# Construct Validity of Physical Activity and Sedentary Behaviors Staging Measures for Adolescents

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## ABSTRACT

*Purpose: To evaluate the construct validity of physical activity (PA) and sedentary behaviors (SB) staging measures for adolescents that incorporate the current national recommendations.* **Method:** *The Progressive Aerobic Cardiovascular Endurance Run, Actigraph accelerometer, and self-reported hours of TV viewing served as criterion measures. Participants were 878 adolescents (M age = 12.74, 53.6% girls, 39.9% non-White).* **Results:** *The PA staging measure had mixed evidence of convergent validity and strong evidence of divergent validity. The SB staging measure had strong and generalized evidence of convergent validity but weak evidence of divergent validity, which could be related to inaccurate assumptions about the relation of SB to PA and fitness. Results were generally in the expected direction and provide preliminary evidence for the construct validity and generalizability of both staging measures. However, more research is warranted to validate the staging measures with Actigraph-measured PA and sedentary time. Effect sizes ($\eta^2$ values) ranged from small to large (.02–.63).* **Conclusion:** *PA and SB stage-of-change measures that are congruent with current national recommendations and appropriate for use among adolescents were partially supported for their construct validity.*

## INTRODUCTION

The Transtheoretical Model (TTM) has been used in physical activity (PA) assessment and interventions with adolescents (1–4). The TTM postulates that people change their behavior as they progress through a series of five stages. PA stages are defined by present and past level of activity and intention to change (5). Present level of PA is typically defined by an established recommendation for PA. Individuals who meet the recommendation are classified as an Active or Maintainer, depending on the length of time the recommendation was met. Those who do not meet the recommendation are classified according to intention to change.

The National Association for Sports and Exercise guidelines (6), consistent with those of an international consensus group (7) and the U.S. Dietary Guidelines (8), recommend at least 60 min of moderate to vigorous PA daily for adolescents. This recommendation is more days per week and minutes per day than the Healthy People 2010 guidelines (9) but may be more appropriate given that rates of obesity among youth continue to increase even when many young people are meeting the Healthy People 2010 PA guidelines (10). A recent meta-analysis of PA and TTM studies found no studies that incorporated the adolescent-specific guidelines of daily activity for at least 60 min with adolescents (2), and none have been reported since.

Sedentary behavior (SB) among youth has also gained increasing attention as a contributor to obesity and has been targeted in several intervention studies (11–13). Healthy People 2010 guidelines recommend 2 hr or fewer of TV viewing time on school days for adolescents (9). However, no published staging measure for SB for youth was found in the literature.

This study evaluated the construct validity of recently developed PA and SB staging measures based on recent recommended health guidelines. Measurement validity was assessed using multiple behavior criteria and analyzed by subgroups defined by sex, age, and household socioeconomic status (SES). Subgroup analyses assessed the generalizability of the validity evidence given that PA levels among adolescents are known to vary by sex and age, and potentially by SES (14). We hypothesized that the PA staging measure would be associated with fitness level and objectively measured minutes of PA, whereas the SB staging measure would be associated with objectively measured estimates of weekday and weekend minutes of SB and self-reported TV viewing time. Nonsignificant associations were expected for the nonmatched staging measures and criterion variables, providing evidence of discriminant validity.

## METHOD

### Participants

The data were collected by PACE+: Counseling Adolescents for Exercise and Nutrition, a randomized controlled trial of a PA and nutrition intervention for adolescents. The sample consisted of 878 adolescents, 471 girls and 407 boys, ranging in age from 10 to 16 years ($M = 12.74$, $SD = 1.35$). Participants self-identified as White (57.9%), multiracial/ethnic (14.7%), Latino/Hispanic (13.1%), Black/African American (6.6%), Asian/Pacific Islander (3.4%), Native American (0.7%), and Other (3.6%).

### Staging Measures

The PA criterion used to classify an individual into at least the action stage of change was *doing PA at least 5 days each week, for at least 60 min each day* and was based on the most recent adolescent-specific guidelines (6,7). The SB criterion used to classify an individual into at least the action stage of change was *doing no more than 2 hr of sedentary time daily* and was based on the recent TV viewing recommendation (9). *Sedentary time* was defined as: TV viewing and video and computer games and excluded school-related SB, such as time spent in school,

doing homework, and reading. School-related SB were excluded because the staging measure was directly related to an intervention that in part focused on reducing non-school-related SB.

