventions. Dr. King mentioned the telephone-based interventions were often across 2-3 years that showed potential for sustainability. She mentioned that with several of these interventions, we see rapid uptake initially that eventually levels off/plateaus. She compares physical activity interventions to blood pressure control – even when BP is controlled, it doesn’t mean you stop taking medication. She noted that physical activity interventions need to be developed with sustainability in mind. Dr. Campbell asked to re-visit what the controls were for these experiments; he asked if comparable programs/interventions were provided using technology vs. human contact. Dr. King responded that it truly varies across the reviews. The goal of the physical activity field is to broaden the array of intervention choices, as different people have success using different interventions (e.g., computer-based vs. face-to-face).

The Promotion of Physical Activity Subcommittee presented the following draft conclusions for the community settings level:

- Childcare
 - Limited evidence that interventions are effective for physical activity in this setting for children <6 years of age. **PAGAC Grade: Limited**
- Community-wide
 - Moderate evidence that interventions that employ intensive contact with majority of target population over time can increase physical activity across the population. **PAGAC Grade: Moderate**
 - Limited evidence that interventions using strategies limited in intervention reach or intensity over time and which focus on a narrow set of strategies are effective in community-wide physical activity change. **PAGAC Grade: Limited**
- Faith-based
 - Limited evidence that interventions that are either faith-based (integrated with spiritual aspects) or faith-placed (delivered through setting) are effective for promoting physical activity in adults. **PAGAC Grade: Limited**
- Nurse-delivered
 - Limited evidence that nurse-delivered community-based interventions are effective for increasing physical activity in adults. **PAGAC Grade: Limited**
- Primary care
 - Limited evidence for effectiveness in the general population in primary care settings when compared with minimal or usual-care controls, especially over medium (6-11 mos.) or longer (12+ mos.) periods. **PAGAC Grade: Limited**
- Schools
 - Moderate evidence that interventions that revise the structure of physical education (P.E.) classes are effective for increasing physical activity in primary school-aged youth. **PAGAC Grade: Moderate**
 - Limited evidence that interventions that modify designs of school playgrounds or that change recess sessions in other ways are effective for increasing physical activity in youth. **PAGAC Grade: Limited**
- Worksite
 - Limited evidence that interventions are effective for increasing physical activity in *adults*. **PAGAC Grade: Limited**

Question 1 Community Setting Level Discussion. Dr. Pate mentioned that the Physical Activity Guidelines Midcourse Report reviewed physical activity interventions aimed at increasing physical activity in children. Just two approaches were rated as “Sufficient”, and both were school-based (modifications to P.E. and multi-component interventions). He questioned why multi-component interventions were not discussed in the presentation. After comments from Dr. Marquez and Dr. Whitt-Glover, Dr. King remarked that the Promotion Subcommittee will take another look at the multicomponent piece of school-based interventions as they relate to schools since they considered the Midcourse Report in the individual level. Dr. Macko asked about physical activity programs in senior centers for older adults. Dr. King said some of that evidence for older adults will be mentioned in the individual level, but it is difficult to capture this because there were no reviews specific to senior centers.

The Promotion of Physical Activity Subcommittee presented the following draft conclusions for the individual level:

- Older Adults

- Moderate evidence that interventions targeting older adults have small but positive physical activity effects when compared with minimal/no-treatment controls. **PAGAC Grade: Moderate**
- Peer-led Interventions
 - Moderate evidence that peer-led self-management interventions are effective in older adults and individuals with chronic disease at producing small but meaningful increases in physical activity when compared with minimal/no-treatment controls, particularly over time periods of <12 months. **PAGAC Grade: Moderate**
- Postnatal
 - Limited evidence that postnatal interventions are effective for increasing physical activity compared with minimal/no-treatment controls. **PAGAC Grade: Limited**
- Theory-based Behavioral Interventions
 - Moderate evidence that behavior change techniques based on a broad range of theories are useful for increasing physical activity of different types, intensities, and formats in adults. **PAGAC Grade: Moderate**
 - Limited evidence that providing financial rewards or incentives for reaching physical activity behavior targets are effective in adults. **PAGAC Grade: Limited**
- Youth
 - Strong evidence that interventions in healthy youth (<18 years) have a small but positive physical activity effect when compared to a variety of control conditions. (Effects are enhanced when programs incorporate family or are delivered in schools.) **PAGAC Grade: Strong**

