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Reliability and validity of a global physical activity classification measure

Paul D. Loprinzi, Eveleen Sng

Department of Health, Exercise Science and Recreation Management, The University of Mississippi, University, MS 38677, USA

Address for correspondence:
Paul D. Loprinzi, Department of Health, Exercise Science, and Recreation Management, The University of Mississippi, 229 Turner Center, University, MS 38677, USA.
Phone: 662-915-5561,
Fax: 662-915-5525,
E-mail: pdloprin@olemiss.edu

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ABSTRACT

Purpose: The purpose of this study was to evaluate the reliability and validity of a global physical activity classification (GPAC) measure employed in the National Health and Nutrition Examination Survey (NHANES).
Methods: For validity assessment ($N = 6039$), the NHANES GPAC was compared to NHANES accelerometry data. For reliability assessment ($N = 94$), a convenience sample completed a 1 week test-retest of the GPAC.
Results: The association between total physical activity and GPAC ranged from 0.25 to 0.40, with the range for moderate to vigorous physical activity (MVPA) and GPAC being 0.17-0.39. In general, associations were stronger for total physical activity and GPAC compared to MVPA and GPAC. Similarly, associations were generally stronger for men, younger individuals, and Mexican Americans. In the reliability assessment, the intraclass correlation (ICC) ranged from 0.58 to 0.90, with the older participants having the lowest ICC (0.58).
Conclusion: Findings of this study demonstrate suggestive evidence of both reliability and validity for the NHANES GPAC.

KEY WORDS: Accelerometry, National Health and Nutrition Examination Survey, reliability, validity

INTRODUCTION

An accurate and reliable measure of physical activity is essential for improving our understanding of (1) the association between physical activity and health outcomes, (2) the dose of physical activity required to elicit favorable health outcomes, (3) determinants of physical activity, and (4) the impact of physical activity interventions on health outcomes. The previous research has addressed the limitations associated with self-reported physical activity [1-3], which underscores the importance of implementing objective measures of physical activity (e.g., accelerometry, pedometry) in lieu of, or in addition to, subjective measures of physical activity. Despite the notable limitations recognized with self-report measures of physical activity, objective measures of physical activity may not always be feasible in physical activity research. Thus, identifying reliable and valid measures of physical activity is important [4]. The purpose of this brief report was to evaluate the reliability and convergent validity of a global physical activity classification (GPAC) measure used by the National Health and Nutrition Examination Survey (NHANES).

METHODS

Study Design

The validation aspect of this study included comparing the NHANES GPAC measure against NHANES accelerometry data. The reliability aspect of this study included having a convenience sample from the authors' institution complete the GPAC measure twice, for test-retest reliability assessment.

The NHANES is an ongoing survey conducted by the Center for Disease Control and Prevention designed to evaluate the health status of the U.S. adults through a complex, multistage, and stratified clustered probability design. Participants are interviewed in their homes and then subsequently examined in a mobile examination center. Further information on NHANES methodology and data collection is available on the NHANES website (http://www.cdc.gov/nchs/nhanes.htm). Procedures were approved by the National Center for Health Statistics Review Board. Consent was obtained from all NHANES participants before data collection. Similarly, for the reliability study from the convenience sample, ethics approval was granted by the authors' Institutional Review Board, with participant consent obtained.

GPAC Measures

During a household interview, participants were asked:

"Please tell me which of these four sentences best describes your usual daily activities?"
1. You sit during the day and do not walk about very much
2. You stand or walk about a lot during the day, but not have to carry or lift things very often

3. You lift light load or have to climb stairs or hills often
4. You do heavy work or carry heavy loads.

Procedures and Sample Size

Publically accessible NHANES accelerometry data is currently available in the 2003-2006 NHANES cycles. Thus, for the validation aspect of this study, these NHANES cycles were utilized.

Physical activity was assessed using the ActiGraph 7164 accelerometer, with participants instructed to wear the monitor (affixed to an elastic belt) on their waist for 7 days. The moderate-to-vigorous physical activity (MVPA) cut-point of 2020 counts/min was applied to define MVPA [5], with total physical activity (light-to-vigorous) defined using the cut-point of ≥100 counts/min, within each intensity level, the data was expressed in a continuous format. Nonwear time identified as ≥60 consecutive minutes of zero activity counts, with allowance for 1-2 min of activity counts between 0 and 100 [5]. Participants with, at least, 4 days of 10+ h/day of monitoring were included in the analysis.