Two distinct staging measures classified stage of change for PA and SB. Figure 1 depicts the general format of both staging measures. First, the participant reported whether he or she was currently meeting the PA or SB recommendation. If yes, then the participant reported whether the recommendation was met for less than or more than 6 months and was classified into either action or maintenance accordingly. If the participant was not at present meeting the recommendation, then intention to meet it was assessed. On the basis of reported intention, the participant was classified into precontemplation (no intent), contemplation (intent to change within the next 6 months), or preparation (intent to change within the next 30 days). The 6-month criterion and general measurement format was modeled after previously used staging measures (15) and data indicating the utility of a 6-month stage classification (16).

### Criterion Measures

Three criterion measures were used to assess convergent and discriminant validity as evidence of overall construct validity of both staging measures. The first criterion measure was the Progressive Aerobic Cardiovascular Endurance Run (PACER), a progressive shuttle run test that assesses cardiovascular endurance by engaging participants in a run back and forth across a flat 20-m distance (17). Completion of one 20-m distance is one PACER lap. The test has been found to be reliable and valid for use with children and adolescents (18,19). The number of PACER laps completed was the variable used in the analysis.

The MTI Actigraph accelerometer (see http://www.mtiactigraph.com; formerly sold by Computer Science and Applications) was the second criterion measure. The Actigraph is a uniaxial accelerometer that records acceleration counts per minute from which minutes of moderate (3–5.99 metabolic equivalents [METs]) and vigorous (6–9 METs) activity, and sedentary time (roughly 0–1.1 METs) is estimated (20,21). Participants wore the monitor on their waist for 1 week, removing it only
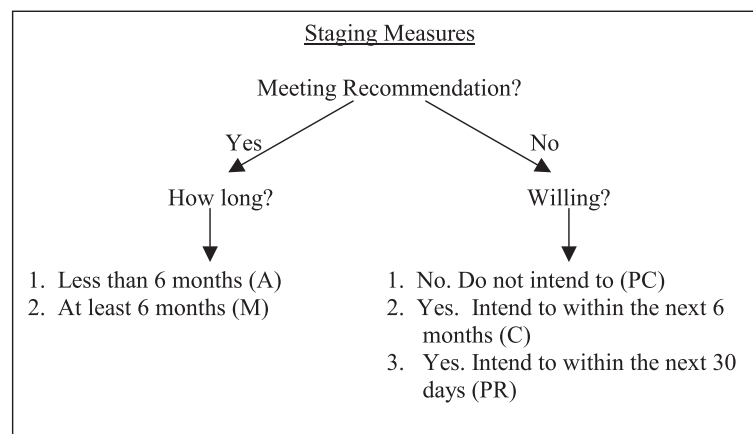
FIGURE 1   General format of the staging measures. PC = precontemplation; C = contemplation; PR = preparation; A = action; M = maintenance.

during bathing, swimming, and sleeping. The monitor has been successfully used with adults in field settings (22) and is reliable and valid for use with children and adolescents (20,21). Minutes spent doing PA (moderate and vigorous), and SB on weekend days and weekday afternoons, were the variables used. Weekday afternoons, classified as 3:00 p.m. to 11:00 p.m., was used to capture SB after school and before bedtime.

The third criterion measure was self-reported TV viewing hours (9). Participants reported hours spent viewing TV on school and nonschool days from 0 to 6 or more hr each day on a scale adapted from Robinson (12) that is valid for use among adolescents (23). A weighted weekly average of TV viewing hours on school and nonschool days were the variables used in the analysis.

## Procedure

The staging and criterion measures were administered within an assessment battery during a baseline measurement visit. Participants were given the Actigraph at baseline and instructed to wear it for 7 days beginning the following day. Monitors were returned by mail and analyzed. Days of assessment were not matched across measures.

## Analysis

Analyses were conducted for the overall sample and by sex, age, and SES. The sample was split into two age groups: (a) younger (10–12, $n = 405$, 46.1%) and older (13–16, $n = 473$, 53.9%). Parent or guardian highest level of education served as a proxy for household SES: Thirty-three percent were categorized into low SES (less than high school through an associate's degree) and 66.3 % into high SES (bachelor's degree through some graduate school or professional degree).