Question 1 Individual Level Discussion. Dr. Katzmarzyk asked about the role of publication bias in this area. Dr. King said she believes it is extreme. For example, if a study cannot show a difference in physical activity levels, the likelihood of getting into a good journal will be much lower. It is a subject that will be addressed in the limitations of this chapter. Dr. Marquez responded by saying that one journal (the Translational Behavioral Medicine Journal of the Society of Behavioral Medicine) now has a section for statistically non-significant findings. Dr. Macko addressed the issue of access and how some people in rural areas may not have access to specific technologies or community centers. Dr. King mentioned that there were one or two reviews that fell into the category of “rural”, but they were insufficient to allow the subcommittee to draw conclusions from and had to be triaged out. She mentioned that the Promotion Subcommittee will comment on topic areas that could not be graded and the importance of them. Dr. Campbell asked for clarification on whether the studies were looking at 24 hour physical activity or, for example, during school hours? Dr. King said it really varies for youth as it is measured mostly with accelerometers and often just during the school day. With older adults, there is more of a mixture (accelerometer, observations, self-report). Dr. Campbell then pointed out that children were lumped into K-12 and asked if there are more defined data for effectiveness across different youth age groups? Dr. King mentioned that the Promotion Subcommittee did not search specifically for any of these topics, and are commenting on topics that surfaced in the search and had sufficient evidence to show an effect. However, smartphone apps appeared to show an effect in children and adolescent age groups. Dr. Pate mentioned that the effect sizes tend to be small for each of the interventions and stressed that it will be important to address this issue in the Committee’s report. Additionally, the effect size of one type of intervention may underestimate the potential impact of implementing a lot of interventions in many settings.

Committee Discussion

Scientific Report Integration Chapter. Dr. Powell introduced a summary table of evidence for every question that appeared in the 2008 Integrating the Evidence chapter. The next part of the Integrating the Evidence chapter is a Q&A section. He showed a Word document with the questions from both 2008 and 2018 color-coded to show which questions and answers correspond. He also mentioned the topics that are missing in 2018 that were answered in 2008 will be answered in this section of the 2018 PAGAC report. For every question that is being asked in 2018, the integration chapter will include a comment on how that information relates to information in the 2008 report (e.g., this is new or this expands/updates a 2008 conclusion, etc.). For topics that were addressed in 2008 but not 2018, the uncovered questions will be distributed to subcommittee leaders to assess their acceptability for use in the 2018 PAGAC report. Moving forward, Dr. Powell suggested that as the subcommittees are writing their conclusions, keep in mind the Integrating the Evidence chapter because this is the part of the Committee's work that is most useful to the federal group in translating the science in the Committee's report into policy, the *2018 Physical Activity Guidelines for Americans*.

Dr. Pate acknowledged the group's responsibility for distinguishing between the 2008 and 2018 reports, but questioned if the Integrating the Evidence chapter should focus on this. He asserted that the chapter should focus on pulling out the new innovation in this report, not just differentiating between the two reports. Drs. Kraus and Buchner stated the need to compare findings that have yet to be laid out, including differentiating recommendations about reducing sedentary behavior, sitting time, increasing light intensity activity, sleeping time, etc. They placed particular emphasis on the light intensity recommendation because that is what sitting time (sedentary behavior) displaces. Dr. Powell sees this as being addressed in the Integrating the Evidence and/or the Background chapter where definitions and concepts of domains of physical activity will be located.

