Factor structure and psychometric properties of a perceived barriers to physical activity scale for low-income teens

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Research

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Abstract

Background: Despite known benefits of health and well-being, high-school aged adolescents don't engage in regular daily physical activity (PA). PA levels are lesser among low-income adolescents. One significant predictor of PA levels is perceived barriers, however, there is a lack of a valid and reliable scale to measure perceived barriers among the low-income adolescent population. The objective of this study was to develop a scale to assess perceived barriers to PA among these high-school aged, low-income adolescents.

Methods: The Perceived Barriers to PA Survey for Low-Income Adolescents (PBPA-A) was developed using a mixed-method approach. Initially, 110 items were identified from pre-existing surveys and extensive literature review. These items were then tested using cognitive interviews (n=15) to ensure the wording clarity and appropriateness. Items were deleted and revised based on the feedback from the cognitive interviews. Then, a 2-week test-retest reliability was conducted with 105 adolescents to assess the scale's consistency over time using intraclass correlation coefficient (ICC). Items with ICC $\leq$ 0.4, indicating insufficient reliability, were deleted, as were those demonstrating a floor effect. Exploratory factor analysis (n=999) and confirmatory factor analysis (n=999) were used to explore and confirm the underlying structure of the remaining 73-item scale. Items with a loading of $\geq$0.4 were retained and internal consistencies for the whole scale and subscales were calculated using Cronbach's alpha. Test-retest reliability was recalculated, and concurrent validity was tested in a sample of 1,998 adolescents against the pre-established physical activity questionnaire for adolescent (PAQ-A) using Spearman correlations.

Results: The EFA yielded a 7-factor solution with 37 items, which was further cross-validated by CFA. The test-retest reliability was 0.75 for the whole scale and ranged from 0.65 to 0.81 for the subscales. As predicted, the PABA-A scale and subscales were negatively associated the PAQ-A score, indicating adolescents with higher perceived barriers had lower physical activity levels.

Conclusions: The PBPA-A is a valid and reliable scale that can be used to measure perceived barriers among older, low-income adolescents to better understand the relationship between perceived barriers and PA in this population. Further research is warranted to validate the scale in other adolescent subgroups.

Introduction

The benefits of adolescents' engagement in physical activity (PA) range from reduced risk of type 2 diabetes and obesity to improved mental health and more favorable sleep patterns [1–5]. Despite these benefits, adolescents' PA levels have been found to decline with age by approximately 38–41 minutes per year [6, 7]. The U.S. Youth Risk Behavior Surveillance Survey 2017 results revealed that only 26.1% of high school adolescents met the U.S. Physical Activity Guidelines of engaging in moderate to vigorous PA for $\geq$ 60 minutes per day [8, 9].

One predictor of low PA levels is perceived barriers. In fact, perceived barriers (one's judgments regarding personal, social, environmental, and economic obstacles that hinder engagement in health behaviors, like PA) have been identified as the "most powerful" Health Belief Model's constructs [10]. Yet, studies examining the relationship between adolescents' perceived barriers and PA have been inconclusive [11–14]. This may be due to the lack of a comprehensive, validated scale to assess them. Some studies examining the relationship between high school–aged adolescents' perceived barriers and PA levels have used scales developed for adults, sometimes with minor adaptations [15, 16]. Other studies have developed their own scales, with limited reliability and validity assessment [17–20]. To better understand the relationship between adolescents' perceived barriers and PA, the use of a comprehensive, reliable, and valid barriers scales is critical.

Notably, PA levels are lower among adolescents of low socioeconomic status (SES). Because low-income adolescents may have different perceived barriers than adolescents from higher SES backgrounds [21] and older adolescents demonstrate lower PA levels, this study sought to develop a scale to assess the perceived barriers to PA among low-income high school–aged adolescents.

Methods

A mixed-method approach was used to develop this Perceived Barriers to PA Survey for Low-Income Adolescents (PBPA-A). Multiple steps, detailed below, were conducted in in the PBPA-A's development, including preliminary work to identify PBPA-A items and conduct item cognitive testing, and field-testing to assess its reliability, factor (subscale) structures, and the scale's internal consistency and concurrent validity. All statistical analyses were conducted using SAS (version 9.4, SAS Institute, Cary, NC). This work was approved by Rutgers Institutional Review Board (protocol E13-022).

Preliminary Work

An initial list of 77 barriers to PA perceived by adults was obtained from previous research (i.e., from literature review and interviews) conducted by the study team. Some PA barriers identified were inclement weather, competing interests, lack of motivation, health problems, time, transportation, cost issues, and lack of knowledge. Another extensive literature review was conducted to identify adolescents' barriers to PA. An additional 33 items were identified, including family support and embarrassment. The compiled barrier items (total = 110) were reviewed by the research team and New Jersey Expanded Food and Nutrition Education Program professional staff to establish content validity. Items that were unclearly worded were modified. Items were rated using a 5-point Likert scale regarding how often each barrier stopped teens from exercising. Responses were: (1) Never, (2) Once in a while, (3) Sometimes, (4) Often, and (5) Always.