A series of one-way analyses of variance (ANOVAs) was performed using PA or SB stage as the independent variable and a criterion measure as the dependent variable. Eta-squared values were used to report the variance explained in each test. Familywise alpha level was held at .05 for each of the ANOVAs. Critical values for the post hoc comparisons were obtained via the Games–Howell procedure for large sample sizes. All analyses were conducted using SPSS (Version 11.5).

## RESULTS

Means and standard deviations by stage of change and ANOVA results (including $p$ values, eta-squared values, post hoc comparisons, and subgroup analysis results) are in Table 1 for the PA staging measure and Tables 2 and 3 for the SB staging measure. Eta-squared values were interpreted as small ($< .06$), medium (.06–.14), and large ($> .14$) on the basis of guidelines outlined by Cohen (24).

## PACER and PA Stage of Change

PA stage accounted for significant variance in the PACER within the entire sample ($p < .0001$, $\eta^2 = .04$), older adolescents ($p < .0001$, $\eta^2 = .06$), boys ($p < .0001$, $\eta^2 = .08$), and high-SES participants ($p < .0001$, $\eta^2 = .05$), with PA Maintainers complet-

ing more PACER laps than those in lower stages. Each post hoc comparison demonstrated that PA Maintainers were significantly more fit compared with at least three other stages.

## Actigraph Minutes of Activity and PA Stage of Change

The PA stage measure did not account for a significant amount of the variance in minutes of PA within the entire sample or most subgroups. Younger ($p = .049$, $\eta^2 = .027$) and older adolescents ($p = .005$, $\eta^2 = .036$) yielded the two significant results. There were no significant post hoc comparisons among younger adolescents. Among older adolescents, PA Maintainers engaged in significantly more PA than did Contemplators.

## Actigraph Hours of Sedentary Time and PA Stage of Change

No significant associations were found.

## TV Viewing and PA Stage of Change

No significant associations were found.

## PACER and SB Stage of Change

SB stage accounted for significant variance in the PACER within the entire sample ($p < .0001$) and most subgroups (younger adolescents, $p = .035$; older adolescents, $p = .001$; girls, $p < .0001$; boys, $p = .025$; and high-SES participants, $p = .002$), with participants in higher SB stages completing more PACER laps than those in lower stages. Girls and younger adolescents accounted for the most ($\eta^2 = .054$) and least ($\eta^2 = .026$) variance in SB stage, respectively. Within the entire sample and four subgroups, there was at least one significant post hoc comparison, with participants in higher SB stages of change being more fit than those in lower stages. No significant relationship was found among low-SES participants.

## Actigraph Minutes of Activity and SB Stage of Change

SB stage accounted for significant variance in PA minutes among the entire sample ($p = .004$, $\eta^2 = .02$), boys ($p = .019$, $\eta^2 = .033$), and girls ($p = .043$, $\eta^2 = .02$). Post hoc comparisons from the entire sample, boys, and girls demonstrated that those in higher SB stages of change did more PA than those in lower stages.

## Actigraph Hours of Sedentary Time and SB Stage of Change

SB stage accounted for a significant amount of variance in SB hours on weekend days within the entire sample ($p = .050$, $\eta^2 = .02$), boys ($p = .003$, $\eta^2 = .06$), and high-SES participants ($p = .022$, $\eta^2 = .03$). Significant post hoc comparisons were found among boys and high-SES participants, but not within the entire sample.

There were no significant relationships between SB hours on weekday afternoons and SB stage among any group.

