The Validity of the Stanford Seven-Day Physical Activity Recall in Young Adults

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ABSTRACT

WASHBURN, R. A., D. J. JACOBSEN, B. J. SONKO, J. O. HILL, and J. E. DONNELLY. The Validity of the Stanford Seven-Day Physical Activity Recall in Young Adults. *Med. Sci. Sports Exerc.*, Vol. 35, No. 8, pp. 1374–1380, 2003. **Purpose:** To evaluate the criterion validity of the 7-Day Physical Activity Recall (7D-PAR) and factors associated with reporting error, in a sample of moderately overweight, young adult men and women. **Methods:** Average total daily energy expenditure (TDEE) and physical activity energy expenditure (PAEE) from the 7D-PAR were compared with the same parameters assessed by doubly labeled water in 17 men, age = 23.9 ± 3.8 yr, and 29 women, age = 23.3 ± 4.6 yr, who volunteered to participate in a 16-month supervised aerobic exercise trial. PAEE was estimated from the 7D-PAR and from DLW [0.9 * TDEE −resting metabolic rate (RMR) (indirect calorimetry)]. In addition, peak oxygen uptake and percent body fat were obtained **Results:** No significant differences in TDEE ($kJ \cdot d^{-1}$) were noted between the 7D-PAR (11,825 ± 1,779) and DLW (11,922 ± 2,516) for the complete sample (N = 46) or for men (7D-PAR = 13,198 ± 1,638, DLW = 13,885 ± 2,754) or women (7D-PAR = 11,018 ± 1,323, DLW = 10,771 ± 1,457. The mean PAEE from the 7D-PAR was not different from DLW in the total sample (7D-PAR = 3286 ± 502, DLW = 3508 ± 1863) as well as in men (7D-PAR = 3650 ± 490, DLW = 3989 ± 2461) and women (3073 ± 377, DLW = 3223 ± 1360). In a regression model, PAEE, peak oxygen uptake, gender and percent fat accounted for 86% of the reporting error in total daily energy expenditure when using the 7D-PAR. **Conclusion:** The 7D-PAR provided a reasonable estimate of both the mean TDEE and PAEE in this sample; however, estimates of energy expenditure on an individual basis using the PAR were subject to considerable error. **Key Words:** QUESTIONNAIRES, PHYSICAL ACTIVITY ASSESSMENT, DOUBLY LABELED WATER, TOTAL DAILY ENERGY EXPENDITURE, PHYSICAL ACTIVITY ENERGY EXPENDITURE

A number of physical activity surveys are currently available for use in epidemiologic studies of the association of physical activity and risk for chronic disease (21). One survey, the Stanford Seven-Day Physical Activity Recall (7D–PAR) has been used in studies on the association of physical activity and health parameters (31), and as a primary outcome measure in randomized controlled trials to evaluate the effectiveness of physical activity promotion strategies (12,13). Several studies have evaluated the validity of this instrument in adults by comparing physical activity assessed by the 7D-PAR with direct physical activity assessments obtained by self-report logging procedures, heart rate monitoring and motion sensors, or indirect indicators of physical activity participation such as maximal aerobic capacity, dietary intake, or percent body fat (3,25,26). Results indicated modest correlations between the 7D-PAR and direct measurements of physical activity (median r = 0.50) and lower correlations with indirect physical activity measures.

Few studies have validated the 7D-PAR using doubly labeled water (DLW), considered to be the "gold standard" criterion measure of energy expenditure in free-living individuals (5,14,18). Irwin et al. (16) and Conway et al. (9) compared 7D-PAR total energy expenditure with total energy expenditure assessed by DLW over a 14-d period in 24 adult men, age 27–65 yr. Results showed the 7D-PAR overestimated energy expenditure from doubly labeled water by 4132 ± 1356 $kJ \cdot d^{-1}$ (30.6 ± 9.9%). None of the factors considered (age, body mass index, physical activity level, or percent fat) were significantly associated with error in estimation of energy expenditure using the 7D-PAR (16). Bonnefoy et al. (5) in a small sample of healthy older men (N = 19, mean age = 73.4 ± 4.1 yr) reported the 7D-PAR overestimated total energy expenditure assessed by DLW by 1155 $kJ \cdot d^{-1}$ (10.8%). In a sample of 14 middle-age (40 yr) obese women (45 ± 4% fat), Racette et al. (24) reported that the 7D-PAR overestimated daily energy expenditure by 205 $kJ \cdot d^{-1}$ (3.4 ± 14.4%).