Cognitive interviews were conducted with 15 low-income high school students to further assess the survey's face validity. The adolescents were asked to read the instructions and each item aloud, describe in their own words what the question was asking, and then explain how they would respond using the response choices provided. All cognitive interviews were audio-recorded; no identifiable information was collected. Items and responses were assessed for readability, comprehension, completeness, and clarity. Items that were unclear, too complex, did not apply (as written), or had multiple meanings were modified based on the interviews' results. Three items were removed due to redundancy. Other changes made were minor; thus, 107 items remained.

Field Testing

Study Population and Recruitment

The field-test sample was recruited from 12 low-income high schools in which more than 50% of the adolescents qualified for free or reduced-priced lunch from the U.S. National School Lunch Program and 6 community agencies in low-income areas of New Jersey. Eligible participants were adolescents (grades 9 to 12) who could understand, read, and speak English. Surveys were collected between May 2012 and April 2016 (N = 2,762).

Test-Retest Reliability

A subsample of older adolescents (n = 105) from 5 sites participated in the test-retest assessment. The teens were asked to complete the PBPA-A survey twice, 2 weeks apart. At baseline, their demographic information, such as age, gender, and ethnicity, was provided. Because the questionnaire was lengthy, three versions were created, wherein the order of the barrier items was randomized and 3 attention-check questions (i.e., “On this line, put two checks in the ‘Often’ column”) were placed in different locations such that surveys belonging to adolescents whose attention waned could be removed from the sample. The survey took approximately 10–15 minutes to complete. No compensation was provided. All responses were anonymous and matched by unique identifiers.

Reliability over time was assessed as an early item-reduction step, and again for the revised full PBPA-A and its subscales after factor analysis. Both times this was accomplished by comparing the adolescents’ PBPA-A test-retest responses for each item on PBPA-A scale. Intra-class correlation coefficients (ICC) were used to compare the responses [22]. ICCs were classified as follows: “excellent” (≥ .81), “good” (0.61–0.80), “moderate” (0.41–0.60), or “poor” (≤ 0.40) [22–24]. Questions were considered to have poor reliability over time if the ICC was < 0.40 [22].

Preliminary Item-Reduction Steps

Prior to the factor analysis, the survey items were removed if they exhibited: (1) poor test-retest reliability (i.e., ICC < 0.40), or (2) a floor effect (i.e., > 80% of participants rated the item as a “1” (“Never a barrier”). Remaining items were used for exploratory factor analysis and internal consistency testing.

Factor Analysis and Internal Consistency

In order to cross-validate the proposed measure, the sample was randomly split into halves. One half (n = 999) was used to perform an EFA to explore the underlying structure of the survey items, and the other half was used to perform a CFA (n = 999) to confirm the identified structure. The samples did not differ regarding gender (χ^2 = 0.10, df = 998, p = 0.74), race/ethnicity (χ^2 = 3.51, p = 0.48), and grades (χ^2 = 2.79, df = 998, p = 0.42).

Prior to the EFA, the items’ factorability was examined using the intercorrelation matrix from Pearson’s correlations. Items with correlation coefficient (r) values below 0.20 were to be deemed inappropriate for factor analysis [25, 26]. Items with r values above 0.80 suggested multicollinearity (i.e., items can be predicted by each other) and were to be eliminated before the EFA [25, 26].

The Kaiser-Meyer-Olkin (KMO) test was used to examine sampling adequacy. The KMO test values ranged between 0 and 1. A value of 0 means that the sum of partial correlations is larger relative to the sum of correlations, indicating diffusion in the correlation pattern (hence, again, factor analysis is likely to be inappropriate). The values for KMO tests should be above 0.60 [25, 27]. The Bartlett’s test of sphericity either confirms or rejects the null hypothesis (that there are no relationships observed between items); thus if relationships are ample to cause the test results to be significant (p < 0.05) to reject the null hypothesis and indicate the items are factorable [26].

An EFA using maximum likelihood estimates with oblique rotation (Promax) was conducted to identify the factor structure. The oblique rotation enables the factors' correlations to be examined, so the model can be better interpreted [27, 28]. While determining the number of factors, it has been recommended that researchers should utilize different methods [26]. Thus, to determine the best factor solution these models were used: (1) Kaiser-Guttman criteria (i.e., eigenvalue > 1); (2) the scree plot; (3) parallel analysis; (4) minimum average partial (MAP) test; and (5) the interpretability of the factor solution (i.e., whether the items loaded on the same factor had the same concept, the factor loading was following a simple structure solution). Parallel analysis and MAP tests were employed because they were considered superior estimates of the number of factors to retain, based on simulation studies [29, 30]. The code used for these test was provided by O'Connor and colleagues [31].

