

## Brief Physical Activity-Related Psychosocial Measures: Reliability and Construct Validity

Jordan A. Carlson, James F. Sallis, Nicole Wagner, Karen J. Calfas, Kevin Patrick,  
Lisa M. Groesz, and Gregory J. Norman

**Background:** Psychosocial factors have been related to physical activity (PA) and are used to evaluate mediation in PA interventions. **Methods:** Brief theory-based psychosocial scales were compiled from existing measures and evaluated. Study 1 assessed factor structure and construct validity with self-reported PA and accelerometry in overweight/obese men (N = 441) and women (N = 401). Study 2 assessed 2-week reliability and internal consistency in 49 college students. **Results:** Confirmatory factor analysis indicated good fit in men and women (CFI = .90; RMSEA = .05). Construct validity was supported for change strategies ( $r = .29-.46$ ), self-efficacy ( $r = .19-.22$ ) and enjoyment ( $r = .21-.33$ ) in men and women, and for cons in women ( $r = -.19$  to  $-.20$ ). PA pros ( $r = -.02$  to  $.11$ ) and social support ( $r = -.01$  to  $.12$ ) were not supported for construct validity. Test-retest reliability ICCs ranged from .49–.81. Internal consistency alphas ranged from .55–.90. Reliability was supported for most scales with further testing needed for cons (alphas = .55–.63) and enjoyment (ICC = .49). **Conclusions:** Many of the brief scales demonstrated adequate reliability and validity, while some need further development. The use of these scales could advance research and practice in the promotion of PA.

**Keywords:** behavior change, health promotion, psychometrics, theory

Considerable evidence supports the relationship between moderate to vigorous physical activity (MVPA) and health outcomes such cardiovascular disease, type 2 diabetes, some cancers, and mortality.<sup>1,2</sup> The U.S. Department of Health and Human Services recommends adults to engage in at least 150 minutes of moderate-intensity physical activity (PA) per week, or at least 75 minutes of vigorous-intensity PA per week, or an equivalent combination of moderate- and vigorous-intensity PA.<sup>3</sup> However, based on self-reports only 64.5% of adults meet these recommendations, 24.1% engage in no leisure-time PA and 13.5% are inactive.<sup>4</sup> Accelerometer data indicate much lower prevalence of meeting recommendations.<sup>5</sup>

Several theory-based psychosocial constructs have been consistently related to PA in adults, including social support, self-efficacy, and behavior change strategies.<sup>6,7</sup> Interventions targeting psychosocial constructs have had success increasing PA.<sup>8–10</sup> Several measures of psychosocial constructs related to PA have been developed and validated for adults.<sup>9,11–15</sup> However, these measures are

often long, and they may be impractical for use in studies where multiple health behaviors are being studied and participant burden is a concern. The current study draws upon several existing measures to develop and evaluate a set of brief measures of theory-based behavior change constructs that parallel psychosocial measures for dietary behaviors (eg, general healthy eating, fruit and vegetable consumption, reducing dietary fat, and increasing servings of whole grains).<sup>16</sup> These brief psychosocial measures may be particularly useful for assessing multiple behavior change interventions, which are needed because most adults fail to meet guidelines for several behaviors.<sup>17,18</sup> Using brief psychosocial measures with parallel versions for multiple behaviors can reduce participant burden while allowing standardization of evaluation across the behaviors.

The present studies investigated the reliability and construct validity of brief measures of psychosocial variables related to PA. The psychosocial variables were based on the Transtheoretical Model of Behavior Change<sup>19</sup> and Social Cognitive Theory.<sup>20</sup> The constructs measured were self-efficacy, decisional balance (the pros and cons of change), social support, use of behavior change strategies, and enjoyment. These constructs were chosen because the intervention studies from which the present data were collected focused on improving these constructs. Measures of the same constructs have been supported for validity in youth<sup>21,22</sup> and adults.<sup>11,23</sup> This is the first study to investigate the reliability and validity

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Carlson and Sallis are with the Dept of Psychology, San Diego State University, San Diego, CA. Wagner is with the Institute for Health Research, Kaiser Permanente Colorado, Denver, CO. Calfas, Patrick, and Norman are with the Dept of Family and Preventive Medicine, University of California–San Diego, La Jolla, CA. Groesz is with the Dept of Psychiatry, Stanford University Medical Center, Stanford, CA.

of brief psychosocial scales in a sample of overweight/obese adults and using accelerometry.