The purpose of the current study was to further evaluate the validity of the 7D-PAR and identify determinants associated with the accuracy of estimation of energy expenditure using DLW as the criterion measure in a larger sample of young adult men and women. Physical activity assessment

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is particularly important for evaluating both the effectiveness of interventions and the association between activity and chronic disease risk factors in young adults, a group at high risk for sedentary behavior and weight gain (19,28).

METHODS

Subjects. Seventy-four sedentary, moderately obese young adults were recruited via advertisements in the campus newspaper and posters in campus buildings, to participate in a 16-month intervention to assess the impact of aerobic exercise training on body weight and body composition. Participants were between the ages of 17 and 35 yr and were overweight or moderately obese (BMI between 25.0 and 34.9 and triceps skinfold ≥ the 85th percentile of the NHANES II population) and sedentary, defined as less than 500 $kcal \cdot wk^{-1}$ of regular leisure time physical activity. Potential participants who had a history of chronic disease (i.e. diabetes, heart disease, etc.), elevated blood pressure (>140/90,) or elevated blood lipids (cholesterol > 6.72 $mmol \cdot L^{-1}$; triglycerides > 5.65 $mmol \cdot L^{-1}$) or fasting glucose (>7.8 $mmol \cdot L^{-1}$) were excluded. Additionally, potential participants were excluded if they were smokers, took medications that would affect physical performance (i.e., beta blockers) or metabolism (i.e., thyroid, steroids), or if they were unable to perform the laboratory tests or participate in moderate intensity exercise. Seventeen men and 29 women who were recruited for this trial were randomly assigned to the DLW protocol. The data collected on these 46 individuals at baseline, before randomization, form the basis for this report. All subjects provided written informed consent before participation. The study protocol was approved by the Human Subjects Committee at The University of Kansas, Lawrence.

Study protocol. All testing was performed in the Energy Balance Laboratories at the University of Nebraska-Kearney or The University of Kansas, Lawrence. Two sites were used as the result of a change in academic affiliation of the principal investigator (JED). Body composition and maximal oxygen uptake were evaluated during a single laboratory visit. For this analysis, we were interested in assessing the association of body composition and cardiovascular fitness on reporting error when using the 7D-PAR. Subjects returned to the laboratory on a separate occasion for the assessment of RMR and to begin the DLW protocol. The DLW evaluation was carried out over a 14-d period. DLW was administered on day 1 with urine collected daily over the next 14 d. The 7D-PAR was administered on day 7 or 8 of the DLW protocol to insure that both assessments were concurrent.

Body composition. Body weight was assessed to the nearest ± 0.1 kg between 0700 h and 0900 h using an electronic scale. Subjects were weighed before breakfast and after voiding, wearing a standard hospital gown. Height was measured to the nearest 0.1 cm using a stadiometer. Body mass index (BMI), defined as weight/height (2) was expressed in kilograms per square meter. Percent body fat was estimated using hydrostatic weighing. Underwater weight was recorded to the nearest ± 25 g. Residual volume was measured in duplicate immediately preceding the body density measurement by the method of Wilmore et al. (30). Body density and percent fat were calculated using the equations of Brozek et al. (6,7).

Peak oxygen uptake. Immediately after body composition assessment, peak oxygen uptake was evaluated on a motor-driven treadmill using a modified Balke protocol (1). The protocol involved walking at a speed of 3 mph, 0% grade, with a 2% increase in grade every 2 min. Peak oxygen uptake was considered as the oxygen uptake value recorded at the point of volitional exhaustion. Oxygen uptake, heart rate, and blood pressure were monitored continuously throughout the test. Oxygen uptake was determined from expired air sampled at 1-min intervals using a SensorMedics 2900 metabolic cart (SensorMedics, Yorba Linda, CA) calibrated before each test according to manufacturer's specifications.

RMR. On a separate day, within 1 wk of completing the body composition and peak oxygen uptake protocols, subjects reported to the laboratory between 0600 h and 0900 h for RMR determination. Subjects were required to refrain from exercise for 48 h before RMR evaluation and did not consume any liquids or food, except water, for 12 h before the RMR measurement. Adherence to the testing protocol was verified by questionnaire before the RMR assessment. The 48-h time period has been shown to eliminate any residual effects on RMR from the most recent exercise session (22). After entering the laboratory, the subjects rested supine for 20 min before RMR assessment. RMR was determined using a ventilated hood system and a SensorMedics 2900 metabolic cart. The oxygen and carbon dioxide analyzers were calibrated with gases of known concentration before each test, and the flow meter was calibrated with a 3-L syringe. Each RMR test required a minimum of 30 min of measurement. The test was continued until at least three 5-min blocks of steady-state measurements were obtained. The average RMR over the three 5-min blocks was used in the analysis. Criteria for a valid RMR evaluation was a steady state determined as less than 10% fluctuation in minute ventilation and oxygen consumption, and less than 5% fluctuation in respiratory quotient (12,23).