After determining the number of factors, only items that achieved a factor loading > 0.4 and that loaded on only one factor were retained. Internal consistency for the entire PBPA-A an8d for each subscale was measured using the Cronbach's alpha, with acceptable alpha values ≥ 0.70.

Again, to confirm the EFA factor structure identified, a CFA was conducted with the second sub-sample. Although a chi-square test (χ^2) is traditionally used to test goodness of fit, with statistically significant results suggesting that a model exhibits a lack of fit to the data, χ^2 results are not always dependable with larger samples so both χ^2 and other fit indices were examined [28]. Those used were: the model, the Standardized Root Meant Square Residual (SRMR), the goodness-of-fit index (GFI), the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and the Bentler-Bonett Non-normed Fit Index (NFI). The model fit was assessed using these criteria: GFI, NFI, and CFI values of > 0.90 were considered to be acceptable; SRMR and RMSEA values ≤ 0.055 were considered to be acceptable [28, 32–34].

After assessing the model fit, the significance of the parameter estimates for each item was examined to see if they were different from zero. The parameter estimate is equivalent to a path coefficient from a survey's latent factor. A nonsignificant parameter estimate suggests the survey item did not significantly contribute to the underlying model and should be deleted.

Concurrent Validity

In the absence of a standard for measuring perceived barriers, concurrent validity was assessed by examining the relationship between adolescents' perceived barriers as measured by the PBPA-A and their self-reported PA levels evaluated using the Physical Activity Questionnaire for Adolescents (PAQ-A). The PAQ-A has been deemed the most suitable, valid, and reliable self-report tool for examining adolescents' PA levels during the school year [35–37]. PAQ-A items are assessed using a 5-point Likert scale to estimate total activity via items that address the following: spare time PA; PA during physical education classes, lunch, right after school, evening, weekends; and PA and PA frequency for each day during the past week [38]. It was hypothesized that perceived barriers would be negatively associated with PAQ-A scores. Skewness, kurtosis, and the Shapiro-Wilk test for normality were used to assess variables' distributions. None were found to be normally distributed, so the Spearman correlation coefficient was used.

Results

Participants' Characteristics

From among the teens surveyed (N = 2,762), only data those students who responded correctly to the bogus questions (i.e., who were deemed to have given adequate attention to the survey), 1,998 (see Table 1) were included in the analyses.

Table 1. Sample Characteristics*

	Total (N = 1998)	Reliability study (n = 74)
Variables	n (%)	n (%)
Female	1071 (57.1%)	46 (68.7%)
Race/Ethnicity		
Hispanic	890 (46.2%)	44 (61.1%)
Non-Hispanic African American	226 (11.7%)	3 (4.2%)
Non-Hispanic Caucasian/White	622 (32.2%)	19 (26.4%)
Non-Hispanic Other	196 (10.1%)	6 (8.3%)
Grade		
9th	514 (27.5%)	8 (10.8%)
10th	432 (23.1%)	9 (12.2%)
11th	416 (22.2%)	6 (8.1%)
12th	510 (27.2%)	51 (68.9%)
*sample size included in the final analysis excluding missing values		

Preliminary Item Reduction: Test-Retest Reliability and Floor Effect

The ICC of the original 107 items ranged from 0.002 to 0.830. Twenty-eight (26.2%) items scored above 0.60, indicating good to excellent reliability; 50 (46.7%) had an ICC between 0.41–0.60, indicating moderate reliability; and 32 had ICC values below 0.40.

Among the 32 items that did not met the reliability criteria (ICC > 0.40), 3 items—"I am lazy" (ICC = 0.39), "I get enough exercise in gym class" (ICC = 0.39), and "It makes me feel stressed" (ICC = 0.38)—were retained because their values were extremely close to the cutoff, and the researchers believed they were conceptually important and their ICCs were very close to 0.40. An additional 7 items exhibited a floor effect; thus, 71 items were remained for further analyses.

Exploratory Factor Analysis and Confirmatory Factor Analysis

Values for the assessment of factorability were all within acceptable ranges. The correlations between items ranged between 0.2 and 0.8. The Bartlett's test of sphericity was significant (χ^2 = 21,612.6, $p < .0001$), and the KMO value (0.95) exceeded Kaiser's (1974) recommendation of > 0.90 [39]. Also, measures of sampling adequacy for each item were all above 0.89, (i.e., larger than the recommended value of > 0.70 [39]. Therefore, no additional items were removed prior to the EFA.

Four methods were used to determine the number of factors that should be retained. The Kaiser-Guttman criteria (eigenvalues ≥ 1.0), suggested 16 factors, which accounted for 99.9% of the total variance; the “elbow” of the scree plot indicated 7 factors; and the parallel analysis and MAP test suggested 11 and 8 factors, respectively. Thus, separate EFAs were run for the 16-, 11-, 8-, and 7-factor solutions. As per recommendations, the interpretability of the factor solution (i.e., whether the items loaded on the same factor shared conceptual similarity, or the factor loadings followed a simple structure solution) was used to determine the final factor structure [28]. An attempt was made to include at least 3 items per domain to ensure minimum coverage of each construct’s theoretical domain. The 7-factor solution was deemed to be the most interpretable model.