Dr. Powell then brought the discussion back to thinking about sedentary behavior. The full range of energy expenditure, including sedentary behavior, belongs in the report. He encouraged Committee members to envision and empathize with the majority of people that will be influenced by what is written in both the Committee's report and the federal *Physical Activity Guidelines*, not just how they may apply to the Committee members themselves. Dr. Pate agreed that an important piece of the integration chapter is pulling in the evidence regarding sedentary behavior and showing how it applies to physical activity guidance. Dr. Jakicic suggested the group start thinking about how reducing sedentary behavior can be a "gateway" or transition to other increased physical activity outcomes. Dr. King agreed with the gateway illustration, similar to how changing diet was viewed as gateway to being more physically active and vice versa.

Dr. Powell turned the discussion to the need to discuss a target dose/range of physical activity, and mentioned that the 2008 target has been discussed as an appropriate target for 2018. Dr. Campbell pointed out that the public does not seem to know that there is a range, and the lower level of the range is often seen as the target. He questioned whether 150 minutes/week remains the magic number; and if it is, how communication efforts might need to change. If not, he asked if it needs to be changed. Dr. Campbell then brought up an example of increased benefits at the higher end of the range (e.g., decreased mortality, decreased cancer incidence) citing the figure Dr. Powell had presented on Day 1. Dr. Pate pointed out that this is complicated and as the Committee is trying to bring this all together, the

members need to remember their purpose in describing the data. The Committee's primary job is to ask: is there a range of activity levels that we can confidently conclude provides important health benefits in most people? There are implications with how people meet those targets, but that is not the Committee's duty to discuss.

Dr. Powell agreed, and stated that it is incorrect to think of the target dose/range as a "threshold" for any benefit. Dr. Campbell added that the demographic and disease makeup of the general American population is different now than 10 years ago and stressed the importance of making sure the recommendation is still valid in the current American population. He suggested that fixating on a number may set up people to not achieve this goal. Dr. DiPietro then suggested that perhaps the bottom number of this range is too low, as sedentary behavior has increased dramatically.

Dr. Powell agreed that the baseline has always been a bit fuzzy. Dr. Buchner proposed that this may come down to communication of the recommendations. He wondered if the range promotes misunderstanding of the Guidelines. He asked if changing or revising the number would result in confusion and create the need for numerous communication campaigns. He also mentioned that it is important to keep in mind the dose-response relationship and how the benefits are reflected on the curves (e.g., more activity, more benefit). Dr. Campbell proposed describing the benefits in terms of the upper limit rather than the lower limit. Dr. Katzmarzyk agreed with Dr. Campbell, noting that the original recommendation of 150 minutes per week is on top of baseline physical activity level, which is also confusing to the public. Dr. Buchner recommended adding clarification to the target, noting that the 150 minutes/week recommendation is for moderate-vigorous physical activity *on top of* baseline activity.

Dr. Pate again implored the Committee to remember what its job is and how that differs from those who will translate the science into the actual guidelines. The Committee's job is to draw the best conclusions possible about the physical activity-health outcome relationships from the literature and integrate that across the wide range of health outcomes included in its systematic reviews. The communicators will decide how to then take that out to the public.

Dr. Kraus mentioned alternate targets, such as the step count target that has become popular in the last 10 years (i.e., 10,000 per day), noting that adding these to the 150 minutes/week recommendation created more confusion for the general public. He noted that people seem to be more worried about type 2 diabetes than all-cause mortality, so perhaps that should influence the target the Committee proposes.

Dr. King noted that it seems the paradigm has shifted over the past 10 years; it is a continuum, not a threshold. There are different outcomes you can start to achieve at different levels of physical activity (e.g., physical function improves at the lower end of physical activity). She suggested creating a figure with all the outcomes lined up with the x-axis being baseline physical activity level. Other Committee members proposed outcomes and figure ideas for the report, such as personalizing it by age and other demographic factors; centering a figure on a specific outcome; focusing more on short-term outcomes like body weight, physical fitness/function, or brain health outcomes.