DLW procedures. DLW was administered between 0800 h and 0900 h after an overnight fast. Two baseline urine specimens were collected from each subject before oral dosing with a mixed solution of $^2H_2{}^{18}O$. The isotope dose given to each subject was in the form of a mixed stock solution of 0.15 g ^{18}O and 0.05 g $^2H \cdot kg^{-1}$ body weight. This procedure reduced the amount of ^{18}O required as the isotope was in severe short supply at the time of the study. Subjects then drank 100 mL of tap water from the same container used to administer the isotope water. After administration of the isotope dose, subjects were free to engage in daily activities (work, attend classes) but were required to return to the laboratory 4 and 6 h later to provide urine specimens on the first day. On all subsequent study days, urine from the second void of the day was collected for isotopic analyses. The total sample period for analysis was 14 d. All urine samples and samples of the doses given to the subjects were stored in tightly sealed containers at −20°C and subsequently were analyzed at the University of Colorado Health Sciences Center, Clinical Nutrition Research Unit Mass Spectrometry Core.

^{18}O enrichment analysis was determined using a VG Optima Isotope Ratio Mass Spectrometer (IRMS, Fisons Instruments, VG Isotech). This is a magnetic sector dual inlet instrument that is equipped with three faraday collectors to detect the various masses of interest. We used 0.5-mL duplicate urine samples in 10-mL Vacutainers to which 0.7 mL of our internal reference CO_2 gas standard was added. The added CO_2 was allowed to equilibrate in an air-bath at 37°C with the urine sample for 16 h. The masses of interest for ^{18}O analysis were 44 and 46, and the ratio of 46 to 44 ($^{12}C^{16}O^{18}O/^{12}C^{16}O^{16}O$) was measured. The instrument's software automatically applies Craig's correction before enrichment values were reported in δ (%o) units calculated as

$$\delta = \frac{[R_s - R_f]*10^3}{R_f} \tag{1}$$

where R_s and R_f are the isotopic ratios of the sample and reference, respectively (11).

Hydrogen enrichment estimation. Our hydrogen analysis system applies the platinum equilibration technique. Duplicate 0.5-mL aliquots of urine are used during equilibration. The samples are transferred into 4-mL clear glass vials and catalyst-coated glass rods are added such that the uncoated end is immersed in the sample. This prevents the Pt catalyst from making direct contact with the urine sample and thereby prevented potential catalyst poisoning by some urine inclusions. Sample equilibration takes 2 h at a temperature of 44°C. At the end of equilibration, the auto-sampler needle partially pierces the screw cap septum. The needle penetrates just far enough into the septum to be sealed. First, air in the gas sample line between the needle and the IRMS sample side is pumped out at low and then at high vacuum. Then the needle advances completely through the septum and the Teflon layer to sample the equilibrated gas in the vial head space. The sampled gas is first dried in a drying chamber before it is released to the pressure transducer of the ratio mass spectrophotometer for sample size determination. The parameters of interest in this determination are masses 2 (H_2) and 3 (OH) and the ratio of mass 3 to mass 2. The data obtained from the hydrogen analysis system is drift-corrected offline and the values are normalized with respect to Vienna Standard Mean Ocean Water/Standard Arctic Light Precipitation scale. The final results are expressed as units of δ. All enrichments are corrected for predose values. Our isotope ratio mass spectrometer has an external precision of at least 0.01 for ^{18}O and 0.5 ($N = 20$) for ^{2}H enrichment estimations. For total energy expenditure estimation, CO_2 production was estimated using the "multipoint" method described by Coward (10). A computer program, developed in our lab, and based on a bivariate regression model described by Jones et al. (18) was used to calculate rates of carbon dioxide production and total daily energy expenditure ($TDEE_{DLW}$). Physical activity energy expenditure from DLW ($PAEE_{DLW}$) was estimated from $TDEE_{DLW}$ and RMR from the formula $PAEE_{DLW} = (TDEE_{DLW} *0.9) - RMR$ (14). This approach assumes that 10% of total energy expenditure is due to the thermic effect of meals (29).