Items that did not load ≥ 0.4 on any factors (n = 28) were deleted, and EFAs were repeated with the remaining items until a simple structure (i.e., no items loading on multiple factors) was obtained. This resulted in 7 factors and 39 items; however, two items - “It takes too much time” and “It does not feel good” - were deleted as they did not fit into the factor on which they had loaded (i.e., Factor III). The EFA was rerun and yielded 7 factors of 37 items (Table 2). Although “My friends don’t do it” loaded at < 0.4, it was kept due to its conceptual importance. The final factor structure is shown in Table 2. The intercorrelations between factors ranged from 0.30 to 0.59. (Table 3)

Table 2. Factor Loadings, ICC, internal consistency of PBPA-A scale								
Items	Factors	Mean[a]	SD[a]	ICC	Loadings	Eigenvalues	% Variance	Cronbach's alpha
	Factor I: Self-Consciousness	1.68	0.92	0.75		25.1	66.8	0.88
BODY4	Fear of people making fun of me	1.62	1.14	0.57	0.90			
BODY1	I get embarrassed	1.70	1.13	0.46	0.81			
BODY5	I am self-conscious about my looks	1.81	1.24	0.57	0.70			
BODY8	People whispering or pointing at me	1.79	1.22	0.67	0.69			
BODY6	I am concerned about how I look when I exercise	1.62	1.14	0.56	0.66			
EMOT11	I don't think I can do it	1.66	1.10	0.49	0.43			
	Factor II: Competing Interests	2.25	0.96	0.75		4.6	12.1	0.82
COMP9	I would rather watch TV	2.13	1.27	0.77	0.73			
COMP5	I would rather play video games	1.97	1.31	0.67	0.66			
FUN1	I would rather be doing something that is more fun	2.52	1.27	0.67	0.56			
EMOT13	I'd rather spend time with my friends or family	2.43	1.32	0.52	0.54			
COMP1	I would rather spend time on the computer	2.19	1.29	0.53	0.55			

Table 2. Factor Loadings, ICC, internal consistency of PBPA-A scale

COMP8	I would rather talk online, on the phone, or text	2.31	1.35	0.50	0.51			
	Factor III: Personal Expectations and Familial Influences	1.74	0.89	0.68		3.1	8.1	0.82
PHYS7	I am not coordinated	1.65	1.09	0.54	0.57			
FAM6	My family is not active	1.72	1.14	0.65	0.56			
FAM5	People in my family don’t believe it is important	1.43	0.93	0.65	0.55			
FAM4	No one in my family expects me to exercise	1.67	1.15	0.62	0.49			
PHYS6	I’m not good at sports	1.87	1.29	0.66	0.47			
EMOT20	I don’t think exercise will do me any good	1.52	1.00	0.52	0.46			
KNOW3	I don’t know how to do activity	1.62	1.03	0.54	0.44			
PEER1*	My friends don’t do it	1.60	1.01	0.40	0.26			
	Factor IV: Lack of Resources	1.61	0.76	0.81		2.2	5.8	0.82
COST2	There are no free or low-cost places to exercise near me	1.78	1.24	0.48	0.85			
COST3	I cannot afford exercise classes	1.70	1.23	0.67	0.73			
TRANS2	There is nowhere close to exercise	1.67	1.10	0.43	0.66			

Table 2. Factor Loadings, ICC, internal consistency of PBPA-A scale

TRANS3	No one helps me with transportation	1.84	1.21	0.49	0.43			
TRANS1	I have no way to get to where I could exercise	1.79	1.17	0.51	0.43			
	Factor V: Weather	2.15	1.00	0.65		1.5	4.0	0.81
OUTD12	It is raining outside	2.21	1.40	0.59	0.83			
OUTD8	It is cold outside	2.30	1.47	0.51	0.73			
OUTD11	There is snow outside	2.07	1.28	0.49	0.70			
OUTD9	It is dark outside	1.95	1.29	0.55	0.57			
	Factor VI: Lack of Motivation	2.12	1.07	0.68		1.4	3.7	0.84
PHYS4	It feels like hard work	2.00	1.26	0.50	0.73			
EMOT5	I am lazy	2.53	1.42	0.39	0.68			
EMOT2	I don’t like doing it	2.07	1.26	0.42	0.65			
PHYS1	Lack of energy	2.28	1.23	0.56	0.53			
	Factor VII: Competing Priorities	1.82	0.82	0.72		1.3	3.5	0.71
TIME2	Chores leave me with too little time	1.74	1.11	0.56	0.85			
BODY9	My chores wear me out	1.72	1.10	0.60	0.54			
TIME4	When I am at home, I need to baby-sit	1.70	1.15	0.60	0.46			
TIME1	I am too busy to exercise	2.16	1.22	0.56	0.40			