TABLE 1
ANOVA Results for the PA Staging Measure and PA Criteria Measures

| Sample Particulars | Stage of Change (M, SD) | | | | | Effects | |
|---|---|---|---|---|---|---|---|
| | Pc | C | Pr | A | M | p, η² | Post Hoc Analyses |
| PACER[a] | | | | | | | |
| Total | 24.2 | 22.3 | 25.0 | 23.4 | 29.4 | *p* < .0001 | M > Pc,C,Pr,A |
| | (12.7) | (12.2) | (14.1) | (11.7) | (15.3) | .041 | |
| Younger | 22.8 | 21.1 | 23.4 | 19.7 | 23.4 | — | — |
| | (12.1) | (10.6) | (11.4) | (9.1) | (11.1) | — | — |
| Older | 25.8 | 23.9 | 26.3 | 25.65 | 33.14 | *p* < .0001 | M > Pc,C,Pr,A |
| | (13.4) | (13.8) | (15.8) | (12.5) | (16.4) | .063 | |
| Girls | 21.2 | 21.3 | 22.4 | 20.4 | 23.5 | — | — |
| | (8.8) | (10.9) | (12.0) | (10.5) | (11.8) | | |
| Boys | 26.9 | 23.9 | 29.1 | 25.8 | 34.6 | *p* < .0001 | M > Pc,C,Pr,A |
| | (15.1) | (13.8) | (16.2) | (12.1) | (16.2) | .081 | |
| Low SES | 25.5 | 20.7 | 23.8 | 22.3 | 25.1 | — | — |
| | (12.9) | (10.3) | (10.6) | (9.8) | (12.8) | | |
| High SES | 23.8 | 23.3 | 25.7 | 24.4 | 31.5 | *p* < .0001 | M > Pc,C,Pr,A |
| | (12.8) | (13.0) | (15.5) | (13.0) | (16.1) | .052 | |
| Actigraph activity counts[b] | | | | | | | |
| Total | 56.9 | 59.3 | 57.0 | 59.5 | 64.4 | — | — |
| | (29.4) | (29.5) | (29.1) | (31.9) | (30.8) | | |
| Younger | 66.8 | 71.1 | 66.9 | 81.3 | 77.5 | *p* = .049 | *ns* |
| | (26.3) | (28.0) | (27.6) | (27.7) | (32.3) | .027 | |
| Older | 45.2 | 45.0 | 48.9 | 46.2 | 56.1 | *p* = .005 | M > C |
| | (28.7) | (24.5) | (28.0) | (26.6) | (26.8) | .036 | |
| Girls | 47.1 | 51.5 | 47.6 | 58.0 | 54.8 | — | — |
| | (27.8) | (23.8) | (22.6) | (31.7) | (25.1) | | |
| Boys | 65.9 | 71.4 | 75.4 | 60.8 | 72.3 | — | — |
| | (28.0) | (33.3) | (31.8) | (32.3) | (32.9) | | |
| Low SES | 56.5 | 55.5 | 56.1 | 60.6 | 59.6 | — | — |
| | (31.4) | (26.4) | (30.0) | (32.0) | (24.8) | | |
| High SES | 56.4 | 61.2 | 57.2 | 59.9 | 66.5 | — | — |
| | (28.5) | (31.1) | (28.8) | (31.3) | (33.1) | | |

*Note.* Dashes indicate nonsignificant analysis of variance (ANOVA) results (eta-squared values were not estimated and post hoc analyses were not conducted when the ANOVA was nonsignificant). PA = physical activity; Pc = Precontemplators; C = Contemplators; Pr = Preparers; A = Actives; M = Maintainers; PACER = Progressive Aerobic Cardiovascular Endurance Run; SES = socioeconomic status; *ns* = no pairs significant.
[a]Total pacer laps completed. [b]Average minutes of moderate and vigorous activity combined.

## TV Viewing and SB Stage of Change

SB stage accounted for significant variance in TV viewing hours in all groups (*p* < .001 for all one-ways). Participants in the maintenance and action stages for SB reported significantly fewer TV viewing hours than did participants in all lower stages and across all groups. Participants in the preparation stage for SB reported significantly fewer hours of TV viewing than those in the precomtemplation stage among the entire sample and younger adolescents. Hours of TV viewing accounted for the most variance among younger adolescents (η² = .63) and the least among older adolescents (η² = .57).

## DISCUSSION

The primary aim was to evaluate the construct validity of PA and SB staging measures for adolescents that incorporate the most recent national recommendations (6,7,9). Analyses were also conducted by sex, age, and SES status to assess the generalizability of the validity findings.

We expected the PA staging measure to be significantly related to the PA criterion variables and not the SB criterion variables. The results demonstrated that the PA staging measure was significantly related to the PACER, and subgroup findings were generally consistent with results from the entire sample. The PA staging measure was not significantly related to Actigraph recordings of activity. Consistent with the TTM, however, the activity minute means generally increased from pre-action (precontemplation, contemplation, preparation) to postaction (action, maintenance) stages of change.