7D-PAR. The 7D-PAR, originally developed for use in the Stanford Five-Cities project during the early 1980s and described by Sallis et al. (27) was used in this study. The 7D-PAR was administered by two trained interviewers during a 15- to 20-min structured interview. Interviewer reliability (intraclass correlation = 0.85) was established by comparing 10 interviews conducted on the same individual by both interviewers. During the interview, subjects were asked to recall the amount of time spent in sleep, moderate, hard, and very hard physical activities during weekdays and weekend days of the previous week. The average amount of time spent in light activities each day was calculated as the difference between 24 h and the sum of the time spent in sleep, moderate, hard, and very hard activities. Total daily energy expenditure $TDEE_{7D\text{-}PAR}$ ($kJ \cdot d^{-1}$) was calculated as the average hours per day in each activity category multiplied by an assigned MET value (sleep = 1, light = 1.5, moderate = 4, hard = 6, and very hard = 10) and body weight in kilograms. Physical activity energy expenditure from the 7D-PAR ($PAEE_{7D\text{-}PAR}$) was estimated as the sum of energy expenditure in light, moderate, hard, and very hard activity minus the contribution of RMR (body weight (kg) * 4.186 $kJ \cdot kg^{-1} \cdot h^{-1}$).

Statistics. Data were entered into Microsoft Excel and analysis was performed using SPSS-PC for Windows Version 9.0 (SPSS Inc, Chicago, IL). Means and standard deviations were calculated for all dependent measures. Dependent *t*-tests were used to evaluate the mean difference between energy expenditure estimated from DLW and the 7D-PAR. Differences in energy expenditure ($kJ \cdot d^{-1}$) between DLW and the 7D-PAR were computed as 7D-PAR minus DLW. Therefore, a negative difference indicates an underestimation and a positive difference represents an overestimation of energy expenditure by the 7D-PAR. Additionally, agreement between energy expenditure measured with DLW and estimated using the 7D-PAR was evaluated using Bland and Altman plots (4). Specifically, plots of the difference in energy expenditure between DLW and the 7D-PAR versus the mean energy expenditure assessed by DLW and the 7D-PAR were examined. Limits of agreement between DLW and the 7D-PAR were calculated as the mean difference between DLW and the 7D-PAR ± 2 SD of the difference. Narrow limits of agreement (i.e., ± 209–419 $kJ \cdot d^{-1}$) suggest that the 7D-PAR provides a useful alternative measure of energy expenditure. Pearson product-moment correlations were used to assess the association between energy expenditure from the 7D-PAR and DLW as well as between age, physical activity level, percent fat, and maximal oxygen uptake and reporting error. Forward stepwise regression analysis was used to identify and evaluate the relative importance of factors associated with reporting error.

TABLE 1. Descriptive characteristics by gender (mean ± SD).

Variable	Men (N = 17)	Women (N = 29)
Age (yr)	23.9 ± 3.8	23.3 ± 4.6
Height (cm)	178.9 ± 8.3	163.7 ± 6.6*
Weight (kg)	95.1 ± 11.9	79.1 ± 9.9*
BMI (kg·m^{-2})	29.8 ± 2.7	29.4 ± 2.8
Body fat (%)	28.2 ± 4.7	36.6 ± 4.2*
Peak $\dot{V}O_2$ (mL·kg^{-1}·min^{-1})	39.6 ± 5.7	32.7 ± 3.8*

* $P < 0.001$ between genders.

RESULTS

The study sample (Table 1) consisted of 46 overweight men and women with an age range from 18 to 33 yr; 37 non-Hispanic whites, 4 African-Americans, 4 Asian-Americans, and 1 Native American. No significant differences were noted between the mean $TDEE_{7D\text{-}PAR}$ (11,825 ± 1,779 kJ·d^{-1}) and $TDEE_{DLW}$ (11,922 ± 2,516 kJ·d^{-1}) in this sample. On average, the 7D-PAR underestimated mean daily energy expenditure by −96 ± 2,080 kJ·d^{-1} (−1.3 ± 17%). A Bland-Altman plot (Fig. 1) indicated that the underestimation of energy expenditure by the 7D-PAR increased as the total daily energy expenditure increased. The limits of agreement were large (−4065 to + 4257 kJ·d^{-1}). The correlation between $TDEE_{7D\text{-}PAR}$ and $TDEE_{DLW}$ was 0.58 ($P < 0.01$).