[a] Answer choices: Never, Once in a while, Sometimes, Often, and Always; score = 1 to 5 respectively.
*This item was added to this factor due to conceptual similarities although it did not meet the criteria of >0.40

CFA was used to confirm the factor structure. While the Chi-Square statistic's significance ($\chi^2 = 1665.5$, $p < 0.0001$) suggested that the model did not fit the data, the CFI and NFI values demonstrated acceptable fit at the 0.90 cutoff point. Further, the SRMR and RMSEA values (i.e., 0.053 and 0.052, respectively) suggested the model had a good fit with the data. The GFI value was 0.88, just slightly below the recommended threshold of 0.90. Standardized item-factor parameter estimates were all significant ($p < 0.0001$), indicating that all items contribute significantly to the underlying factors' measurement. The parameter estimates ranged from 0.50 to 0.84.

Table 3
Inter-correlations Among Factors of the PBPA Scale

Factors	Factor I	Factor II	Factor III	Factor IV	Factor V	Factor VI	Factor VII
Factor I	1.00	0.41	0.52	0.61	0.50	0.33	0.35
Factor II		1.00	0.32	0.45	0.59	0.40	0.38
Factor III			1.00	0.51	0.42	0.35	0.41
Factor IV				1.00	0.55	0.45	0.43
Factor V					1.00	0.34	0.40
Factor VI						1.00	0.46
Factor VII							1.00

Internal Consistency and Test-Retest Reliability

The Cronbach's alpha for the PBPA-A scale was 0.94 (including the item "My friends don't do it"), and subscales' alphas ranged from 0.71 to 0.88 (Table 2). Also, the Cronbach's alpha analysis suggested no improvement if any items were removed. The ICC for the full scale was 0.75. Table 2 shows the ICC values for each item and each subscale, all of which were above 0.6.

Concurrent Validity

Because the factor structure was confirmed and the internal consistency and test-retest reliability were reasonable, the adolescents' scores for the PBPA-A and each of its subscales were calculated by computing a mean score for all items loading on them. Table 4 presents the means, standard deviations of the PBPA-A subscales. To establish concurrent validity, the PBPA-A score and the score for each PBPA-A subscale were correlated with the PAQ-A score. As expected, they were negatively correlated ($r = -0.20$ to -0.43; $p < 0.0001$) (Table 4).

Table 4. Spearman Correlations between the PBPA-A Scale and Subscales' Scores with PAQ-A Score (N = 1,998)

Scores	Mean ± SD	Correlations with PAQ-A score
PBPA Full scores	1.9 ± 0.7	−0.42****
PBPA Subscale 1 score	1.7 ± 0.9	−0.30****
PBPA Subscale 2 score	2.2 ± 1.0	−0.36****
PBPA Subscale 3 score	1.6 ± 0.8	−0.37****
PBPA Subscale 4 score	1.7 ± 0.9	−0.28****
PBPA Subscale 5 score	2.1 ± 1.1	−0.20****
PBPA Subscale 6 score	2.2 ± 1.1	−0.43****
Subscale 7 score	1.8 ± 0.8	−0.23****

PBPA-A: Perceived Barriers to Physical Activity Survey for Low-Income Adolescents; PAQ-A Physical Activity Questionnaire for Adolescents

*p < 0.05, **p < 0.01, ***p < 0.001, ****p < 0.0001

Discussion

This study addressed a lack of scale development and validation for assessing low income teens' perceived barriers to PA. To the best of the authors' knowledge, this is the first study that has undergone rigorous testing for factor analysis, reliability, and validity to develop a comprehensive scale for use with this audience.

One contribution of the PBPA-A was the inclusion of barriers regarding preferred engagement in technology-related activities (e.g., "I would rather play video games"; "I would rather spend time on the computer"). Preferred involvement in technology-related activities (e.g., television, computer, phone) has been identified as a significant PA barrier for high school–aged adolescents in qualitative studies [16, 40, 41]; however, no previously developed scales have addressed these concepts [16, 18, 19, 42, 43]. Due to teens' high prevalence of technology-based device usage, the inclusion of these concepts provides a more comprehensive picture to document low-income adolescents' PA barriers.

Contrary to previous PA barrier scales developed for teens [16, 18, 19, 42], two commonly assessed barriers, safety and injury, did not end up in the final PBPA-A. During the initial development of the PBPA-A, 9 items related to safety and 2 items related to injury were included among the 110 items. However, some items were removed due to floor effect, and none of the others exhibited sufficient ICCs or EFA loadings. Further, over 70% of the adolescents responded "Never" or "Once in a while" to all 11 items, suggesting to most they were not perceived barriers. Notably, safety and injury have been found to be rated low by adolescents in other studies [16, 19, 42]. Although it is counterintuitive that lack of a safe environment or having an injury or medical condition would not be perceived barriers to PA, previous research has suggested that adolescents perceive themselves as invulnerable [44]. Thus, while these factors may indeed be barriers to PA, they are not perceived as such by this population.