Study 1 assessed the convergent and discriminant validity of psychosocial measures by examining associations with PA measured via self-report and accelerometry in overweight and obese adults. Convergent and discriminant validity, subtypes of construct validity, together provide stronger support for a scale's validity.<sup>24</sup> Measures of related constructs should have higher associations (ie, convergent validity) than measures of unrelated constructs (ie, discriminant validity).<sup>24</sup> It was hypothesized that each psychosocial scale would be significantly and positively related to leisure PA and accelerometry to support its convergent validity (with the exception of the "cons" scale which was expected to have an inverse association with PA). Each scale was expected to have a weaker or null association with occupational and transportation PA to support its discriminant validity. Study 2 was conducted to determine the test-retest reliability and internal consistency of the psychosocial measures in a sample of college students. It was hypothesized that each scale would display adequate reliability based on published standards.

## Study 1 Method

### Participants

Participants were overweight or obese men ( $N = 441$ ) and women ( $N = 401$ ) enrolled in separate but similar randomized controlled trials of Internet-based health promotion and weight control interventions targeting PA and dietary outcomes intended to lead to weight loss. Demographic characteristics for the 2 samples were similar. Mean age was 43.87 ( $SD = 7.98$ ) for men and 41.21 ( $SD = 8.68$ ) for women. Body mass index (BMI) was slightly higher for men (Mean = 34.19;  $SD = 4.06$ ) than women (Mean = 32.35;  $SD = 4.55$ ),  $F(1,838) = 38.71$ ,  $P < .001$ . Seventy-one percent of men were white, 63% had at least a college degree, and 70% were married or living with a partner. For women, 61% were white, 46% had at least a college degree, and 67% were married or living with a partner.

### Procedures

Women were recruited through their primary care providers, and men were recruited from the community through newspaper and radio advertisements and posted fliers. Eligibility criteria for both studies included having a BMI between 25 and 40, having Internet computer access, being in good general health, not pregnant or planning to be pregnant in the next 2 years, able to read and speak English, and able to engage in moderate intensity PA. Potential participants were also screened for eating disorders. Participants completed survey measures on computers in a quiet setting at the research office and were compensated \$15 for completing the baseline measurement visit. The 2 studies used the same data collection

protocol. All measures used in the present analyses were collected at baseline, before participants being randomized to study conditions. All study protocols were approved by the university institutional review board, and all participants provided written informed consent.

### Measures

**Brief Psychosocial Scales.** Items were selected from existing measures based on their performance in previous studies and some original items were added.<sup>9,15,21,25,26</sup> Items (both previously developed items and original items) with the strongest content validity based on consensus among authors were retained, with an emphasis on keeping wording and constructs simple so scales could be completed by participants with limited education levels (final readability: Flesch Reading Ease = 53.6; Flesch-Kincaid Grade Level = 8.8). Six scales were compiled: use of change strategies, self-efficacy, decisional balance (pros of change and cons of change), social support, and enjoyment for PA. Possible scores for each scale ranged from 1–5 where higher scores represented more of that construct. Response anchors were similar for each scale. Items in the scales referred to PA in general but were worded so participants would consider their leisure PA when responding. These measures can be obtained at <http://sallis.ucsd.edu/measures.html>.