In the 2003-2006 NHANES, 10,020 adults (20+ years) were evaluated. Among these, 6093 provided valid accelerometry (i.e., ≥4 days of 10+ h/day of monitoring). Among these, 6088 provided GPAC data. Among these, 6039 provided data for the evaluated covariates (i.e. age, gender, race-ethnicity and measured body mass index), which constitutes the analytic sample for the validation study.

For the test-retest reliability assessment of the GPAC, a random sample of 1/3rd of the faculty/staff at the authors' institution were sent an e-mail asking if they would be willing to complete an on-line survey (delivered via Qualtrics). About 197 participants completed the baseline survey. About 7 days after this baseline assessment, these participants were re-sent the survey. Among 197 participants with data from the first assessment, 102 recompleted the survey. Among these 102 participants, 94 provided complete data on all survey items (i.e., age, gender, race-ethnicity, self-reported height and weight, and GPAC). These 94 participants constituted the test-retest reliability analytic sample.

Analysis

In Stata (version 12), and for the validation assessment, analyses accounted for the complex survey design employed in NHANES. For the validation assessment, a weighted multivariable linear regression analysis was employed that examined the association between the 4 levels GPAC (independent variable) and accelerometer-assessed total physical activity and MVPA. Models were computed separately for total physical activity and MVPA. Similarly, models were computed separately for men, women, age group (20-39 years, 40-59 years, 60+ years), race-ethnicity (Mexican American, non-Hispanic white, non-Hispanic black) and obesity status (≥30 kg/m^2).

In SPSS (version 22), and for the reliability assessment, intraclass correlation (ICC) was used to evaluate the test-retest reliability of the GPAC. Separate ICCs were evaluated for men, women, age-group and obesity status (≥30 kg/m^2); stratification by race-ethnicity was not possible due to minimal sample heterogeneity with regard to race-ethnicity. For all analyses, a statistical significance was established as $P < 0.05$.

RESULTS

Table 1 displays the characteristics of the study samples across the GPAC variable. In the validation NHANES sample, the mean age across the 4 levels of the GPAC ranged from 39 to 48 years. In the convenience sample used for the reliability assessment, the mean age ranged from 43 to 49 years across the 4 levels of the GPAC. As shown in Table 1, and for the validation assessment, there was an association between unadjusted total physical activity and MVPA across the 4 levels of the GPAC. This trend was observed across all strata (gender, age, race-ethnicity, and obesity).

Table 2 displays the Spearman rho correlations between GPAC and accelerometer-assessed total physical activity and MVPA. The association between total physical activity and GPAC ranged from 0.25 to 0.40, with the range for MVPA and GPAC being 0.17-0.39. In general, associations were stronger for total physical activity and GPAC compared to MVPA and GPAC. Similarly, associations were generally stronger for men (vs. women), younger individuals (vs. older individuals), and Mexican Americans (vs. whites or blacks).

Table 3 displays the weighted multivariable regression associations between the GPAC and accelerometer-assessed physical activity (total physical activity and MVPA). Similar to the unadjusted results [Table 1], these findings, which controlled for age, gender, race-ethnicity and body mass index, showed an association between total physical activity and MVPA across the 4 levels of the GPAC. In general speaking, with the exception of older adults, results were similar across all strata.

Table 4 displays the test-retest reliability of the GPAC in the convenience sample. The ICC ranged from 0.58 to 0.90, with the older participants having the lowest ICC (0.58).

DISCUSSION

The purpose of this brief report was to examine the reliability and validity of the NHANES GPAC. Such an investigation is useful when interpreting other NHANES studies utilizing this GPAC variable [6,7] as well as future NHANES and non-NHANES studies considering the use of this single-item physical activity measure. This GPAC item demonstrated reasonable evidence of test-retest reliability among our convenience sample. Further, there was a statistically significant association between GPAC and accelerometer-assessed total physical activity and MVPA. The observed associations (0.17-0.40) are within the range observed in other studies examining the association between

Table 1: Characteristics of the study samples across the NHANES global physical activity classification variable