Previous research examining the factor structure of adolescents' perceived PA barriers is somewhat limited. Multiple studies have reported on adolescents' barriers [16–20, 42, 43], yet only five provided detailed information about the items they included in the scales used [16, 18, 19, 42, 43], and only one conducted a factor analysis [16]. That study, conducted by Allison and colleagues, examined the factor structure of a 16-item perceived barrier scale among 1,041 high school students [16]. The results yielded two factors: internal barriers (10 items) and external barriers (6 items). The internal barrier factor included items on individual, physical, or psychological barriers such as discomfort, lack of energy, and self-consciousness. The external barrier factor loaded items regarding lack of social support, facilities, part-time job, and cost. However, both the internal and external barrier scales encompassed single items that are actually multidimensional constructs. From a nutrition education perspective, it would be more useful to use multiple items to assess these constructs to aide in better targeted interventions. For example, "self-consciousness" is a perceived barrier in both Allison et al.'s scale and the PBPA-A. However, in the former scale, self-consciousness is a single item, whereas in the PBPA-A it is a "factor" comprised of 6 items reflecting different constructs, such as "People making fun of me" and "I don't think I can do it." Approaches used and messages tailored to overcoming these barriers would be entirely different depending on the scale's content. For example, to address the former construct professionals may aim to build self-esteem and/or to teach how to deal with bullying, whereas education tailored to the latter would be designed to increase self-efficacy.

Moreover, this study suggests some barriers cannot be classified as internal or external, as responses depend on respondent interpretation. For example, a girl's discomfort (identified as an internal barrier by Allison and colleagues) is an internal barrier if it is due to lack of coordination or her not feeling she is good at sports. However, it is an external barrier when it is due to discomfort caused by unfavorable weather. These problems highlight the complexity of studying perceived barriers and the need for a scale that can better assess concepts within broader barrier constructs.

The factor analysis done for the PBPA-A, identified 7 theoretically meaningful factors (self-consciousness, competing interests, personal expectations and familial influences, lack of resources, unfavorable weather, lack of motivation, and competing priorities (i.e., job, chores) with 37 items. With multiple item loadings on each factor, the PBPA-A is able to more thoroughly examine PA barriers, reduce ambiguity, and better examine the complexity of the perceived barriers. The correlations among factors (shown in Table 3), all less than 0.70, suggest that each factor likely measures a unique concept[45]. The PBPA-A' theoretical structure having been cross-validated by CFA strengthens the evidence that this structure is acceptable.

Additionally, this study showed evidence of the PBPA-A's and its subscales' reliability (i.e., the internal consistency and test-retest reliability). These reliability results were comparable to the two previously published scales that reported their Cronbach's alphas, which ranged from 0.73 to 0.90 [16, 43], and the one scale that reported a test-retest reliability ICC of 0.90) [43]. These reliability results suggest that the PBPA-A can be used in its entirety or separately with each subscale.

Multiple health behavior models indicate that perceived barriers impact behavioral outcomes, like PA [10, 46–48]. Yet, systematic reviews have yielded mixed results. Some have found perceived barriers had a small to moderately negative association [11, 37], while others were inconclusive or found no association [12, 13]. These inconsistencies might be caused by lack of the use of a valid and reliable scale, considering all the scales developed previously had limited reliability and validity information [16, 18, 19, 42, 43]. The strong negative correlation demonstrated by the concurrent validity results of the PBPA-A indicates a better alignment with the expected impact of the barriers on PA behaviors [10, 46–48]

Limitations

One notable study limitation was the use of a convenience sample in New Jersey, which might limit the findings' generalizability. Nonetheless, since the study sample was relatively large and racially/ethnically diverse with an approximately equal number of male and female participants, its generalizability to low-income teens throughout the U.S. and other developed countries may be reasonably good. Additional research to confirm the PBPA-A's factor structure, reliability, and validity in other geographical areas would be prudent. Another limitation was the lack of a "gold standard" to be used for concurrent validity testing. Yet PBPA-A's concurrent validity was established through the notion that those with more barriers are less active, and this was done using a valid and reliable tool (i.e., the PAQ-A). Further validity studies to establish criterion validity against objective measures may be warranted.

Conclusion

This study is one of few studies done to develop a scale to assess perceived barriers to PA among older adolescents. The findings reported herein provide empirical support for its reliability and validity. The use of the PBPA-A can contribute to greater prevision in the measurement of perceived barriers to PA among low-income adolescents. Researchers can use information obtained through the PBPA-A's administration to design better targeted interventions to assist adolescents in achieving PA recommendations. Further validation work is needed using an objective measure of PA and in other groups, such as middle school–aged adolescents.

