

Validity of two brief primary care physical activity questionnaires with accelerometry in clinic staff

Trever J. Ball¹, Elizabeth A. Joy^{2,3}, Tan L. Goh¹, James C. Hannon¹, Lisa H. Gren² and Janet M. Shaw¹

¹Department of Exercise and Sport Science, University of Utah, Salt Lake City, UT, USA

²Department of Family and Preventive Medicine, University of Utah, Salt Lake City, UT, USA

³Intermountain Healthcare, Salt Lake City, UT, USA

Background: To date, no physical activity (PA) questionnaires intended for primary care have been compared against a criterion measure of PA and current (2008) aerobic PA recommendations of the American College of Sports Medicine/American Heart Association (ACSM/AHA). **Aim:** This study evaluated preliminary evidence for criterion validity of two brief (<1 min) PA questionnaires with accelerometry, and their ability to identify if individuals meet ACSM/AHA PA recommendations. **Methods:** 45 health clinic staff wore an accelerometer for seven consecutive days and afterwards completed two brief PA questionnaires, the Physical Activity Vital Sign (PAVS), and the Speedy Nutrition and Physical Activity Assessment (SNAP). Agreement and descriptive statistics were calculated between the PAVS or SNAP and accelerometry in order to measure each questionnaire's ability to quantify the number of days participants achieved ≥ 30 min of moderate–vigorous PA (MVPA) performed in bouts of ≥ 10 continuous minutes. Participants with <5 days of ≥ 30 bout-min of MVPA were considered insufficiently active according to PA recommendations. **Findings:** There was a significant positive correlation between number of days with ≥ 30 bout-min MVPA and the PAVS ($r=0.52$, $P<0.001$), and SNAP ($r=0.31$, $P<0.05$). The PAVS had moderate agreement with accelerometry for recommending if individuals met or did not meet PA recommendations ($\kappa=0.46$, $P<0.001$), whereas SNAP had poor agreement ($\kappa=0.12$, $P<0.05$). **Conclusions:** This study provides preliminary evidence of criterion validity of the PAVS and SNAP with accelerometry and agreement identifying if respondents meet current (2008) ACSM/AHA aerobic PA recommendations. The PAVS and SNAP should be evaluated further for repeatability, and in populations varying in PA levels, age, gender, and ethnicity.

Key words: accelerometry; lifestyle interventions; physical activity; physical activity counseling; primary care; self-report

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Introduction

Physical inactivity contributes significantly to the leading causes of illness and premature death in the United States, and has consequently become one of public health's greatest concerns (Mokdad

et al., 2004; Blair, 2009). Numerous organizations recommend counseling for physical activity (PA) in primary care, including the US Preventive Services Task Force (USPSTF), the American Heart Association (AHA), the American College of Sports Medicine (ACSM), and the American College of Preventive Medicine (Nawaz and Katz, 2001; Haskell *et al.*, 2007; Lin *et al.*, 2010). Challenges to assessing PA in primary care include having little time to do it while still making the

Correspondence to: Trever J. Ball, MS, MPH, Department of Exercise and Sport Science, University of Utah, 250 S. 1850 E. Rm 200, Salt Lake City, UT 84112, USA. Email: trever.ball@utah.edu

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assessment easy to understand. Existing PA assessments intended for use in primary care are too long and too complex, and do not reflect current ACSM/AHA aerobic PA recommendations (Glasgow *et al.*, 2005; Smith *et al.*, 2005; Meriwether *et al.*, 2006; Topolski *et al.*, 2006; Fernald *et al.*, 2008).