The behavior change strategies for engaging in PA scale was composed of 15 items that reflected thoughts, activities, and feelings people may use when making a behavior change. These items reflect constructs common to many health behavior theories, including the processes of change construct from the Transtheoretical Model.<sup>19</sup> The items were based on a previously developed scale.<sup>9</sup> Five of the 14 items from the previously developed scale were retained and 10 original items were added (many were similar to items from the previously developed scale with slight rewording). The decisional balance items were adapted from a previous decisional balance scale for PA.<sup>11</sup> Five of the 16 items from the previously developed scale were retained, a sixth item was retained but slightly reworded, and 2 items relevant to overweight/obese individuals were added. The self-efficacy scale comprised 5 items asking about confidence to overcome various barriers to engaging in PA and a sixth item that asked about confidence to make time for PA daily. The 5 barrier items were adopted from a previously developed 5-item self-efficacy scale for PA.<sup>23</sup> The sixth item was developed for this study.

The social support for engaging in PA scale assessed how often, in the past 30 days, family or friends provided support or were not supportive of PA. Items were adapted from previously evaluated measures of support for PA in youth.<sup>21,22</sup> Two items were retained from the previously developed 9-item measure and 3 original items were added for this study. Enjoyment was assessed with 2 items for men and 1 item for women. Women were asked to rate their enjoyment for exercise, while men rated

their enjoyment for cardiovascular exercise and strength training separately and an average was computed for the 2 items. The difference in number of items between the samples was because the women's study focused on improving aerobic capacity through walking, while the men's study focused on walking and strength training.

**Body Mass Index (BMI).** Height was measured with a wall stadiometer, and weight was measured with a calibrated digital scale. BMI was calculated as weight in kilograms divided by height in meters squared ( $\text{kg}/\text{m}^2$ ). Two BMI categories were created based on Centers for Disease Control (CDC) criteria wherein BMI between 25 and 34.9 equals overweight to obesity class I and BMI between 35 and 40 equals obesity class II.

**International Physical Activity Questionnaire (IPAQ).** Participants completed the long version of the IPAQ to assess PA over the previous 7 days in 4 domains: leisure, occupational, transportation, and household. The IPAQ has been evaluated in a 12-country study and found to have test-retest reliability and validity (compared with accelerometers) comparable to other questionnaires.<sup>27</sup> Reported frequency (days per week during last 7 days) and duration (hours and minutes per day) for leisure vigorous, moderate, and walking PA were used to derive total MET-min per week of leisure-time PA. Leisure time PA was used in the present analyses because the psychosocial variables were designed primarily to explain activity in this domain. Occupational and transportation PA MET-min per week were calculated in the same manner and used in the present analyses as evidence for discriminant validity because the psychosocial items did not reflect PA in these domains.

**Accelerometer Measured Total Moderate-to-Vigorous Physical Activity (MVPA).** Participants wore Actigraph accelerometers (model 7164) on the right hip to assess PA across 7 days. The Actigraph stored acceleration counts at 1-minute intervals. A monitored hour was not considered valid if the number of consecutive minutes of 0 counts exceeded 30 minutes. Acceleration counts were translated into minutes of moderate to vigorous PA (MVPA) using accepted cut points of 1952 and 5725, respectively.<sup>28</sup> Data from the accelerometers were considered valid if the monitor was worn for at least 3 of the 7 days and for at least 10 hours each day. A range of 3–7 days of monitoring has been found to give reliable estimates of PA.<sup>29</sup> Due to incomplete data from some participants, sample size for accelerometer measures was 362 for men and 309 for women.

## Analyses

Confirmatory factor analysis (CFA) was performed using Mplus version 6.0. A 5-factor model was specified with interfactor correlations (ie, change strategies, pros, cons, self-efficacy, and social support). The comparative fit index (CFI) and root mean square error of approximation (RMSEA) were used to determine overall model fit.<sup>30</sup> Items with standardized component loadings  $\geq .4$  were considered to be representative of the underlying construct.

SPSS version 17.0 was used for all other analyses. Means and internal consistency reliability (Cronbach's alpha) were investigated for each scale. Pearson correlations were used to investigate associations between the psychosocial scales and PA measures. Correlations of the psychosocial scales with leisure PA and accelerometry were used to examine convergent validity, with smaller magnitude correlations expected for accelerometers due to the accelerometer capturing total MVPA and the absence of shared method variance between the psychosocial scales and accelerometers. Correlations of the psychosocial scales with occupational and transportation PA were used to examine discriminant validity.