Multiple Committee members voiced concern with health literacy, communication challenges, and trust in science when the issue of perhaps pivoting from the previous target/dose was raised. Dr. King expressed interest in highlighting how this Committee's systematic review augments and expands upon the 2008 report, showing how the field is growing. Dr. Jakicic commented that the Committee needs to integrate the science into a story in the report while also getting ahead of the data. He noted that the papers included in the Committee's review are based on older studies that do not reflect the present.

Dr. Campbell noted that while the Committee started talking about the minimum amount of physical activity that people could get by with at the first meeting, it seems to have come to discussing a range, or continuum-like representation for how being physically active impacts health outcomes. He suggested framing the message in a positive light (health promotion) rather than a negative light (disease prevention). Dr. Whitt-Glover pointed out that much of the evidence reviewed specifically talks about leisure-time and recreational physical activity, but that activity patterns of different segments of the population reflect more occupational or transportation activity. It is important that the Committee communicates that the evidence shows that health benefits come mostly from leisure-time and recreational activity. Dr. Campbell suggested using physical activity patterns (i.e., just being physically active vs. a range of minutes) to tell the story similarly to what is seen with multi-component interventions, which are more successful than other types of interventions. Dr. Katzmarzyk agreed, and mentioned that the new Canadian Physical Activity Guidelines are for the 24-hour period, including light, moderate, and vigorous physical activity, and sleep. He indicated that this sounds like the direction in which the Committee may be heading. Dr. Buchner added the final word in the discussion that the Committee should emphasize the muscle-strengthening component of the Guidelines.

Wrap-Up and Close

Dr. Powell closed Day 2 of the meeting

Day 2 Adjourned

4:45 PM

Day 3 Summary

Friday, July 21, 2017

8:00 AM

Welcome

Dr. Katrina Piercy, Alternate Designated Federal Officer, ODPHP, HHS, welcomed the Committee members as she called to order day three of the fourth meeting of the Physical Activity Guidelines Advisory Committee.

Working Group Presentations

Pregnancy. Dr. DiPietro presented an overview of the work of the Pregnancy Working Group. This working group did not do a *de novo* search specifically on pregnancy, rather they utilized existing

searches from the Aging, Brain Health, and Cardiometabolic and Weight Management Subcommittees, along with existing high quality reviews to address the following questions:

1. What is the relationship between physical activity and the health of the mother during pregnancy?
2. What is the relationship between physical activity and the health of the mother during postpartum (up to one year)?
3. What is the relationship between physical activity during pregnancy and the health of the child at birth?

Dr. DiPietro presented the outcomes of the Pregnancy Working Group's first question, including draft key findings, conclusion statements with grades, and research recommendations.

1. Is physical activity related to excessive weight gain, gestational diabetes, preeclampsia, quality of life, physical fitness, ease of labor and delivery, and musculoskeletal injury during pregnancy?
 - a. If yes, what dose of physical activity is associated with the reported quantitative benefit or risk?
 - b. Is there a dose-response relationship? If yes, what is the shape of the relationship?
 - c. Does the relationship vary by age, sex, ethnicity, socio-economic status, or weight status?

The Pregnancy Working Group assigned the following draft evidence grades for its conclusions of excessive weight gain of the mother outcome:

1. Strong evidence demonstrates a significant, but modest, inverse relationship between physical activity and gestational weight gain. **PAGAC Grade: Strong**
2. Limited evidence suggests that a dose of physical activity consistent with the 2015 ACOG Guidelines and the 2008 U.S. Physical Activity Guidelines (150-180 minutes/week of moderate-intensity activity) is associated with minimized weight gain and a lower risk of excess gestational weight gain. **PAGAC Grade: Limited**
3. Insufficient evidence is available to determine whether there is a dose-response relationship between physical activity and gestational weight gain. **PAGAC Grade: Grade not assignable**
4. Insufficient evidence is available to determine whether the relationship between physical activity and gestational weight gain varies by age, race/ethnicity, socio-economic status, or weight status. **PAGAC Grade: Grade not assignable**

Pregnancy Discussion. Dr. Campbell asked if there were upper limits for exercise and any outcomes. Dr. DiPietro noted there seems to be a J-shaped curve with certain outcomes, but most of the trials they looked at used the Guidelines as the exposure. Dr. Campbell asked to clarify the second conclusion statement and suggested using the word "lower" instead of "minimized."