The accuracy and precision of assessing patient PA becomes increasingly important when clinics adopt a regular practice of assessing PA. In their 2010 review of PA and nutrition behavioral counseling interventions in primary care, the USPSTF found statistically significant, but small, reported changes in PA from relatively common PA interventions that require little time and few resources (Lin *et al.*, 2010). Although greater changes were found when more resources were used, these higher-resource PA interventions are not practical for use in primary care. Valid and reliable PA questionnaires are thus especially important when changes in behavior are likely to be relatively small but practically meaningful from a public health perspective. Valid, reliable, and practical primary care measures of PA are also imperative in order to compare the effectiveness of different intervention settings and intensities with populations of varying risk (Glasgow *et al.*, 2005).

To our knowledge, no questionnaires developed to assess PA in primary care have been compared with a criterion measure of PA to correctly classify individuals according to current public health aerobic PA recommendations by ACSM/AHA (Haskell *et al.*, 2007). The Physical Activity Vital Sign (PAVS) and the PA component of the Speedy Nutrition and Physical Activity Assessment (SNAP) were each developed to improve current questionnaires developed to assess PA in primary care. The PAVS was created by a primary care provider and has evidence of construct validity (Greenwood *et al.*, 2010). SNAP was developed with input from culturally diverse focus groups that included providers, staff, and patients from community health centers. Both the PAVS and SNAP read easily and require <1 min to administer.

The aims of this pilot study were: (a) to examine the preliminary evidence for criterion and discriminant validity of the PAVS and SNAP with accelerometry in clinic staff and (b) to determine how well the PAVS and SNAP correctly classify clinic staff as being sufficiently or insufficiently

active according to aerobic ACSM/AHA PA recommendations of acquiring ≥ 30 min of moderate-vigorous PA (MVPA) at least 5 days of the week.

Methods

Participants

This study was approved by the Institutional Review Board of the University of Utah, and all participants provided written, informed consent. Participants were clinic staff recruited from seven primary care clinics in the Salt Lake Valley. Clinic staff were chosen in order to help familiarize clinic staff with these new clinical PA assessments that were being incorporated into regular clinical practice at the time of this study. This study was thus partly a participatory design intended to engage and educate clinic staff that would be responsible for administering these new assessments of PA. Participants were recruited by word of mouth and assistance from clinic administrative staff. Eligible participants included generally healthy men and women ≥ 18 years of age. Staff with unmanaged chronic disease, musculoskeletal disease that would limit PA, or who were pregnant were excluded from this study. For descriptive purposes, basic demographic information was collected by questionnaire.

Instruments

The PAVS asks two questions designed to assess past and typical week MVPA (Figure 1a, Greenwood *et al.*, 2010). This study assessed only agreement of past week MVPA with the PAVS and SNAP. The PAVS assesses MVPA because of MVPA's association with health outcomes and to facilitate identifying if patients meet aerobic PA recommendations (Haskell *et al.*, 2007). The PAVS has been shown to be feasible to administer at each patient-provider encounter, and most often requires <30 s to administer. Consistent with ACSM/AHA PA guidelines, the PAVS specifies that PA be performed in at least one 30-min, or three 10-min bouts.

The PA component of SNAP is distinguished from the PAVS by simultaneously assessing patient cumulative weekly PA, regardless of bouts, as well as readiness to change PA behaviors based

(a)

PAVS

1. How many **days in the past week** have you performed physical activity where your heart beats faster and your breathing is harder than normal for 30 minutes or more? (*In 3, 10 minute bouts, or 1, 30 minute bout*)

0 1 2 3 4 5 6 7 (circle one)

2. How many **days in a typical week** have you performed activity such as this?


0 1 2 3 4 5 6 7 (circle one)

(b)

How Active are You?

Examples of activity are

- Walking
- House work
- Work in the yard or garden
- Dancing
- Jobs that require walking, lifting or other hard work
- Exercise



Are you active for 30 minutes on 5 days of the week?