There were no significant differences between $TDEE_{7D\text{-}PAR}$ and $TDEE_{DLW}$ for either men ($TDEE_{7D\text{-}PAR}$ = 13,198 ± 1,638 kJ·d^{-1}, $TDEE_{DLW}$ = 13,885 ± 2,754 kJ·d^{-1} or women ($TDEE_{7D\text{-}PAR}$ = 11,018 ± 1,323 kJ·d^{-1}, $TDEE_{DLW}$ = 10,771 ± 1,457 kJ·d^{-1}. In men, the 7D-PAR underestimated mean daily energy expenditure by an average of 687 ± 2,654 kJ·d^{-1} (−5.9 ± 19.7%), whereas the 7D-PAR overestimated mean daily energy expenditure by an average of 247 ± 1,641 kJ·d^{-1} (1.3 ± 16%) in women. $TDEE_{7D\text{-}PAR}$ and $TDEE_{DLW}$ were not significantly correlated in either men (r = 0.36) or women (r = 0.32). Approximately 57% of women, compared with 24% of men were able to estimate total mean daily energy expenditure to within ± 10% of the criterion measure (DLW) using the 7D-PAR. The 7D-PAR underestimated the mean daily energy expenditure by greater than 10% in approximately 47% of men compared with 17% of women, and overestimated mean daily energy expenditure by greater than 10% in approximately 29% of men and 27% of women.

In the total sample, $PAEE_{7D\text{-}PAR}$ (3286 ± 502 kJ·d^{-1}) was not significantly different from $PAEE_{DLW}$ (3508 ± 1863 kJ·d^{-1}); however, the two measures were not significantly correlated (r = 0.12). $PAEE_{7D\text{-}PAR}$ underestimated $PAEE_{DLW}$ by an average of 222 ± 1863 kJ·d^{-1} (−8 ± 56%). The Bland-Altman plot (Fig. 2) shows that the magnitude of underestimation of $PAEE_{7D\text{-}PAR}$ increased with increased level of physical activity. The limits of agreement between the two measures were large, −4366 to +3922 kJ·d^{-1}.

The 7D-PAR underestimated physical activity energy expenditure by an average of 339 ± 2474 kJ·d^{-1} (−11 ± 65%) in men and 150 ± 1440 kJ·d^{-1} (−7 ± 50%) in women. $PAEE_{7D\text{-}PAR}$ and $PAEE_{DLW}$ were not significantly correlated in either men (r = 0.07) or women (r = −0.07). Approximately 30% of women compared with 6% of men were able to estimate physical activity energy expenditure with the 7D-PAR within ± 10% of the criterion measure. The 7D-PAR underestimated physical activity energy expenditure by greater than 10% in approximately 53% of men and 33% of women and overestimated physical activity energy expenditure by more than 10% in 41% of men and 37% of women.

Factors associated with reporting error. Correlations of age, percent fat, peak oxygen uptake, and physical activity energy expenditure with reporting error for total energy expenditure from the 7D-PAR ($TDEE_{7D\text{-}PAR} - TDEE_{DLW}$) are presented in Table 2. In both men and women, a higher level of physical activity energy expenditure was associated with an underestimate of total daily energy expenditure from the 7D-PAR (men, r = −0.91, $P < 0.01$; women r = −0.80, $P < 0.01$). In women, a higher percent fat was associated with an overestimate of total daily physical activity from the 7D-PAR (r = 0.52, $P < 0.01$). In a regression model (Table 3) physical activity energy expenditure, peak $\dot{V}O_2$, gender, and percent fat accounted for 86% of the variance in reporting error for total daily energy expenditure from the 7D-PAR ($P < 0.01$).

Correlations of age, percent fat, peak oxygen uptake, and total daily energy expenditure with reporting error for physical activity energy expenditure from the 7D-PAR ($PAEE_{7D\text{-}PAR} - PAEE_{DLW}$) are shown in Table 4. Total daily energy expenditure was the only factor significantly correlated with reporting error for physical activity in both men (r = −0.87, $P < 0.01$) and women (r = −0.66, $P < 0.01$). In a regression model (Table 5) gender, percent fat, and total daily energy expenditure accounted for 53% of the variance in reporting error for physical activity energy expenditure from the 7D-PAR.

DISCUSSION

We assessed the accuracy of the 7D-PAR to assess both total and physical activity energy expenditure in a sample of moderately obese, young adult men and women using DLW with indirect calorimetry as the criterion measure. Our results indicated that the 7D-PAR provided a reasonable estimate of the mean total and physical activity energy expenditure in this sample; however, high individual variability suggests that the use of the 7D-PAR to assess individual levels of energy expenditure may be limited. Our data also indicated that the accuracy of the 7D-PAR is influenced by personal and behavioral characteristics such as gender, percent fat, total energy expenditure, and cardiovascular fitness.