The lack of significant associations in these analyses may be attributable to adolescents' misperceptions about the amount of their total activity. For example, vigorous activity (e.g., running during soccer practice) may be more salient than moderate activity (e.g., walking between classes at school), resulting in

TABLE 2
ANOVA Results for the Sedentary Behavior Staging Measure and Physical Activity Criteria Measures

| Sample Particulars | Stage of Change (M, SD) | | | | | Effects | |
|---|---|---|---|---|---|---|---|
| | Pc | C | Pr | A | M | $p, \eta^2$ | Post Hoc Analyses |
| PACER[a] | | | | | | | |
| Total | 26.2 | 23.3 | 22.1 | 25.5 | 29.2 | *p* < .0001 | M > C,Pr |
| | (15.5) | (12.3) | (13.3) | (12.9) | (14.8) | .031 | |
| Younger | 21.6 | 21.2 | 19.8 | 22.2 | 25.4 | *p* = .035 | M > Pr |
| | (11.0) | (9.9) | (11.6) | (9.9) | (13.0) | .026 | |
| Older | 28.5 | 25.0 | 24.2 | 29.8 | 32.4 | *p* = .001 | M > C,Pr |
| | (17.0) | (13.8) | (14.5) | (14.9) | (15.5) | .042 | |
| Girls | 18.7 | 20.9 | 19.5 | 22.9 | 26.5 | *p* < .0001 | M > Pc,C,Pr |
| | (10.3) | (10.0) | (9.6) | (10.4) | (13.7) | .054 | |
| Boys | 31.4 | 26.7 | 25.5 | 28.4 | 31.8 | *p* = .025 | *ns* |
| | (16.4) | (14.5) | (16.4) | (14.7) | (15.3) | .028 | |
| Low SES | 23.2 | 21.5 | 22.1 | 23.7 | 27.0 | — | — |
| | (12.9) | (10.2) | (12.6) | (9.3) | (12.7) | | |
| High SES | 27.7 | 24.3 | 22.3 | 26.5 | 30.0 | *p* = .002 | M > C,Pr |
| | (16.6) | (13.4) | (14.0) | (14.1) | (14.7) | .031 | |
| Actigraph activity counts[b] | | | | | | | |
| Total | 55.2 | 56.7 | 58.8 | 64.3 | 65.7 | *p* = .004 | M > Pc,C |
| | (28.2) | (28.7) | (33.0) | (31.4) | (29.7) | .02 | |
| Younger | 67.0 | 69.1 | 72.6 | 73.6 | 78.3 | — | — |
| | (27.2) | (28.8) | (31.9) | (28.1) | (29.8) | | |
| Older | 48.6 | 47.1 | 46.3 | 52.6 | 54.2 | — | — |
| | (26.6) | (24.7) | (28.9) | (31.5) | (24.7) | | |
| Girls | 45.0 | 51.4 | 49.3 | 51.1 | 58.8 | *p* = .043 | M > Pc |
| | (22.1) | (26.1) | (24.5) | (24.3) | (27.2) | .024 | |
| Boys | 63.1 | 64.8 | 71.7 | 79.0 | 72.2 | *p* = .019 | A > Pc,C |
| | (29.9) | (30.8) | (38.4) | (31.9) | (30.7) | .033 | |
| Low SES | 55.8 | 55.4 | 52.9 | 63.1 | 61.4 | — | — |
| | (28.2) | (27.9) | (33.1) | (26.4) | (23.1) | | |
| High SES | 55.8 | 57.4 | 63.7 | 64.0 | 66.76 | — | — |
| | (28.1) | (29.3) | (31.8) | (33.3) | (32.2) | | |

*Note.*    Dashes indicate nonsignificant analysis of variance (ANOVA) results (eta-squared values were not estimated and post hoc analyses were not conducted when the ANOVA was nonsignificant). Pc = Precontemplators; C = Contemplators; Pr = Preparers; A = Actives; M = Maintainers; PACER = Progressive Aerobic Cardiovascular Endurance Run; SES = socioeconomic status; *ns* = no pairs significant.
    [a]Total pacer laps completed. [b]Average minutes of moderate and vigorous activity combined.

underestimating their total activity or recalling mainly vigorous PA. In analyses not presented, we found that when Actigraph-estimated minutes of moderate and vigorous PA were analyzed separately, the PA staging measure was significantly related to vigorous PA, but not moderate PA, in the overall sample. As expected, the PA staging measure was not related to Actigraph estimates of hours of SB or to reports of TV viewing in the total sample or any of the subgroups, concurring with previous reports (12,14). The lack of relationships between the PA staging measure and all SB criteria is evidence for the measure's discriminant validity as it was not intended to classify stage of change on the basis of SB criteria.