Circle one number only


1. No, and I have no plans to be more active.

2. No, but I have been thinking about being more active.

3. Sometimes I am active for 30 minutes, but not all the time.

4. Yes, I am active for 30 minutes on 5 days of the week.

Score



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Figure 1 Physical activity questions asked on the (a) PAVS, and (b), the physical activity component of the SNAP. PAVS = Physical Activity Vital Sign; SNAP = Speedy Nutrition and Physical Activity Assessment.

on the stages of change construct of the Trans-theoretical Model (Figure 1b) (Prochaska and Velicer, 1997). Accordingly, SNAP allows providers to give tailored preventive health counseling and track alterations between stages of behavior change. SNAP has a fifth-grade literacy level, based on the Flesch-Kincaid readability metric, and requires <1 min to administer (Kincaid, 1975). Basic examples of PA are listed above the single-item questionnaire.

Criterion validity of the PAVS and SNAP was evaluated using data from seven days of PA monitoring by uniaxial accelerometry (ActiGraph 3GTx, Pensacola, FL, USA). Accelerometry (accel) is the most widely used objective measure of PA and is shown to be a valid measure of free-living PA (Freedson *et al.*, 1998; Hendelman *et al.*, 2000; Matthews, 2005; Rothney *et al.*, 2008;

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Sasaki *et al.*, 2011). The accelerometers used in this study do not allow wearers to view their activity measured by the accelerometers. Uniaxial (vertical axis) data were used with uniaxial cut-points by Freedson and colleagues in analyzing PA levels (Freedson *et al.*, 1998). These cut-points were chosen in order to compare results to other validated questionnaires that assess PA in primary care, which have most commonly applied uniaxial cut-points by Freedson and colleagues.

Procedures

Data for this study were collected January–September 2010 and evaluated October 2010–June 2011. Participants wore a hip-based accelerometer for seven days during waking hours, and removed the accelerometer during water-based activities.

Accelerometers measured motion in the vertical axis and recorded 1-min intervals of acceleration 'counts'. Time spent in water-based activities and when the accelerometer was otherwise not worn was recorded by participants on a daily log sheet. Time spent in these activities was then transformed into accelerometer counts using the activities' metabolic equivalents identified in the Compendium for Physical Activities (Ainsworth *et al.*, 2011). A student research assistant sent daily text or email messages to participants to remind them to wear the accelerometer. After wearing accelerometers for seven days, participants self-reported their PA levels on the PAVS and SNAP. Research personnel read the PAVS and SNAP questions to participants in their health clinic office in order to standardize administration of the questionnaires.

Accelerometry data were downloaded using ActiLife software version 5.7.0 (ActiGraph), and evaluated using MeterPlus software, version 4.2 (Santech Inc., San Diego, CA, USA). Because the PAVS and SNAP intend to measure moderate to vigorous-intensity aerobic activity, minutes per day of accel were calculated at moderate (1952–5724 ct/min) and vigorous (>5724 ct/min) levels (Freedson *et al.*, 1998). MVPA was expressed as bout and non-bout data. A PA 'bout' was 10 or more continuous minutes of MVPA, wherein a maximum of 2 min of activity could be less than moderate intensity. Six hours of accel constituted a valid day, as shown by others (Trost *et al.*, 2005). Seven days of valid accel were required for analysis to avoid transforming missing data that would be less reliable than using real collected data. This allowed us to compare responses of the PAVS and SNAP with PA recommendations as accurately as possible because each questionnaire queried PA performed specifically during the past seven days.

Participant accel data and responses to the PAVS and SNAP were classified as sufficiently active based on current ACSM/AHA PA recommendations of acquiring ≥ 30 min MVPA on ≥ 5 days of the week. Although the PA recommendations used in this study also recommend an alternative of acquiring 20 min of vigorous-intensity PA ≥ 3 days/week, meeting this form of the PA recommendations was not included in this study because preliminary examination of accel data revealed that no participants met this form of the PA recommendations. Subsequently, participant

accel data were classified as sufficiently active if ≥ 30 bout-min of MVPA were achieved on ≥ 5 days of the week (Haskell *et al.*, 2007). Responses to the PAVS question number 1 were classified as sufficiently active if ≥ 5 days during the week was reported. Responses to SNAP were classified as sufficiently active if the reported score was 4.