Abbreviations

PA
physical activity; PBPA-A:Perceived Barriers to PA Survey for Low-Income Adolescents; PAQ-A:Physical Activity Questionnaire for Adolescents

Declarations

Ethics approval and consent to participate

Ethics approvals were obtained from Institutional Review Board from Rutgers, the State University of New Jersey (#E13-022). Informed consent was obtained in writing forms from all participants before data collection.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed may be available from the corresponding author on a reasonable request after IRB approval.

Competing interest

The authors declare that they have no competing interest.

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Authors’ contributions

CL, CH and DPK led the development of this manuscript. DPK and CH contributed to the conception, design of this study, and data collection. CL, DPK, CH wrote the first draft of the manuscript. All authors contributed to data analyses and interpretation and accepted the final version of the manuscript and are responsible for its content.

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References

[1] Teixeira-Lemos E, Nunes S, Teixeira F, Reis F. Regular physical exercise training assists in preventing type 2 diabetes development: focus on its antioxidant and anti-inflammatory properties. Cardiovasc Diabetol. 2011;10(1):12. https://doi.org/10.1186/1475-2840-10-12.

[2] Ness AR, Leary SD, Mattocks C, Blair SN, Reilly JJ, Wells J, et al. Objectively measured physical activity and fat mass in a large cohort of children. PLoS Med. 2007;4(3):e97.

[3] Ahn S, Fedewa AL. A meta-analysis of the relationship between children’s physical activity and mental health. J Pediatr Psychol. 2011;36(4):385-97.

[4] Brand S, Gerber M, Beck J, Hatzinger M, Pühse U, Holsboer-Trachsler E. High exercise levels are related to favorable sleep patterns and psychological functioning in adolescents: a comparison of athletes and controls. J Adolesc Health. 2010;46(2):133-41.

[5] Ekeland E, Heian F, Hagen KB. Can exercise improve self esteem in children and young people? A systematic review of randomised controlled trials. Br J Sports Med. 2005;39(11):792-8.

[6] Nelson MC, Neumark-Stzainer D, Hannan PJ, Sirard JR, Story M. Longitudinal and secular trends in physical activity and sedentary behavior during adolescence. Pediatrics. 2006;118(6):e1627-34.

[7] Nader PR, Bradley RH, Houts RM, McRitchie SL, O’Brien M. Moderate-to-vigorous physical activity from ages 9 to 15 years. JAMA. 2008;300(3):295-305.

[8] Physical Activity Guidelines Advisory Committee. Physical activity guidelines advisory committee scientific report. Washington, DC: US Department of Health and Human Services. 2018.

[9] Kann L, McManus T, Harris WA, Shanklin SL, Flint KH, Queen B, et al. Youth risk behavior surveillance—United States, 2017. MMWR Surveillance Summaries. 2018;67(8):Supplementary Table 207..

[10] Janz NK, Becker MH. The Health Belief Model: a decade later. Health Educ Q. 1984;11(1):1-47.

[11] Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. Med Sci Sports Exerc. 2000;32(5):963-75.

[12] Craggs C, Corder K, Van Sluijs EM, Griffin SJ. Determinants of change in physical activity in children and adolescents: a systematic review. Am J Prev Med. 2011;40(6):645-58.

[13] Van KDH, Paw MJ, Twisk JW, Van WM. A brief review on correlates of physical activity and sedentariness in youth. Med Sci Sports Exerc. 2007;39(8):1241-50.

[14] Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJ, Martin BW, et al. Correlates of physical activity: why are some people physically active and others not? The Lancet. 2012;380(9838):258-71.

[15] Allison KR, Dwyer JJ, Makin S. Self-efficacy and participation in vigorous physical activity by high school students. Health Education & Behavior. 1999;26(1):12-24.

[16] Allison KR, Dwyer JJ, Makin S. Perceived barriers to physical activity among high school students. Prev Med. 1999;28(6):608-15.

[17] Sallis JF, Prochaska JJ, Taylor WC, Hill JO, Geraci JC. Correlates of physical activity in a national sample of girls and boys in grades 4 through 12. Health Psychol. 1999;18(4):410-415.

[18] Zakarian JM, Hovell MF, Hofstetter CR, Sallis JF, Keating KJ. Correlates of vigorous exercise in a predominantly low SES and minority high school population. Prev Med. 1994;23(3):314-21.

[19] Tappe MK, Duda JL, Ehrnwald PM. Perceived barriers to exercise among adolescents. J Sch Health. 1989;59(4):153-5.

[20] Neumark-Sztainer D, Story M, Hannan PJ, Tharp T, Rex J. Factors associated with changes in physical activity: a cohort study of inactive adolescent girls. Arch Pediatr Adolesc Med. 2003;157(8):803-10.

[21] Stalsberg R, Pedersen AV. Effects of socioeconomic status on the physical activity in adolescents: a systematic review of the evidence. Scand J Med Sci Sports. 2010;20(3):368-83.