Characteristics	Sits during the day and does not walk about very much	Stand or walk about a lot during the day, but does not have to carry or lift things very often	Lifts light loads or climbs stairs or hills often	Does heavy work or carries heavy loads
NHANES sample (*N*=6039)				
Sample size, *N*	1391	3210	1012	426
Age, years	48.0 (47.0-49.0)	47.3 (46.1-48.5)	45.5 (43.4-47.6)	38.7 (36.9-40.5)
% Male	42.0	43.1	55.1	82.0
Race-ethnicity, %				
Mexican American	5.1	8.5	6.4	15.4
Non-Hispanic white	73.2	70.2	77.4	69.7
Non-Hispanic black	13.1	11.9	8.8	9.2
Other	8.6	9.5	7.4	5.7
BMI, kg/m^2	29.3 (28.8-29.8)	28.1 (27.6-28.4)	27.4 (26.9-27.9)	27.6 (27.0-28.2)
Accelerometer LVPA	315.3 (308-321)	371.5 (366-376)	405.5 (397-413)	470.1 (460-480)
Accelerometer MVPA	18.0 (16.3-19.6)	22.1 (20.8-23.4)	29.6 (27.8-31.4)	39.6 (36.6-42.6)
Convenience sample (*N*=94)				
Sample size, *N*	50	34	10	0
Age, years	42.9 (39.8-46.0)	48.3 (43.9-52.6)	49.2 (41.5-56.8)	-
% Male	28	44	50	-
% Non-Hispanic white	90	91.2	90	-
BMI, kg/m^2	28.3 (26.5-30.1)	24.9 (22.9-26.8)	25.1 (22.3-27.7)	-
NHANES sample				
Men (*N*=2976)				
Accelerometer LVPA	308.5 (297-319)	374.2 (367-381)	410.8 (398-423)	477.2 (466-487)
Accelerometer MVPA	22.0 (19.4-24.5)	29.1 (27.4-30.9)	35.2 (32.7-37.5)	43.1 (39.6-46.7)
Women (*N*=3063)				
Accelerometer LVPA	320.2 (312-328)	369.4 (362-376)	398.8 (390-407)	437.7 (414-460)
Accelerometer MVPA	15.1 (13.2-16.9)	16.8 (15.5-18.1)	22.8 (20.6-25.1)	23.6 (20.0-27.1)
20-39 years (*N*=1849)				
Accelerometer LVPA	335.7 (324-347)	390.1 (380-399)	425.3 (409-440)	479.2 (464-493)
Accelerometer MVPA	23.9 (20.9-26.8)	27.8 (25.9-29.7)	36.2 (33.4-38.9)	45.4 (40.9-49.9)
40-59 years (*N*=1908)				
Accelerometer LVPA	332.0 (322-341)	388.8 (382-394)	422.2 (413-430)	468.8 (453-484)
Accelerometer MVPA	19.5 (17.1-22.0)	23.9 (22.2-25.7)	31.2 (28.3-34.1)	34.7 (30.1-39.3)
60+years (*N*=2282)				
Accelerometer LVPAS	257.8 (246-269)	318.1 (309-326)	336.4 (325-347)	398.0 (367-428)
Accelerometer MVPA	6.5 (5.3-7.7)	11.1 (9.8-12.2)	14.3 (11.8-16.7)	15.8 (10.0-21.7)
Mexican American (*N*=1255)				
Accelerometer LVPA	341.2 (324-357)	412.6 (404-420)	446.6 (430-462)	514.6 (492-536)
Accelerometer MVPA	16.3 (14.2-18.4)	26.9 (24.4-29.5)	38.3 (31.5-45.1)	56.5 (47.5-65.5)
Non-Hispanic white (*N*=3223)				
Accelerometer LVPA	307.5 (299-315)	363.1 (355-370)	401.1 (392-409)	462.4 (450-474)
Accelerometer MVPA	18.0 (16.0-19.9)	21.4 (19.8-23.0)	28.8 (26.9-30.7)	36.6 (32.7-40.4)
Non-Hispanic black (*N*=1150)				
Accelerometer LVPA	336.1 (322-349)	386.5 (377-395)	401.1 (381-420)	443.1 (417-468)
Accelerometer MVPA	16.4 (14.0-18.8)	22.1 (20.4-23.8)	31.4 (26.2-36.6)	34.5 (27.3-41.8)
Obese (*N*=1988)				
Accelerometer LVPA	315.4 (302-327)	366.0 (358-373)	398.2 (382-413)	459.7 (432-486)
Accelerometer MVPA	14.3 (12.3-16.2)	16.8 (15.6-18.1)	24.8 (21.8-27.8)	30.3 (24.3-36.2)