Statistical analyses

Descriptive statistics were calculated to characterize our sample. Validity of the PAVS and SNAP was assessed distinctively by Pearson (PAVS) and Spearman Rank (SNAP) correlation coefficients between the more continuous nature of the PAVS responses or categorical responses to SNAP and accel. Correlations were specifically determined between the PAVS or SNAP and total weekly minutes of MVPA, and with the number of days with ≥ 30 min of MVPA. Discriminant validity between the PAVS and SNAP was assessed by observing differences in each questionnaire's correlations with bout and non-bout MVPA. The abilities of the PAVS and SNAP to identify participants as being sufficiently or insufficiently active were assessed by κ coefficients of agreement with accel, positive and negative predictive values, sensitivity, and specificity. Agreement of the PAVS and the number of days with ≥ 30 bout-min of MVPA was also assessed by a Bland–Altman agreement plot with 95% limits of agreement. Only the PAVS was assessed by this method because SNAP lacks units of measurement comparable with PA recommendations (i.e., number of days with ≥ 30 bout-min of MVPA), which is required by a Bland–Altman plot (Bland and Altman, 1986, 2010). All data were analyzed using Stata, version 11.

Results

Eighty-five primary care clinic staff volunteered for this study; two were ineligible due to current pregnancy. Of 83 eligible participants, eight discontinued participation due to lack of time or interest in the study, and 30 were excluded from this analysis because they had <7 days of valid accelerometry (Figure 2). There were no significant differences between excluded participants and those with seven days accel in self-reported days with ≥ 30 min MVPA by either the PAVS

(<7 days accel, median = 2 days, IQR = 3 days; 7 days accel, median = 2 days, IQR = 2 days, $P = 0.45$) or SNAP (<7 days accel, median = 3 days, IQR = 1 day; 7 days accel, median = 3 days, IQR = 1 day, $P = 0.72$). Of the remaining 45 participants with sufficient accelerometry data, 42 were female (93%) and 16 were Hispanic (36%). There were also no significant differences between excluded or dropped participants and included participants in age (excluded or dropped, $M = 35.0$ years; included, $M = 38.9$, $P = 0.14$) or in gender (test of proportions, $P = 0.36$). Participants with complete data were 20–63 years old ($M = 38.9 \pm 11.8$), and their body mass index ranged from 19.6 to 47.9 kg/m² ($M = 30.1 \pm 7.9$ kg/m²).

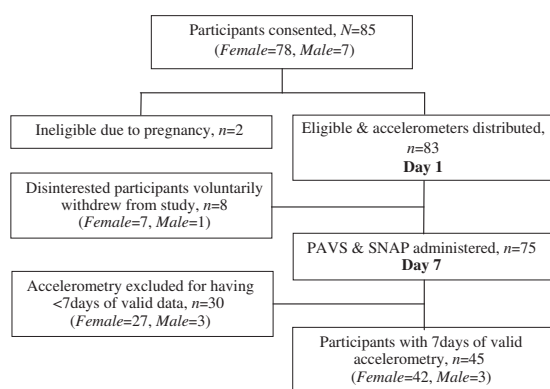


Figure 2 Participant enrollment and adherence with questionnaires and accelerometry.

Criterion and discriminant validity

Results of correlation and agreement analyses are provided in Table 1. The PAVS was moderately strongly correlated with bout measures of PA and weakly correlated with non-bout measures of PA. In contrast, SNAP was moderately correlated with non-bout PA and weakly correlated with bout-measured PA (Figure 3).

Agreement with meeting PA recommendations

Agreement statistics between the PAVS or SNAP and PA recommendations are provided in Table 1 and Figure 3. Kappa statistics indicated that the PAVS agreed moderately with identifying if participants met or did not meet PA recommendations ($\kappa = 0.46$, $P < 0.001$), whereas SNAP agreed poorly ($\kappa = 0.12$, $P < 0.05$).