Construct validity of the SB staging measure was supported by significant associations with Actigraph estimates of SB in the total sample, boys, and girls. However, the variance accounted for was small, and there were nonsignificant results for several subgroups. It is difficult to determine whether the lack of consistent findings was due to a problem with the stag-

ing measure or the use of the Actigraph to estimate SB. We estimated SB minutes using a recommended metric of accelerometer counts less than or equal to 100 per minute (roughly 0–1.1 METs; 21). However, SB has been studied rarely with Actigraphs, and there is some debate in the literature about how to use Actigraph counts to estimate SB (21,22,25,26). Because the SB staging measure was designed to include only certain behaviors (e.g., TV viewing, video game use) and exclude other behaviors (e.g., homework and reading), the association between the staging measure and the Actigraph estimates of total SB may have been attenuated. More research with Actigraph measured SB is needed before firm conclusions can be drawn.

Consistent associations were found with TV viewing in the entire sample and all subgroups. The variance accounted for in the TV viewing variables was large, and these estimates could be inflated by method variance because both stage and TV viewing were self-reported.

TABLE 3
ANOVA Results for the SB Staging Measure and SB Criteria Measures

| Sample Particulars | Stage of Change (M, SD) | | | | | Effects | |
|---|---|---|---|---|---|---|---|
| | Pc | C | Pr | A | M | $p$, $\eta^2$ | Post Hoc Analyses |
| TV viewing[a] | | | | | | | |
| Total | 3.7 | 3.4 | 3.3 | 1.3 | 1.3 | $p < .0001$ | M,A < Pc,C,Pr |
| | (1.1) | (1.1) | (.8) | (.6) | (.5) | .60 | Pr < Pc |
| Younger | 3.7 | 3.3 | 3.1 | 1.3 | 1.2 | $p < .0001$ | M,A < Pc,C,Pr |
| | (1.1) | (1.0) | (.8) | (.5) | (.5) | .63 | Pr < Pc |
| Older | 3.7 | 3.5 | 3.4 | 1.4 | 1.3 | $p < .0001$ | M,A < Pc,C,Pr |
| | (1.1) | (1.1) | (.8) | (.7) | (.5) | .57 | |
| Girls | 3.7 | 3.5 | 3.3 | 1.4 | 1.3 | $p < .0001$ | M,A < Pc,C,Pr |
| | (1.1) | (1.1) | (.8) | (.5) | (.5) | .61 | |
| Boys | 3.6 | 3.2 | 3.2 | 1.4 | 1.2 | $p < .0001$ | M,A < Pc,C,Pr |
| | (1.1) | (1.0) | (.9) | (.7) | (.5) | .59 | |
| Low SES | 3.6 | 3.6 | 3.3 | 1.3 | 1.3 | $p < .0001$ | M,A < Pc,C,Pr |
| | (1.1) | (1.1) | (.8) | (.5) | (.6) | .60 | |
| High SES | 3.8 | 3.3 | 3.2 | 1.4 | 1.2 | $p < .0001$ | M,A < Pc,C,Pr |
| | (1.4) | (1.0) | (.8) | (.7) | (.5) | .60 | |
| Actigraph sedentary counts[b] | | | | | | | |
| Total | 6.8 | 6.3 | 6.1 | 6.2 | 6.1 | $p = .050$ | *ns* |
| | (1.9) | (1.7) | (1.8) | (1.8) | (1.8) | .02 | |
| Younger | 6.1 | 5.7 | 5.6 | 5.8 | 5.7 | — | — |
| | (1.9) | (1.7) | (1.5) | (1.7) | (1.5) | | |
| Older | 7.2 | 6.7 | 6.5 | 6.9 | 6.4 | — | — |
| | (1.8) | (1.6) | (2.0) | (1.7) | (2.1) | | |
| Girls | 6.4 | 6.5 | 6.2 | 6.3 | 6.3 | — | — |
| | (1.5) | (1.6) | (1.9) | (1.6) | (2.0) | | |
| Boys | 7.1 | 5.9 | 6.0 | 6.2 | 5.9 | $p = .003$ | M,C < Pc |
| | (2.2) | (1.7) | (1.8) | (2.0) | (1.7) | .06 | |
| Low SES | 6.1 | 6.2 | 5.9 | 6.0 | 6.2 | — | — |
| | (1.4) | (1.7) | (1.6) | (1.8) | (1.8) | | |
| High SES | 7.1 | 6.3 | 6.3 | 6.4 | 6.0 | $p = .002$ | M < Pc |
| | (2.1) | (1.7) | (1.9) | (1.7) | (1.9) | .03 | |