Dr. Kraus asked about data that exercise of the mother (or father prior to conception) can have transference effects to the offspring. Dr. DiPietro noted that this is an area of recent study, but that information was not in the systematic reviews they evaluated. She suggested this would be an area of interest for the next Advisory Committee.

Dr. Powell asked for the Committee's input on the search strategy of this working group. He noted they were able to identify information related to several other outcomes which were mentioned in the reviews examined (e.g., preterm birth, gestational diabetes, infant outcomes), but that a complete search was not done for every potential outcome. Dr. Kraus suggested that this information be included

in the narrative and that since this was a working group, it was appropriate to not to do *de novo* searches.

Dr. Pescatello asked to clarify “modest” in the first conclusion statement, and Dr. DiPietro responded that it was referring to a modest amount of weight gain which was consistent across 11 meta-analyses. Dr. Powell suggested while the number of pounds was relatively small, perhaps taking out the word “modest” would help to clarify that statement. Dr. Kraus asked about the long-term impact and suggested that although the number of pounds could be small, it could contribute to a lower postpartum weight for the mother.

Physical Fitness. Dr. Kraus gave an overview of progress of the Physical Fitness Working Group to date. The questions that the working group is addressing are:

- 1) What is physical fitness?
- 2) How do we measure it?
- 3) It’s role as an exposure, mediator, moderator or outcome of the benefits of exercise on human health.

The working group is planning to write up an introduction for this topic. Dr. Kraus requested examples regarding aerobic and musculoskeletal fitness from subcommittees, with emphasis on aspects that translate into everyday life outcomes, such as function.

Physical Fitness Discussion. Drs. Buchner and King proposed the working group consider the FAST study and the LIFE trial that looked at changes in physical fitness associated with changes in daily function ability. Dr. Macko added the LEAD trial should also be considered as it includes effects on SF36 and the Short Physical Performance Battery. He commented on effects of disability on fitness and the ability to increase fitness and activities of daily living. Dr. Kraus requested Dr. Macko provide citations and perhaps a paragraph to include in the physical fitness write-up. Dr. Pate asked Dr. King to add examples of physical fitness as a moderator of response to interventions. Dr. Erickson commented on physical fitness as a mediator for brain health and asked about what threshold to use to determine mediation – how will mediation be defined/determined? Dr. Kraus suggests a more robust (statistical) definition rather than a looser definition. Dr. Macko suggested in the write-up on using clinical barometers that are epidemiologically shown, like VO_2 , to monitor fitness, especially in specific populations. Drs. Powell and Pate discussed whether there is a distinction between fitness and function. Dr. Buchner pointed out the distinction between physiologic capacity vs. behavioral measures, such as the 400m walk tests, but Dr. Pate noted that the two aspects are not distinct. Dr. Macko suggested a Venn diagram to show the overlaps. Dr. Pate agrees with a need to clarify the relationship between the two. Dr. DiPietro asked about considering fitness as a confounder of the relationship between physical activity and health outcomes. Dr. Kraus responded that the working group would address parts of this relationship, but not fitness in the Darwinian sense. Dr. Janz proposed a way to improve the multiple paths figure by having function and resilience as the outcome in D, not physical fitness. Drs. Powell and Pate agreed with this approach. Dr. King also proposed a tweak to the figure on the intervention side that will be explored.

Transition from Youth to Adult Guidelines Working Group. Dr. Janz presented an overview of the work of the Transition from Youth to Adult Guideline Working Group.