Agreement with accel

Figure 4 is a Bland–Altman plot of the average number of days with ≥ 30 bout-min of MVPA by accelerometry and the PAVS against the differences of accel and the PAVS. The limits of agreement were constructed around a line of best fit in order to adjust for data that were not normally distributed (Bland and Altman, 1999; Bland, 2006; Ludbrook, 2010). Differences in PA measurement between accel and the PAVS, or bias, were smallest when the average of the PAVS and accel-PA was ≤ 2 days, and ≥ 4 days. This indicates

Table 1 Criterion and discriminant validity correlation and agreement coefficients comparing the PAVS and SNAP categorical responses with accelerometry

	Correlation				Agreement
	Total weekly minutes MVPA		No. of days ≥ 30 min MVPA		κ^c (95% CI)
	Bout	Non-bout	Bout	Non-bout	
PAVS ^a	0.50***	0.33*	0.52***	0.30*	0.46*** (0.04–0.89)
SNAP ^b	0.32*	0.41**	0.31*	0.49***	0.12* (0.04–0.28)

PAVS = Physical Activity Vital Sign; SNAP = Speedy Nutrition and Physical Activity Assessment; MVPA = moderate-vigorous physical activity.

*** $P < 0.001$.

** $P < 0.01$.

* $P < 0.05$.

^a Pearson's correlation coefficients.

^b Spearman's rank-order coefficients.

^c Agreement of the PAVS and SNAP with meeting PA recommendations by accel.

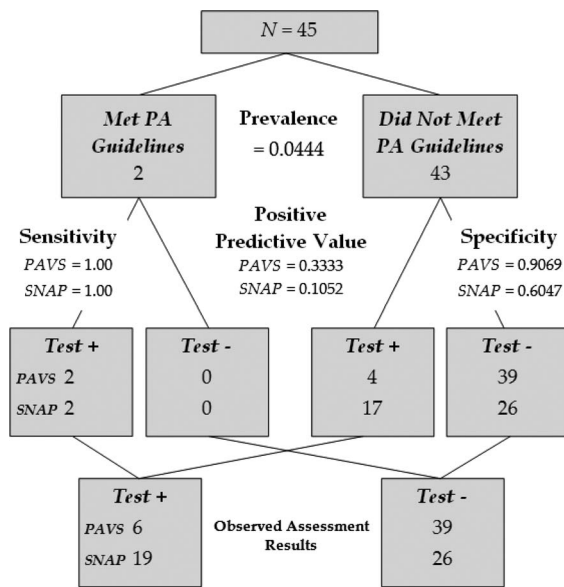


Figure 3 Performances of the PAVS and SNAP in identifying participants that meet American College of Sports Medicine/American Heart Association aerobic PA recommendations. Proportions of participants who did and did not meet PA recommendations by accelerometry appear at the top, followed by proportions of participants identified by the questionnaires as either meeting (Test +), or not meeting (Test -) PA recommendations. Questionnaire responses are stratified by meeting PA recommendations by accelerometry. PAVS=Physical Activity Vital Sign; SNAP=Speedy Nutrition and Physical Activity Assessment; PA=physical activity

that the PAVS agrees more strongly with true PA (implied by the average of the PAVS and accel-PA) when true PA is low and high. Although the PAVS appeared in the Bland–Altman agreement plot, by an increasing bias, to increasingly overestimate PA as true PA increased, both the bias and expanding limits of agreement may be due to measurement error from smaller sampling of those with higher PA levels. Overall, 91% of the respondents to the PAVS overestimated being sufficiently active by ≤ 3 days, and 9% overestimated being sufficiently active by four to seven days.