LVPA: Light-to-vigorous physical activity (total physical activity), MVPA: Moderate-to-vigorous physical activity, CI: Confidence interval, NHANES: National Health and Nutrition Examination Survey, BMI: Body mass index. Continuous variables (e.g., body mass index and physical activity) are reported as means and 95% CI

self-reported and objectively measured physical activity [3]. Thus, clinicians and researchers may have some confidence that this GPAC measure provides a reasonable overview of their patient's/participant's overall physical activity behavior.

Associations between GPAC and physical activity were generally consistent across subsamples, with the exception of older adults. This may be a result of the GPAC possibly not being sensitive enough for older adults, as these individuals may be less likely to engage in activities that require "carrying objects or heavy loads." Further, associations were generally stronger when comparing GPAC to total physical activity as opposed to MVPA. This is not surprising as the GPAC does not include specific activities for higher-intensity aerobic-based exercise.

Limitations of this study include the relatively small sample for the test-retest reliability assessment, along with the low response rate for the follow-up assessment. Further, the GPAC single-item has its obvious limitations in that it is a subjective assessment

of physical activity, does not provide a quantitative number of time spent in physical activity or sedentary behavior, and may be insensitive to certain populations. Further work would benefit by evaluating the convergent validity of the GPAC with a self-report physical activity questionnaire. Strengths of this study, however, include the national sample and accelerometry assessed used for the validation study, as well as employing a reliability assessment.

In conclusion, findings of this study demonstrate some suggestive evidence of both reliability and validity for the NHANES GPAC. In addition to implementing objective measures of physical activity, when feasible, future studies may wish to consider the GPAC as a global indicator of physical activity.

Table 2: Spearman rho correlation between global physical activity classification variable (independent variable) and accelerometer-assessed total physical activity and MVPA, 2003-2006 NHANES (*N*=6039)

Variable	Total physical activity		MVPA	
	rho	*P* value	rho	*P* value
Entire sample (*N*=6039)	0.35	<0.001	0.26	<0.001
Men (*N*=2976)	0.40	<0.001	0.28	<0.001
Women (*N*=3063)	0.28	<0.001	0.17	<0.001
20-39 years (*N*=1849)	0.37	<0.001	0.25	<0.001
40-59 years (*N*=1908)	0.35	<0.001	0.24	<0.001
60+years (*N*=2282)	0.30	<0.001	0.24	<0.001
Mexican American (*N*=1255)	0.39	<0.001	0.39	<0.001
Non-Hispanic white (*N*=3223)	0.37	<0.001	0.23	<0.001
Non-Hispanic black (*N*=1150)	0.25	<0.001	0.22	<0.001
Obese (*N*=1988)	0.31	<0.001	0.24	<0.001

MVPA: Moderate-to-vigorous physical activity, NHANES: National Health and Nutrition Examination Survey

Table 4: Test-retest reliability of the NHANES global physical activity classification variable

Convenience sample	ICC	95% CI	*P* value
Entire sample (*N*=94)	0.867	0.799, 0.912	<0.001
Men (*N*=34)	0.817	0.631, 0.909	<0.001
Women (*N*=60)	0.896	0.816, 0.940	<0.001
20-39 years (*N*=35)	0.898	0.798, 0.949	<0.001
40-59 years (*N*=43)	0.888	0.793, 0.939	<0.001
60+years (*N*=16)	0.587	0.074, 0.851	0.037
Obese (*N*=24)	0.807	0.559, 0.916	<0.001

Obese defined as a self-reported body mass index≥30 kg/m^2.
CI: Confidence interval, NHANES: National Health and Nutrition Examination Survey, ICC: Intraclass correlation

Table 3: Weighted multivariable regression associations (β, 95% CI) between the NHANES global physical activity classification variable (independent variable) and accelerometer-assessed physical activity (total physical activity and MVPA)