Convergent validity coefficients were tested to determine if they were moderated by ethnicity, age, education level or BMI category in a series of regression models with interaction terms. Potential moderators were coded as follows: ethnicity [white vs. nonwhite (including Hispanics)], age (median split;  $< 44$  vs.  $\geq 44$ ), education ( $<$  college degree vs.  $\geq$  college degree), and BMI category ( $< 35$  vs.  $\geq 35$ ). Each IPAQ variable's distribution was corrected for skewness using log transformations. The raw variables were used in the descriptive analysis, and log transformed variables were used in the validity and moderator analyses.

## Study 2 Results

Confirmatory factor analysis indicated good model fit in men and women (CFI = .90 and RMSEA = .05 for both samples; see Table 1). Correlated error terms were specified between 2 items within the pros, cons, self-efficacy, and social support factors; 3 correlations among error terms were specified within the change strategies factor. One item from the change strategies factor was almost identical to an item from the social support factor and was excluded from the CFA. Standardized loadings ranged from .41–.94 with 3 exceptions. Two cons items had loadings  $< .3$  in both samples and 1 self-efficacy item had a loading  $< .4$  in men. Table 2 presents the interfactor correlations.

The men and women samples had similar means and internal consistency alphas for each of the psychosocial scales (see Table 3). Scores were highest for PA pros (Means = 4.09 and 4.21), and lowest for PA cons and social support (Means = 2.03–2.39). Each scale had an acceptable alpha with the exception of the cons scale which had an alpha of .55 and .59 in men and women, respectively. Alphas were highest for change strategies (.89 and .90) and social support (.89 and .85). Men reported a median of 396 MET minutes/week of leisure PA, 80 MET minutes/week of occupational PA, and 99 MET minutes/week of transportation PA (see Table 4). Women reported a median of 297 MET minutes/week of leisure PA, 0 MET minutes/week of occupational PA, and 99 MET minutes/week of transportation PA. Median minutes/day of total MVPA measured by accelerometry was 32 for men and 18 for women.

Table 5 presents correlations between the psychosocial scales and PA outcomes. The change strategies ( $r = .40$ – $.46$ ), self-efficacy ( $r = .19$ – $.22$ ), and enjoyment

**Table 1 Overall Model Fit and Factor Loadings From Confirmatory Factor Analysis in Overweight/Obese Men and Women**

	Men (n = 441)	Women (n = 401)
Overall model fit		
$\chi^2$ (df)	1054 (478)	980 (478)
CFI	.90	.90
RMSEA	.05	.05
Change strategies (15 items)		
I look for information about physical activity or sports	.44	.56
I keep track of how much physical activity I do	.66	.72
I find ways to get around the things that get in the way of being physically active	.49	.49
I think about how my surroundings affect the amount of physical activity I do (surroundings are things like having exercise equipment at home or a park nearby)	.57	.54
I put reminders around my home to be physically active	.42	.42
I reward myself for being physically active	.58	.59
I do things to make physical activity more enjoyable	.73	.73
I think about the benefits I will get from being physically active <sup>a</sup>	.61	.63
I try to think more about the benefits of physical activity and less about the hassles of being active <sup>a,b</sup>	.66	.67
I say positive things to myself about physical activity <sup>b</sup>	.64	.65
When I get off track with my physical activity plans, I tell myself I can start again and get right back on track	.77	.72
I have a friend or family member who encourages me to do physical activity	NA	NA
I try different kinds of physical activity so that I have more choices	.71	.69
I set goals to do physical activity <sup>c</sup>	.73	.75
I make back-up plans to be sure I get my physical activity <sup>c</sup>	.68	.66
Pros (4 items)		
I would have more energy for my family and friends if I did regular physical activity	.55	.60
Regular physical activity would help me to manage my weight <sup>d</sup>	.68	.74
Doing regular physical activity puts me in better mood for the rest of the day <sup>d</sup>	.76	.77
I would look better if I did regular physical activity	.58	.62
Cons (4 items)		
Regular physical activity would take too much of my time	.94	.75
I would feel self-conscious about how I look if people saw me doing physical activity <sup>e</sup>	.17	.29
I feel uncomfortable when I do physical activity because I get out of breath and my heart beats very fast <sup>e</sup>	.21	.27
I would have less time for my family and friends if I exercised regularly	.50	.67
Self-efficacy (6 items)		
When I am tired <sup>f</sup>	.68	.72
When I am in a bad mood <sup>f</sup>	.65	.69
When I feel I don't have the time	.73	.73
When I am on vacation	.34	.41
When the weather is bad	.66	.62
Make time for at least 30 minutes each day of physical activity (like walking)	.53	.63
Social support (5 items)		
Encourage you to do physical activity	.88	.83
Discuss how not doing physical activity is unhealthy <sup>g</sup>	.85	.77
Remind you to do physical activity	.90	.84
Share ideas on how to get enough physical activity	.81	.78
Do physical activity with you <sup>g</sup>	.53	1