Discussion

Our findings demonstrate preliminary evidence of criterion and discriminant validity for the PAVS

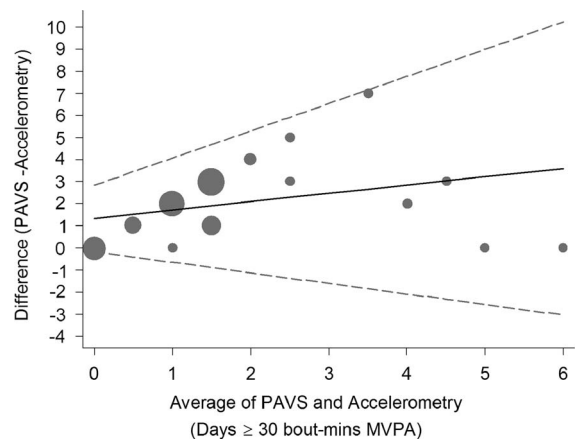


Figure 4 Bland-Altman plot assessing agreement between categorical responses to the PAVS) with uniaxial accelerometry, by units of number of days with ≥ 30 bout-min of MVPA. Solid line represents a line of best fit for mean differences between PAVS and accelerometry. Ninety-five percent limits of agreement about mean differences are superimposed as dashed lines, and circle area is proportional to number of observations. PAVS=Physical Activity Vital Sign; MVPA=moderate-vigorous physical activity

and SNAP, two brief self-report measures of PA intended for use in primary care. We found evidence that the PAVS has a strong ability to identify persons who are insufficiently active that could benefit most from PA counseling and/or interventions, while SNAP did so moderately. Both the PAVS and SNAP correlated significantly with accel-MVPA, although the PAVS correlated more strongly than SNAP.

The PAVS and SNAP demonstrated discriminant validity by their differences in correlation between bout and non-bout minutes of MVPA. The PAVS specifically queries patients about PA in bouts and correlated more strongly with bout-minutes of accel-MVPA than it did with non-bout MVPA. SNAP queries patients about PA not specifically acquired in bouts and it correlated more strongly with number of days of ≥ 30 min of non-bout MVPA than bout-MVPA. Correspondingly, the PAVS demonstrated good agreement with meeting PA recommendations by accelerometry that currently specify PA be performed in ≥ 10 -min bouts, whereas SNAP did not.

The PAVS identified strongly those who were insufficiently active, that is specificity (91% of

the time), and SNAP did so moderately (60% of the time). Neither questionnaire had high positive predictive value (correctly identifying participants who were sufficiently active). A PA questionnaire in primary care should predominantly identify patients that most need PA counseling and intervention. Because of the particularly high specificity of the PAVS compared with SNAP, with accelerometry, we are confident that those who self-reported <5 days on the first question of the PAVS were in fact not sufficiently active.

To our knowledge, the PAVS and SNAP are the first primary care PA questionnaires evaluated against a criterion measure of PA and ACSM/AHA aerobic PA recommendations updated in 2008 (Haskell *et al.*, 2007). A main difference between the PAVS and other primary care PA questionnaires is that the PAVS does not query PA intensity using the terms ‘moderate’ and ‘vigorous’, which are reportedly often misunderstood by research participants, and likely by the general population. The PAVS also does not attempt to conceptualize PA into different domains such as transportation, work-related, home/caregiving, and recreational activities wherein activities can be counted more than once and consequently overestimate PA. The high specificity of the PAVS may support a reported assertion that including intensity levels and PA domains in questionnaires may attenuate PA estimates (Altschuler *et al.*, 2009).

Glasgow *et al.* (2005) did not consider any current self-report PA questionnaires practical to implement in primary care in their 2005 review of patient self-report measures of health behaviors. Their main finding was that PA questionnaires took too long to complete. Both the PAVS and SNAP were developed to be administered in the least amount of time possible without misclassifying activity levels of patients. The two- and three-question PA questionnaires evaluated by Smith *et al.* (2005) (no names for questionnaires were provided), and the Exercise Vital Sign reported by Coleman *et al.* (2012) are the shortest PA questionnaires reported to date, requiring a median of 1–2 min (Smith *et al.*, 2005) and a mean of <1 min (Exercise Vital Sign) to complete. PA questions by Smith *et al.*, however, demonstrated poor agreement with sufficient activity measured by accelerometry (10%), and were evaluated against earlier PA recommendations.