*Note.* Dashes indicate nonsignificant analysis of variance (ANOVA) results (eta-squared values were not estimated and post hoc analyses were not conducted when the ANOVA was nonsignificant). SB = sedentary behavior; Pc = Precontemplators; C = Contemplators; Pr = Preparers; A = Actives; M = Maintainers; SES = socioeconomic status; *ns* = no pairs significant.
[a]Weighted average of TV viewing hours on school and nonschool days. [b]Average hours of SB on weekend days.

Contrary to expectations, the SB staging measure was related to both of the objective PA measures of fitness (PACER) and minutes of activity (Actigraph recordings). These relationships indicate that adolescents who were meeting the guidelines for SB were generally more active and physically fit than participants in the pre-action stages of change for SB. These findings are inconsistent with data showing little or no association between PA and TV viewing (12,14) but are consistent with studies showing that decreasing SB can increase PA (27).

In sum, the PA staging measure had mixed evidence of convergent validity and strong evidence of divergent validity. The SB staging measure had strong and generalized evidence of convergent validity but weak evidence of divergent validity, which could be related to inaccurate assumptions about the relation of SB to PA and fitness. Further research with the Actigraph is warranted for both staging measures.

Limitations of this research should be noted. First, only one self-reported item assessed a particular type of SB, hours of TV viewing, neglecting other contributors to sedentary time, such as video games; reading; and time spent on the Internet, in school, and doing homework. Future studies can incorporate additional measures of sedentary time, including proxy reports or observational measures, to further contribute to validating the SB staging measure. Second, although the SB and PA staging measures consistently differentiated between pre-action (precontemplation, contemplation, and action) and postaction (action and maintenance) stages, and between action and maintenance, other constructs are relevant for testing differences among the pre-action stages, such as self-efficacy and decisional balance (28). However, this study focused on the staging measures' ability to differentiate between pre- and postaction stages, because a core purpose of the staging measures are to identify participants who are or are not meeting the PA and SB recommendations. Third, this study presents evidence for the convergent and discriminant validity of the staging measures, but predictive validity remains to be investigated in future studies. Fourth, the ac-

celerometer data were collected after the staging measures, so there was no direct overlap in the measures. However, the intention for each was to estimate habitual behavior, so it was reasonable to use the Actigraph as a criterion.

This study also had many strengths. First, analyses were stratified by various subgroups (e.g., defined by sex, age, and SES) of interest (14). These analyses supported the generalizability of the staging measures, especially the SB measure. Second, although there is some debate in the literature about PA guidelines for youth (6,9,10), we used the most recent guidelines that we believe are most appropriate (10) as the criteria to classify adolescents who are in the action or maintenance stage of change. Third, this study used multiple validation measures, including objective measures of PA and SB and physical fitness. We presented only relevant "high quality" validating criteria and did not include other variables such self-reported PA that, although it was strongly associated with PA staging, was considered a lower quality level of validity evidence.

This study addressed two gaps in the literature by presenting and validating PA and SB staging measures based on the best available guidelines appropriate for use with adolescents (2,6,7,9). These staging measures can facilitate the standardization of PA and SB stage-of-change assessment in descriptive and intervention studies and can determine motivational readiness on a population basis (29,30). Moreover, commonly accepted valid staging measures can be used in cross-study comparisons, where assorted staging algorithms previously made such comparisons difficult and often inappropriate (2). Although further validation work on these staging measures is being conducted, they are available for use.

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