Note. Items with the same superscript letter had correlated error terms specified in both the men's and women's models. Abbreviations: CFI, Comparative Fit Index; RMSEA, root mean square error of approximation.

**Table 2 Correlations Among Latent Factors From Confirmatory Factor Analysis in Overweight/Obese Men and Women**

	Change strategies	Pros	Cons	Self-efficacy
Change strategies				
Pros	.36**/.42**			
Cons	-.11*/-.30**	-.15**/-.01		
Self-efficacy	.39**/.50**	.30**/.36**	-.21**/-.41**	
Social support	.18**/.33**	.26**/.30**	.12*/-.07	.18**/.28**

Note. First number is for men and second is for women; \*  $P < .05$ ; \*\*  $P < .01$ .

**Table 3 Means, Standard Deviations, and Cronbach's Alpha Internal Consistency Coefficients of Physical Activity (PA) Psychosocial Measures in Overweight/Obese Men and Women**

Variable <sup>a</sup>	Men (n = 441)		Women (n = 401)	
	Mean (SD)	Alpha	Mean (SD)	Alpha
Change strategies	2.57 (.71)	.89	2.64 (.74)	.90
Pros	4.09 (.64)	.70	4.21 (.66)	.73
Cons	2.03 (.68)	.55	2.24 (.77)	.59
Self-efficacy	2.53 (.80)	.76	2.44 (.81)	.80
Social support	2.39 (1.10)	.89	2.31 (1.04)	.85
PA enjoyment	3.55 (.92)	.00	3.88 (1.08)	NA <sup>b</sup>

<sup>a</sup> Scores for each psychosocial scale have a possible range of 1–5.

<sup>b</sup> Only 1 item was used in the women sample.

**Table 4 Medians and Interquartile Ranges for Physical Activity (PA) Estimates in Overweight/Obese Men and Women**

	Men (n = 441) <sup>a</sup>			Women (n = 401) <sup>b</sup>		
	Median	25th percentile	75th percentile	Median	25th percentile	75th percentile
Accelerometer: average MVPA min/day	32	18	49	18	10	30
IPAQ: leisure PA MET min/week	396	0	1382	297	0	921
IPAQ: occupational PA MET min/week	80	0	1036	0	0	1095
IPAQ: transportation PA MET min/week	99	0	462	99	0	479

<sup>a</sup> N = 362 for accelerometer measures; <sup>b</sup> N = 309 for accelerometer measures.

( $r = .21$ – $.33$ ) scales were significantly associated with leisure PA (self-report) in both samples and with total MVPA (objectively assessed) in women only ( $r = .22$ – $.30$ ). The cons scale was significantly related to total MVPA and leisure PA in women ( $r = -.19$  and  $-.20$ ) but not in men. The pros scale and social support scale were unrelated to the convergent validity PA outcome measures except for a modest relationship between social support and leisure PA in women ( $r = .12$ ). As expected, there were no significant associations between the psychosocial scales and occupational PA. The change strategies

scale was significantly related to transportation PA in men ( $r = .16$ ).