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To our knowledge, only the Exercise Vital Sign assesses patient PA behaviors as rapidly as the PAVS and SNAP (<1 min).

The decreasing accuracy by which the PAVS measured days with ≥ 30 bout-min MVPA as PA increased (see Figure 4) may be due to increasing measurement error caused by a small number of participants with four or more days with ≥ 30 bout-min MVPA. Others have also noted that a small sample with greater than average PA levels is a limitation to assessing agreement between objective and self-report measures of PA (Prochaska *et al.*, 2001, Shephard, 2003). It is also noteworthy that random error, identifiable only by replicate measures of a questionnaire, can inflate limits of agreement (Ludbrook, 2010). Accordingly, Bland–Altman agreement of the PAVS should be interpreted with caution until repeatability of the PAVS is investigated.

Recalling PA by bouts (eg, sets of 10 continuous minutes MVPA) has also previously been reported as a challenge with brief self-report measures of PA (Prochaska *et al.*, 2001). We feel that perhaps placing a greater focus on explaining the nature of ‘bouts’ of PA will improve recall of recommended bout-minutes of MVPA. The PAVS might be improved by prefacing its questions with a more descriptive explanation of ‘bouts’. For example, the PAVS might more accurately measure PA in bouts by first stating ‘physical activity is most beneficial when performed in 10 or more continuous minutes at a time – how many days in the past week have you performed...’

The findings of this study are not without limitations. The sample of mostly female clinic staff was chosen with a dual purpose of helping clinic staff familiarize themselves with new tools potentially being integrated into clinical practice and to gather preliminary evidence for the validity of those tools. Conclusions therefore cannot be generalized to whole populations. It is noteworthy; however, that the low prevalence of meeting PA recommendations either by MVPA or vigorous PA by accel in this study is similar to other adult populations, including US representative samples (Hagströmer *et al.*, 2007; Troiano *et al.*, 2008; Tucker *et al.*, 2011). While this may indicate similarity between the PA behaviors of our study sample and the general population, agreement of the PAVS and SNAP with those that meet PA recommendations is unwarranted. A larger and

more diverse sample with respect to PA behaviors would help confirm our findings of agreement. Lastly, although the questionnaires were administered in a primary care setting, respondents may interpret the questionnaires differently when administered by a provider.

Our findings demonstrate preliminary evidence of the PAVS to strongly identify insufficiently active people in a sample of clinic staff predominately female. The PAVS appears helpful to identify individuals that most need PA counseling from their primary care provider. The ability of SNAP to identify insufficient activity appears moderate, although still comparable to previously evaluated questionnaires that assess PA in primary care (Smith *et al.*, 2005; Meriwether *et al.*, 2006; Topolski *et al.*, 2006). SNAP allows providers to tailor PA counseling because it identifies patients' stage of readiness to change their PA behavior. In order to be congruent with public health aerobic PA recommendations, a primary care PA questionnaire needs to identify MVPA performed in bouts of 10 or more continuous minutes (Haskell *et al.*, 2007). Evidence that determines the usefulness of a primary care PA questionnaire should include statistical agreement with a criterion measure of PA, as well as sensitivity to change, or repeatability (Bland and Altman, 1986; Luiz and Szklo, 2005; Schmidt and Steindorf, 2006; Mâsse, 2010). The PAVS and SNAP should be evaluated further for repeatability, and in populations varying in PA levels, age, gender, and ethnicity.

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Conflicts of Interest

Trever J. Ball, Elizabeth A. Joy, Tan Leng Goh, James C. Hannon, Lisa H. Gren, and Janet M. Shaw have no financial disclosures.

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