VariableS	Sits during the day and does not walk about very much	Stand or walk about a lot during the day, but does not have to carry or lift things very often	Lifts light loads or climbs stairs or hills often	Does heavy work or carries heavy loads
NHANES entire sample (*N*=6039)				
Accelerometer LVPA	Referent	53.3 (46.3-60.3)	84.9 (73.9-95.9)	135.1 (120.4-149.8)
Accelerometer MVPA	Referent	2.9 (1.3-4.6)	8.1 (6.1-10.1)	12.1 (8.8-15.2)
Men (*N*=2976)				
Accelerometer LVPA	Referent	61.6 (51.1-72.2)	95.2 (81.2-109.2)	144.2 (126.1-162.3)
Accelerometer MVPA	Referent	5.8 (3.1-8.4)	10.4 (7.3-13.4)	13.9 (9.7-18.1)
Women (*N*=3063)				
Accelerometer LVPA	Referent	47.3 (38.8-55.8)	75.7 (63.5-88.0)	108.5 (83.9-133.1)
Accelerometer MVPA	Referent	0.9 (-0.7-2.6)	6.2 (3.6-8.8)	5.7 (2.0-9.9)
20-39 years (*N*=1849)				
Accelerometer LVPA	Referent	53.7 (39.5-68.0)	88.6 (71.7-105.4)	134.9 (115.8-154.0)
Accelerometer MVPA	Referent	3.5 (0.2-6.8)	8.9 (5.1-12.6)	13.8 (8.1-19.6)
40-59 years (*N*=1908)				
Accelerometer LVPA	Referent	52.2 (42.7-61.7)	87.0 (73.4-100.6)	129.0 (108.5-149.5)
Accelerometer MVPA	Referent	2.2 (-0.2-4.6)	8.5 (5.6-11.4)	8.5 (3.6-13.3)
60+years (*N*=2282)				
Accelerometer LVPA	Referent	48.6 (39.3-57.8)	64.3 (50.2-78.4)	113.5 (75.0-152.0)
Accelerometer MVPA	Referent	2.7 (1.3-4.1)	4.7 (2.4-7.0)	4.1 (−1.9-10.1)
Mexican American (*N*=1255)				
Accelerometer LVPA	Referent	64.7 (49.1-80.3)	88.9 (71.4-106.4)	142.5 (113.1-172.0)
Accelerometer MVPA	Referent	7.1 (3.3-11.0)	14.0 (8.0-20.0)	25.4 (17.4-33.3)
Non-Hispanic white (*N*=3223)				
Accelerometer LVPA	Referent	54.9 (47.2-62.7)	89.0 (76.0-102.1)	137.9 (121.0-154.9)
Accelerometer MVPA	Referent	2.7 (0.8-4.6)	7.6 (5.2-9.9)	9.6 (5.1-14.2)
Non-Hispanic black (*N*=1150)				
Accelerometer LVPA	Referent	45.2 (28.6-61.8)	52.7 (27.8-77.5)	88.2 (59.4-116.9)
Accelerometer MVPA	Referent	3.1 (0.9-5.3)	9.6 (4.1-15.2)	9.4 (2.3-16.4)
Obese (*N*=1988)				
Accelerometer LVPA	Referent	44.1 (32.1-56.2)	74.1 (49.6-98.5)	116.4 (87.8-145.0)
Accelerometer MVPA	Referent	1.5 (-0.6-3.6)	7.0 (3.6-10.4)	7.4 (1.8-13.0)

Models were computed for the entire sample and separately across age, gender and race-ethnicity parameters. In each model, covariates included: Age, gender, race-ethnicity, and body mass index. Bolded text indicates statistical significance (*P*<0.05). LVPA: Light-to-vigorous physical activity (total physical activity), MVPA: Moderate-to-vigorous physical activity, CI: Confidence interval, NHANES: National Health and Nutrition Examination Survey, Obese defined as a measured body mass index≥30 kg/m^2

What does this Article Add?

This article provides evidence of reliability and validity for the NHANES GPAC. Thus, findings from previously published studies using this NHANES GPAC can be viewed in a positive light. Further, future research may wish to consider using this NHANES GPAC measure when it is not feasible to consider more objective measures of physical activity. Such future work should also consider employing other (more comprehensive) self-report measures to complement the results obtained from the NHANES GPAC.

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