A total of 96 tests (48 in each sample; data not shown) were analyzed to investigate interactions between the psychosocial scales and the convergent validity PA outcomes in terms of ethnicity, age, education and BMI. Of these, 4 were significant at the  $P < .01$  level, none were observed in both men and women, and none were observed for both total PA and IPAQ leisure time PA. Due to this lack of consistent evidence of moderation, interactions were not investigated further.

**Table 5 Correlations Between Psychosocial Measures and Outcome Measures for Physical Activity (PA) in Overweight/Obese Men and Women**

Sample		Convergent validity				Discriminant validity			
		Accelerometer: average MVPA min/day		IPAQ: leisure PA MET min/week		IPAQ: work PA MET min/week		IPAQ: transport PA MET min/week	
		<i>r</i>	95% CI	<i>r</i>	95% CI	<i>r</i>	95% CI	<i>r</i>	95% CI
Change strategies	Men	.12	.02, .22	.40**	.32, .48	.11	.02, .20	.16**	.07, .25
	Women	.29**	.18, .39	.46**	.38, .53	.06	-.04, .16	.11	.01, .21
Pros	Men	-.01	-.11, .09	.11	.02, .20	-.02	-.11, .07	.02	-.07, .11
	Women	-.02	-.13, .09	.07	-.03, .17	-.05	-.15, .05	.01	-.09, .11
Cons	Men	.02	-.08, .12	-.06	-.15, .03	.06	-.03, .15	.02	-.07, .11
	Women	-.20**	-.30, -.09	-.19**	-.29, -.10	-.03	-.13, .07	.07	-.03, .17
Self-efficacy	Men	.06	-.04, .16	.19**	.10, .28	.12	.03, .21	.02	-.07, .11
	Women	.22**	.11, .32	.20**	.12, .31	.06	-.04, .16	.07	-.03, .17
Social support	Men	-.01	-.11, .09	.09	.00, .18	.03	-.06, .12	.07	-.02, .16
	Women	.04	-.07, .15	.12*	.02, .22	.09	-.01, .19	.09	-.01, .19
PA enjoyment	Men	.06	-.04, .16	.21**	.12, .31	.06	-.03, .15	.00	-.09, .09
	Women	.30**	.19, .40	.33**	.24, .44	.01	-.09, .11	.04	-.06, .14

\*  $P < .01$ ; \*\*  $P < .001$ .

## Study 2 Method

### Participants and Procedures

Participants were 49 college students in a large southwestern US city. Ages ranged from 19–24 (Mean = 20.39, SD = 1.30) and 33 were women (67.3%). Fourteen participants identified as Asian-American/ Pacific Islander (28.5%), 1 as Black non-Hispanic (2%), 8 as Hispanic (16.3%), and 26 as White non-Hispanic (63.3%). Body mass index (BMI) ranged from 18.4–31.9 (Mean = 23.29, SD = 2.92). Participants were recruited through introductory psychology courses and received course credit. Participants completed identical pen-and-paper measures in a classroom twice across a 2-week interval. Retention rate was 100%. The university institutional review board approved the protocol.

### Measures

Participants completed the same survey measures described in Study 1: Change strategies, Pros, Cons, Self-efficacy, Social support, and PA enjoyment. The exception was that enjoyment was assessed with 1 item in all participants.

### Analyses

Cronbach's alpha was used to assess internal consistency of the scales. Alphas  $\geq .70$  were considered to meet minimal standards.<sup>31</sup> Intraclass Correlation Coefficients (ICCs) were used to assess 2-week test-retest reliability.<sup>32</sup> The criteria for interpreting the strength of the ICC values were  $\leq .40$  is poor; .41–.60 is fair; 0.61–0.80 is moderate; and .81–1.0 is substantial.<sup>33</sup> Confidence intervals (95% CIs) around the ICCs indicated if the reliability estimate was statistically different from 0 at the  $P < .05$  significance level.