Total daily energy expenditure. We have shown that the mean total daily energy expenditure estimated from the 7D-PAR was not significantly different from that measured by DLW. On average, the total energy expenditure from the 7D-PAR slightly underestimated energy expenditure measured by DLW by −1.3 ± 17%; however, the variability in individual errors was large (range = −49 to + 27%). These results are in agreement with several reports in the literature. For example, Bonnefoy et al. (5) compared total daily energy expenditure estimated from the 7D-PAR with daily

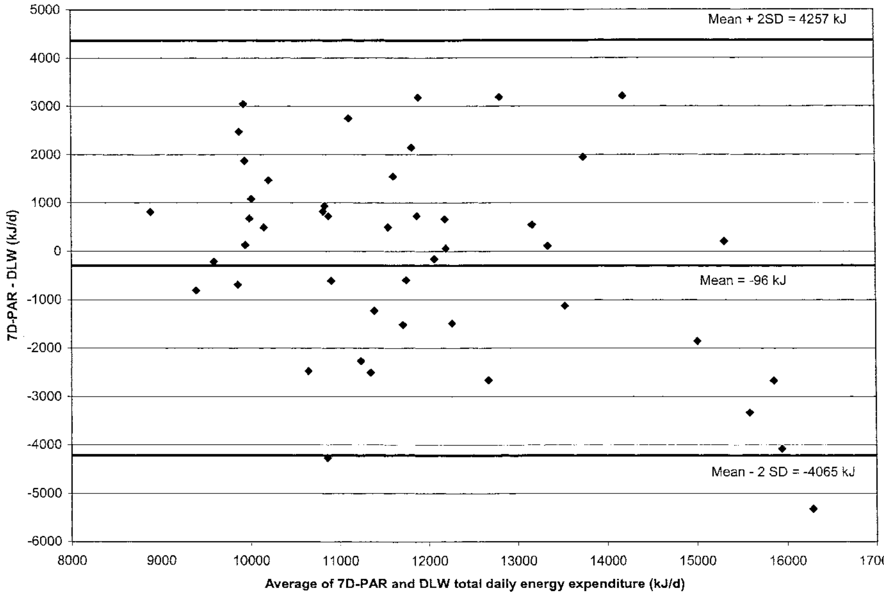

FIGURE 1—Bland-Altman plot for total daily energy expenditure as estimated by the 7-Day Physical Activity Recall in 46 overweight adults.

energy expenditure measured from a 14-d DLW protocol in 19 healthy, community-dwelling older men (age 73 ± 4 yr). The 7D-PAR provided a nonsignificant overestimation of total energy expenditure (1115 $kJ \cdot d^{-1}$, 10.8%, $P < 0.09$); however, the Bland and Altman limits of agreement were large (−4500 to + 6802 $kJ \cdot d^{-1}$). Racette et al. (24) in 14 obese women reported that the 7D-PAR slightly overestimated mean total daily energy expenditure measured by 14-d DLW (3.4 ± 14%); however, the individual variability in estimation was large (range −24.4 to + 36.2%). In contrast to the majority of reports which indicated that the 7D-PAR provides a reasonable estimate of mean energy expenditure for a group, Irwin et al. (16) reported that the 7D-PAR overestimated energy expenditure measured by DLW by 4132 ± 1356 $kJ \cdot d^{-1}$ (30.6%) in 24 middle-aged, healthy men (41.2 ± 9.6 yr). Although difficult to evaluate in these studies, it is likely that the variability in results across studies and the high individual variability in estimation accuracy is due, at least in part, to the use of absolute MET values when calculating energy expenditure when using the 7D-PAR. Recent evidence suggests that there is considerable interindividual variability in MET values assigned to physical activity which can range in magnitude from 0.5 to 1.5 METs (2,14). Differences in the true energy expenditure of reported activities could lead to significant over or under-estimation of energy expenditure when using the 7D-PAR.

Limited information is currently available regarding the impact of behavioral and personal characteristics on reporting error when using the 7D-PAR. Our results suggest that the 7D-PAR may provide more accurate assessments of total daily energy expenditure in women compared with men. In the current study, $TDEE_{7D\text{-}PAR}$ was within ± 10% of the value obtained from DLW in 57% of women compared with 37% of men. In a regression model, gender was a significant predictor of reporting error after controlling for