The main question the working group considered was:

1. In young adults, are the needs for physical activity different in number, type, or pattern from adults?

Dr. Janz provided some background for this working group and the data for adolescents and adults meeting the Physical Activity Guidelines. She noted the main outcomes for youth guidelines (healthy growth and development) and adults (disease prevention and quality of life) and highlighted the overlap of outcomes for young adults (bone health, weight gain/obesity, and brain health). The working group reviewed literature from other searches done by the subcommittees that stratified findings by the young adult age group (18-35). Overall, the group recommended that this process was not adequate to fully answer this question in terms of the dose or physical activity patterns. They plan to include information in the scientific report noting that this may be an emerging issue.

Transition Discussion. Dr. Kraus asked about the total physical activity count slide and inquired if it suggested that what you do in young adulthood would impact how much physical activity you do as an older adult (i.e., can physical activity benefits accumulate similar to development of peak bone mass?). Dr. Pate noted tracking coefficients tend to be significant for only a few years. He commented this is a plastic behavior, modifiable in both directions. Dr. Janz clarified that bone is an attribute, but physical activity is a behavior, so it would be difficult to draw that conclusion from that study.

Dr. Macko suggested there is a gap not being able to specifically address this age group and suggested this should be commented on in the integration chapter of the Committee's report. He suggested the Venn diagram comparing youth, adult, and young adult outcomes presented by Dr. Janz would be helpful to include. Dr. Kraus noted his impression that young adults are not interested in specific disease outcomes. Dr. Pescatello suggested flipping it and focusing on health promotion vs. disease progression. Dr. Pate suggested you could use 3 diagrams (youth, adults, young adults) to show the continuum of physical activity related to anticipated health effects. He noted the guidelines have not traditionally been focused on the literature from the young adult age range. Dr. Powell inquired where this information would go in the PAGAC Scientific Report, and they discussed putting it in the background section.

Committee Discussion

Dr. Powell opened the session by asking how the Committee can best deliver the messages that they want to convey through its report. He noted that they do not have to come up with one master graphic, but can convey the information in different ways. He proposed using the remaining time to develop several concepts through which they might visually portray the work the Committee has done. To frame the discussion, Dr. Powell presented physical activity and the "3 P's of public health": promotion, population, and prevention. He situated the Subcommittees onto this framework. He reminded the Committee of the 2008 all-cause mortality dose-response curve, to which he added the gestational weight gain outcome. Additionally, he provided other examples of visual representations of reduced risk of all-cause mortality by physical activity level. He proposed coming up with a number of figures to help make the points suggested by the literature.

Dr. Campbell asked for clarification on the different points on the all-cause mortality dose-response curve with the 2008 recommendations highlighted. Dr. Powell explained that each specific point represents the amount of reduction in risk that matched a particular volume of physical activity for different outcomes in 2008. Dr. Pate prefers individual dose-response curves for each outcome rather than point estimates as shown as they better portray the nature of the relationships. Dr. Powell

concluded, but that level of information is not always available. He hopes that for many of the outcomes, the Committee will be able to develop dose-response curves. He clarified that what the point estimates figure shows is that the curve for a specific outcome will likely pass through the point specified on his figure.

Dr. Macko brought up the physical activity continuum and how that continuum is different for people with different levels of sedentary behavior. He asked how the Committee would visually portray the interaction between sedentary behavior and physical activity.

Dr. King started a list of figures that the Committee may consider. The Committee referenced a group of hypothetical curves for different outcomes developed by Dr. Bill Kohl after the 2008 process. Dr. Kraus questioned to what extent they could start to build this with the information the 2018 Committee is examining.

Drs. Powell and King began creating example figures of how the continuum may look. They proposed that the figure does not necessarily need point estimates, but may be important to talk about benefits/outcomes in terms of ranges. The group considered how to illustrate a continuum of benefit, proposing various examples/ideas. The Committee agreed to continue this conversation in small groups from now until the October meeting.

Wrap-Up Discussion and Next Steps

Dr. Powell noted the Committee is continuing its work in subcommittees until the next public meeting.

Dr. Piercy adjourned the fourth public meeting of the 2018 Physical Activity Guidelines Advisory Committee and stated that the Committee will reconvene in October 2017.

Meeting Adjourned

11:25 AM