## Study 2 Results

Table 6 presents means, standard deviations, alpha coefficients and test-retest reliability estimates for the 6 psychosocial scales at baseline and 2-week follow-up. Alphas ranged between .55 and .88 for all scales. Each scale, with the exception of the cons scale, had an alpha  $\geq .70$  for at least 1 time point. The self-efficacy (ICC = .81) scales exhibited substantial test-retest reliability. Test-retest ICCs for the change strategies, pros, cons and social support scales were in the moderate range (ICCs = .61–.80). Test-retest reliability for enjoyment was fair (ICC = .49).

**Table 6 Means, Standard Deviations, and Reliability Estimates of Psychosocial Scales for Physical Activity (PA) in College Students, N = 49**

Variable	# of items	Baseline			Two week follow-up			ICC	95% CI
		Mean	SD	Alpha	Mean	SD	Alpha		
Change strategies	15	3.28	.62	.88	3.22	.64	.88	.80	.67, .88
Pros	4	3.71	.71	.55	3.68	.96	.80	.65	.45, .79
Cons	4	1.85	.68	.61	1.94	.67	.63	.61	.40, .76
Self-efficacy	6	2.73	.66	.68	2.69	.69	.71	.81	.69, .89
Social support	5	2.35	.92	.78	2.49	1.03	.87	.67	.48, .80
PA enjoyment	1	4.43	.82	NA	4.22	.85	NA	.49	.24, .68

Abbreviations: SD, standard deviation; ICC, intraclass correlation coefficient; CI, confidence interval.

Note. Mean scores for each scale have a possible range of 1–5.

## Discussion

This was the first study to test the reliability and validity of theoretically-derived brief psychosocial measures related to PA in an overweight/obese sample of adults and using accelerometry. Confirmatory factor analysis (CFA) supported the construct validity of the scales. Convergent validity varied across psychosocial measures. The strongest and most consistent correlates of PA were the scales for change strategies, self-efficacy and enjoyment of PA. The cons scale showed evidence of construct validity with accelerometry and leisure PA among women. The scales measuring PA pros performed poorly, as they were not related to any measures of PA. Discriminant validity for the measures was strong and superior to measures of parallel constructs for dietary behaviors.<sup>16</sup> There was evidence supporting acceptable internal consistency for each scale in both samples with the exception of cons. Test-retest reliability was moderate to substantial in the college sample for all scales except PA enjoyment.

CFA identified good fit for the 5-factor solution and fit indices were almost identical in men and women. Two cons items had loadings below the acceptable range, suggesting that the cons items could be divided into 2 scales in future studies. Several correlations among error terms were specified within the factors, suggesting that some shared variance existed between the 2 items that was not accounted for by the latent factor for the construct. The shared variance could be because the items were worded similarly or that they appeared next to each other in the survey. Correlated error terms also suggest that some items are overlapping and could be cut from the survey. However, cutting items would have to be balanced against potentially reducing the internal consistency of the scale and reducing the breadth of the scale to cover the content domain of the construct.

An important limitation of these psychosocial measures is that none were related to objectively measured MVPA among men. It is possible that men engaged in a wider range of types of PA that were not well assessed by accelerometers, such as bicycle riding, weight lifting and swimming. If there was differential measurement error by sex, this would contribute to the reduced magnitude

of the observed correlations for men. These sex-specific analyses revealed the need for further research to explain the less-consistent validity of psychosocial variables for men. Social support, for example, was related to PA in women but not men. While previous studies have found relationships between social support and PA,<sup>21,22</sup> it is possible that social support is more important for women than men.