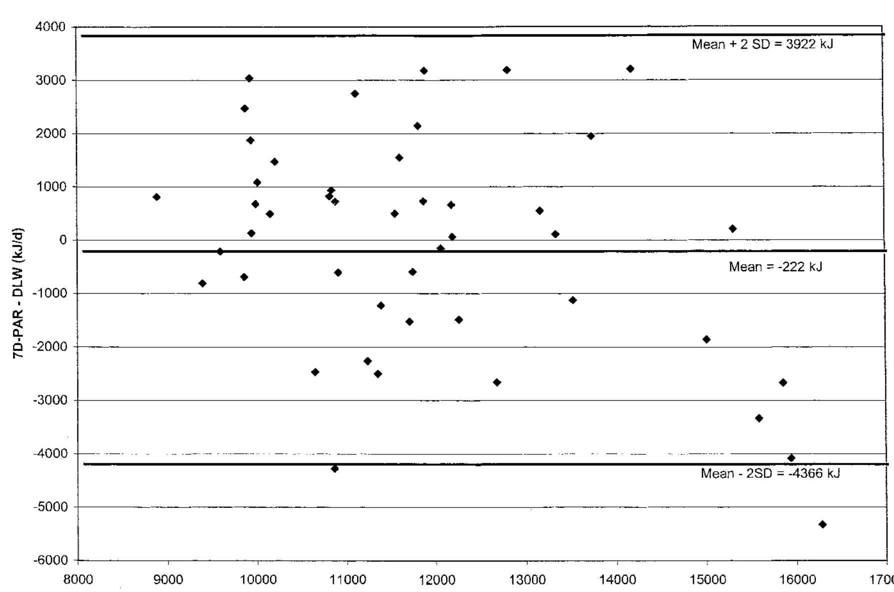

FIGURE 2—Bland-Altman plot for physical activity energy expenditure estimated by the 7-Day Physical Activity Recall in 46 overweight adults.

TABLE 2. Pearson correlations between age, percent fat, $PAEE_{DLW}$ [a], and peak oxygen uptake and reporting error for total daily energy expenditure for the 7D-PAR ($TDEE_{7D\text{-}PAR}$ [b] - $TDEE_{DLW}$ [c]).

Factor	($TDEE_{7D\text{-}PAR}$ - $TDEE_{DLW}$) Men (N = 17)	Women (N = 29)
Age	−0.14	−0.24
Percent fat	0.23	0.52*
Peak $\dot{V}O_2$	−0.39	−0.28
$PAEE_{DLW}$	−0.91*	−0.80*

[a] Physical activity energy expenditure from DLW: ($TDEE_{DLW}$ * 0.9) - RMR.
[b] Total daily energy expenditure from the 7D-PAR.
[c] Total daily energy expenditure from DLW.
* $P < 0.01$.

TABLE 4. Correlation between age, percent fat, $TDEE_{DLW}$ [a], and peak oxygen uptake with reporting error for physical activity energy expenditure from the 7D-PAR ($PAEE_{7D\text{-}PAR}$ [b] - $PAEE_{DLW}$ [c]).

Factor	($PAEE_{7D\text{-}PAR}$ - $PAEE_{DLW}$) Men (N = 17)	Women (N = 30)
Age	−0.22	−0.32
Percent fat	0.12	0.34
$TDEE_{DLW}$	−0.87*	−0.66*
Peak $\dot{V}O_2$	−0.18	−0.09

[a] Total daily energy expenditure from DLW.
[b] Physical activity energy expenditure from the 7D-PAR.
[c] Physical activity energy expenditure from DLW: ($TDEE_{DLW}$ * 0.9) - RMR.
* $P < 0.01$.

age, percent fat, cardiovascular fitness, and PAEE. The regression analysis also indicated that the level of PAEE accounted for the largest percentage of the variance in reporting error (76%). High levels of physical activity energy expenditure were associated with an underestimation of TDEE when using the 7D-PAR. We are aware of only one other investigation that has evaluated factors associated with reporting error using the 7D-PAR. Irwin et al. (16) in a comparison of $TDEE_{7D\text{-}PAR}$ with TDEE from a 14-d DLW assessment in 24 adult men used a regression model to evaluate the association of percent fat, BMI, physical activity level, and age with reporting error for the 7D-PAR. None of the factors considered explained a significant percentage of the variance in reporting error.

Physical activity energy expenditure. In addition to TDEE, which included the energy expenditure associated with sleep, we also evaluated the accuracy of the 7D-PAR to estimate energy expenditure associated only with physical activity (light, moderate, hard, and very hard activities). We found that the mean $PAEE_{7D\text{-}PAR}$ did not differ significantly from $PAEE_{DLW}$ in either men or women. $PAEE_{7D\text{-}PAR}$ tended to underestimate $PAEE_{DLW}$ in both men and women. The magnitude of the underestimation increased as $PAEE_{DLW}$ increased. It might be hypothesized that individuals with higher levels of $PAEE_{DLW}$ participate in regular, structured physical activities which may be more accurately recalled; however, this was most likely not the case in this study as evidenced by the generally sedentary lifestyle of the participants.