[22] Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977:159-74.

[23] Kohl III HW, Fulton JE, Caspersen CJ. Assessment of physical activity among children and adolescents: a review and synthesis. Prev Med. 2000;31(2):S54-76.

[24] McGraw KO, Wong SP. Forming inferences about some intraclass correlation coefficients. Psychol Methods. 1996;1(1):30-46.

[25] Field A. Discovering statistics using IBM SPSS statistics. Thousand Oaks, CA: Sage Publications Ltd; 2013.

[26] Watson JC. Establishing evidence for internal structure using exploratory factor analysis. Meas Eval Couns Dev. 2017;50(4):232-8.

[27] Tabachnick BG, Fidell LS, Ullman JB. Using multivariate statistics. Boston: Pearson; 2007.

[28] O'Rourke N, Psych R, Hatcher L. A step-by-step approach to using SAS for factor analysis and structural equation modeling. Cary, NC: SAS Institute; 2013.

[29] Velicer WF, Fava JL. Affects of variable and subject sampling on factor pattern recovery. Psychol Methods. 1998;3(2):231-251.

[30] Velicer WF, Eaton CA, Fava JL. Construct explication through factor or component analysis: A review and evaluation of alternative procedures for determining the number of factors or components. Problems and solutions in human assessment: Honoring Douglas N. Jackson at seventy. Boston: Kluwer; 2000, p. 41-71.

[31] O’Connor BP. SPSS and SAS programs for determining the number of components using parallel analysis and Velicer’s MAP test. Behavior Research Methods, Instruments, & Computers. 2000;32(3):396-402.

[32] Suhr DD. Exploratory or confirmatory factor analysis. SAS Users Group International Conference (pp. 1-17). Cary: SAS Institute, Inc. 2006.

[33] Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct Equ Modeling. 1999;6(1):1-55.

[34] Tabachnick BG, Fidell LS, Ullman JB. Using multivariate statistics. Boston: Pearson; 2007.

[35] Kowalski KC, Crocker PRE, Kowalski NP. Convergent validity of the Physical Activity Questionnaire for Adolescents. Pediatric Exercise Science. 1997;9(4):342-52; doi:10.1123/pes.9.4.342.

[36] Janz KF, Lutuchy EM, Wenthe P, Levy SM. Measuring activity in children and adolescents using self-report: PAQ-C and PAQ-A. Med Sci Sports Exerc. 2008;40(4):767-72; doi:10.1249/MSS.0b013e3181620ed1.

[37] Biddle SJ, Whitehead SH, O’Donovan TM, Nevill ME. Correlates of participation in physical activity for adolescent girls: a systematic review of recent literature. Journal of Physical Activity and Health. 2005;2(4):423-34.

[38] Kowalski KC, Crocker PR, Donen RM. The physical activity questionnaire for older children (PAQ-C) and adolescents (PAQ-A) manual. College of Kinesiology, University of Saskatchewan. 2004;87(1):1-38.

[39] Kaiser HF. An index of factorial simplicity. Psychometrika. 1974;39(1):31-6.

[40] Dwyer JJ, Allison KR, Goldenberg ER, Fein AJ, Yoshida KK, Boutilier MA. Adolescent girls' perceived barriers to participation in physical activity. Adolescence. 2006;41(161):75-90.

[41] Allison KR, Dwyer JJ, Goldenberg E, Fein A, Yoshida KK, Boutilier M. Male adolescents' reasons for participating in physical activity, barriers to participation, and suggestions for increasing participation. Adolescence. 2005;40(157):155-71.

[42] Kimm SY, Glynn NW, McMahon RP, Voorhees CC, Striegel-Moore RH, Daniels SR. Self-perceived barriers to activity participation among sedentary adolescent girls. Medicine & Science in Sports & Exercise. 2006;38(3):534-40.

[43] Taylor WC, Sallis JF, Dowda M, Freedson PS, Eason K, Pate RR. Activity patterns and correlates among youth: differences by weight status. Pediatric exercise science. 2002;14(4):418-31.

[44] Wickman ME, Anderson NLR, Greenberg CS. The adolescent perception of invincibility and its influence on teen acceptance of health promotion strategies. J Pediatr Nurs. 2008;23(6):460-8.

[45] Nunnally, Jum C., Bernstein,Ira H.,. Psychometric theory. New York: McGraw-Hill; 1994.

[46] Pender NJ. Health promotion model manual. http://deepblue.lib.umich.edu/bitstream/2027.42/85350/1/HEALTH_PROMOTION_MANUAL_Rev_5-2011.pdf, 2011. Accessed 2/14/20.

[47] Bandura A. Human agency in social cognitive theory. Am Psychol. 1989;44(9):1175-1184.

[48] Glanz K, Rimer BK, Viswanath K. Health behavior and health education: theory, research, and practice. San Francisco: John Wiley & Sons; 2008.