Lack of association of PA pros with any of the PA outcomes was unexpected although previous research similarly indicated that barriers to change (cons) were more consistently related to PA than were benefits of change (pros).<sup>34</sup> It may be that, because these men and women were enrolling in a weight loss program, the pros items were consistently endorsed as being important because they reflected the expectations of being in a weight loss program (ie, look better, help to manage my weight, have more energy) regardless of how much PA participants were currently doing. This was consistent with the high mean score and low variance for the pros scale for the samples, which can also lower reliability coefficients and may explain the unstable alphas across time points in Study 2. The cons items were more difficult to endorse, leading to lower means, but cons discriminated PA levels among women, but not men. The cons items may be more salient to women (eg, feel self-conscious, feel uncomfortable, less time for family and friends), particularly women who have begun exercise programs in the past to lose weight. Developing cons items that are more salient and pros items that are more difficult to endorse for men may be necessary for the scale to discriminate men's PA levels.

Findings for the new brief scales are generally consistent with the extensive evidence of significant associations between PA and constructs of change strategies, self-efficacy, enjoyment and cons.<sup>6</sup> The scales for change strategies and self-efficacy for PA were consistently related to leisure PA, providing further evidence that they are useful explanatory variables for PA. The change strategies scale incorporated items related to self-monitoring, overcoming barriers, thinking about benefits, social support, and goal setting, which are all evidence-based behavioral strategies. The PA enjoyment

items also demonstrated strong construct validity, even though the construct was measured with only 1 (women) or 2 (men) items. However, the 2 items for men (enjoyment of cardiovascular or strength activities) had a low alpha, indicating they are not a coherent scale, so they may be better used separately as predictors of different target behaviors.

Moderator analyses revealed few differences in the relationship between the psychosocial scales and PA measures across ethnicity, age, education and BMI categories. There was no apparent pattern of moderation. No interactions were significant in both samples or for both of the outcome measures for convergent validity, indicating the psychosocial scales performed similarly for diverse population segments. However, the pattern of psychosocial variables being unrelated to men's MVPA measured by accelerometers indicates a potential limitation in generalizability of the current measures.

Most of the brief psychosocial scales demonstrated acceptable internal consistency and test-retest reliability in a sample of university students. The exceptions were the cons scale which had an alpha value below the acceptable criterion, and the enjoyment scale which had a test-retest ICC in the fair range. These scales need further development and testing. The psychometric performance compared favorably to longer measures of the same constructs.<sup>9,15</sup> For example, the test-retest coefficient for subscales of a longer PA self-efficacy scale was .68. The generalizability of the findings was limited by having a well-educated sample that was mostly young and White non-Hispanic. Because the scales were designed to be concise, they did not reflect the multiple factors of the constructs identified in previous studies.<sup>15,21,26</sup>

A limitation of the current study was that most measures used were self-report and subject to inaccuracies and biases. However, the self-report PA variables were derived from the well established IPAQ, and accelerometry was also used to objectively measure total PA. For women but not men, construct validity of several variables was supported by associations with both self-reported and objectively measured PA. The nature of the Study 2 sample as participants in a weight loss program could be considered a weakness, but moderator analyses indicated that level of obesity did not affect the validity of the psychosocial measures. However, a more heterogeneous sample in regard to body weight would likely result in more variation in the item responses, which should have the effect of improved reliability and potentially improved validity coefficients. Since the goal was to investigate performance of the scales in a sample of overweight/obese adults, the use of a college sample to assess test-retest reliability can be seen as a limitation of this study. However, each study sample provides evidence for the psychometric properties of the measures for that particular sample, which adds to the overall knowledge about these instruments. Strengths of the study included testing the measures in multiple samples and evaluating if the validity evidence was moderated by multiple individual factors of interest.

The current study provided evidence for the reliability and construct validity of brief theory-based

psychosocial scales related to physical activity. The cons and enjoyment scales need further development and testing. The findings provided further support for the relationship between these psychosocial constructs and PA, including for less-studied variables such as enjoyment and use of change strategies. These measures can be used in PA and weight loss intervention studies to assess the extent to which interventions work through these mediating constructs to influence PA.<sup>35</sup> Evidence supporting psychosocial mediation of PA interventions is inconsistent,<sup>36–38</sup> so the use of the wider range of brief, consistently formatted, theory-based mediator measures from the present scales could advance both research and practice in the promotion of improved levels of PA for individuals and populations.

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