Similar to our results for total daily energy expenditure the individual variability in estimation of $PAEE_{7D\text{-}PAR}$ was large (range, men = −112 to +89%; women = −151 to + 81%). Our results suggest that the 7D-PAR may provide a better estimate of PAEE in women than in men. $PAEE_{7D\text{-}PAR}$ was within ± 10% of the value obtained from DLW in 30% of women compared with 6% of men. A regression model indicated that gender and percent fat accounted for approximately 47% of the variance in reporting error for $PAEE_{7D\text{-}PAR}$.

Body composition and reporting error. Our results suggest that higher percent body fat was associated with overestimates of both total and physical activity energy expenditure using the 7D-PAR. This finding is in agreement with most, but not all, reports on this topic. It has been suggested that social desirability, the tendency to provide positive or culturally appropriate information to enhance self-esteem, may, at least partially explain this phenomena (15,16). Irwin et al. (16) reported that men with BMI > 25 $kg \cdot m^{-2}$ overestimated total daily energy expenditure using both the 7D-PAR and daily physical activity logs compared with their leaner counterparts. Others have shown similar results. For example, Jakicic et al. (17) found that 40–60% of 50 overweight women over-reported the amount of exercise they performed when comparing exercise logs with activity assessed by a portable accelerometer. Buchowski et al. (8) in a comparison of self-report physical activity over two separate days spent in a whole-room calorimeter in 115 adults (age 38 ± 9 yr, 45 men, 70 women) found that for physical activities at an intensity ≥ 4.5 METs, energy expenditure was overestimated as percent body fat increased. Finally, Lichtman et al. (20) compared energy expenditure measured by a 14 d DLW protocol with that obtained from 15-min logs of physical activity in 16 obese individuals. Results indicated that physical activity was over-reported by an average of 40%.

The current study is limited by sample size and the homogeneity of the study sample. Although the sample size is relatively large (N = 46) for this type of investigation, and larger than other studies that have evaluated the 7D-PAR using DLW as the criterion measure (5,16,24), the sample available for gender comparisons was still relatively small

TABLE 3. Factors associated with reporting error in total daily energy expenditure for the 7D-PAR ($TDEE_{7D\text{-}PAR}$ [a] - $TDEE_{DLW}$ [b]) in 46 young adults.

Factor	Partial R^2	Partial P Value	Model R^2	Model P Value
$PAEE_{DLW}$ [c]	0.76	0.000	0.76	—
Peak $\dot{V}O_2$	0.065	0.000	0.825	—
Gender [d]	0.017	0.037	0.842	—
Percent fat	0.018	0.027	0.860	0.000

[a] Total daily energy expenditure from the 7D-PAR.
[b] Total daily energy expenditure from DLW.
[c] Physical activity energy expenditure from DLW: ($TDEE_{DLW}$ * 0.9) - RMR.
[d] 1, male; 2, female.

TABLE 5. Factors associated with reporting error in physical activity energy expenditure for the 7D-PAR ($PAEE_{7D\text{-}PAR}$ [a] - $PAEE_{DLW}$ [b]) in 46 young adults.

Factor	Partial R^2	Partial P Value	Model R^2	Model P Value
Gender [c]	0.32	0.000	0.32	—
Percent fat	0.145	0.001	0.465	—
$TDEE_{DLW}$ [d]	0.066	0.018	0.531	0.000

[a] Physical activity energy expenditure from the 7D-PAR.
[b] Physical activity energy expenditure from DLW: ($TDEE_{DLW}$ * 0.9) - RMR.
[c] 1, male; 2, female.
[d] Total daily energy expenditure from DLW.

(17 men, 29 women). The study sample recruited for an exercise intervention was 80% white and moderately obese. They were not highly active as exemplified by the finding that over 95% of the total energy expenditure reported on the 7D-PAR was accounted for by sleep and light physical activity. The degree to which these results are generalizable to other samples differing in ethnicity, body size, and with higher levels of physical activity is unknown and worthy of investigation.

In conclusion, our results suggest that the 7D-PAR provides a reasonable estimate of the mean level of TDEE or PAEE for a group; however, the high level of individual variability observed limit the use of the 7D-PAR for estimating energy expenditure on an individual basis. In addition, we have shown gender, body fat, and level of energy expenditure are associated with reporting error when using the 7D-PAR. This instrument, in its present form, should not be used to compare physical activity levels in cross-sectional studies or to track individual changes in physical activity. Additional work to further evaluate factors associated with reporting error and, if feasible, identify and evaluate strategies to reduce reporting error when using the 7D-PAR are warranted.

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