

Criterion Validity of the Yale Physical Activity Survey (YPAS) in Croatian Older Adults

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Abstract

Objective. The Yale Physical Activity Survey (YPAS) is one of the most commonly used questionnaires to assess physical activity (PA) levels in older adults. Although previous studies have explored its validity properties against accelerometry, to date, no evidence has been provided in Croatian older adults. Therefore, the primary purpose of this study was to examine whether the YPAS is a valid tool for measuring PA levels. **Materials and methods.** A total of 46 older women (mean age 72.3 ± 1.2 years) were recruited from three randomly selected public residential aged-care facilities. During the first stage, all participants wore a tri-axial GENEActiv accelerometer on their non-dominant hand for 7 consecutive days. After the wearing period, the participants completed the YPAS questionnaire. The correlations between the YPAS and GENEActiv data were calculated using Spearman's order-rank coefficients. **Results.** The YPAS total PA was positively and moderately correlated with the number of steps, light and moderate PA, and moderate-to-vigorous PA (MVPA; $\rho=0.48-0.64$), yet a low positive correlation was found with vigorous PA ($\rho=0.33$). The YPAS total energy expenditure (EE) and the number of stairs performance showed similar correlation patterns with GENEActiv accelerometry data as the total PA ($\rho=0.33-0.64$). The summary index score exhibited moderate and positive correlations with the number of steps, light, moderate, and vigorous PA and MVPA ($\rho=0.28-0.49$). **Conclusion.** This study shows that the YPAS is a valid tool for assessing PA patterns in older Croatian adults.

Key Words: Aged ■ Motor Activity ■ Surveys and Questionnaires ■ Energy Metabolism ■ Croatia.

Introduction

In recent decades, population ageing has become a major global challenge, driven by increased life expectancy and improved living conditions (1, 2). As a result, maintaining health, functional capacity, and independence in older adults has become a key priority for healthcare systems (3). Despite increased longevity, older adults have a higher prevalence of non-communicable diseases and mental health risk factors compared to younger populations (4), underscoring the need for effective strategies to promote healthy ageing (5, 6).

Non-pharmacological interventions, particularly regular physical activity (PA), represent a cornerstone of disease prevention and health promotion in older adults (7-10). A substantial body

of evidence demonstrates that regular PA positively affects physical health, cognitive function, functional capacity, and overall successful aging (11-13). Accordingly, the World Health Organization recommends that older adults engage in at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity PA per week, along with muscle-strengthening activities on two or more days weekly (12). Despite these well-established benefits, the prevalence of physical inactivity continues to increase, especially among individuals aged 60 years and older (14). This trend toward sedentary behavior is associated with declines in muscle strength and functional performance, leading to an increased risk of adverse outcomes, such as falls, fractures, and hospitalizations (15).

Regular PA can be measured using objective measures, such as direct calorimetry, doubly labelled water, and motion sensors, including accelerometers, pedometers, and heart rate and oxygen consumption monitors (16). Although these approaches have gained popularity by providing reliable and valid PA data in various populations of older adults (16), they do not apply to population-based studies due to the disadvantages of high costs, time consumption, and limited availability of resources. In the absence of objective measures, subjective methods, such as questionnaires and activity diaries, are widely used to assess different types and intensities of PA (16). Their low cost, ease of administration, and shorter data collection time make them particularly suitable for large-scale studies and routine screening. However, subjective measures generally demonstrate lower validity compared to direct methods, a limitation that may be more pronounced in older adults due to age-related declines in health status, motivation, and PA patterns (15-17).

Commonly used PA questionnaires in older populations include the Physical Activity Scale for the Elderly (PASE), the Community Healthy Activities Model Program for Seniors (CHAMPS), and the International Physical Activity Questionnaire (IPAQ) (18-20). Nevertheless, these instruments have limited ability to capture household and light-intensity activities, which constitute a substantial proportion of daily PA in older adults (21). To address this limitation, Dipietro et al. developed the Yale Physical Activity Survey (YPAS), an interviewer-administered questionnaire designed specifically for older populations, enabling detailed assessment of PA type, intensity, and temporal patterns, including light-, moderate-, and vigorous-intensity activities (15, 22).

To date, the validity of the Yale Physical Activity Survey (YPAS) has been examined in several studies conducted in the United States, Africa, and higher-income European countries (15, 22-30). These studies generally reported low-to-moderate correlations between YPAS scores and accelerometer-derived measures of PA. Variability in validity estimates has been attributed to methodological differences in accelerometer placement

and intensity cut-off values, particularly in relation to the assessment of light-intensity activities, which predominate in older populations (31, 32). Although the Croatian version of the YPAS has demonstrated satisfactory translation and reliability properties in older adults (32), its criterion validity has not yet been investigated.

Therefore, the primary aim of this study was to examine the criterion validity of the YPAS in a sample of Croatian older adults by comparison with accelerometer-based measures of PA. Based on previous findings (22-24), we hypothesized that YPAS outcomes would demonstrate low-to-moderate validity in relation to objective PA measures.

Materials and Methods

Study Participants

This observational, cross-sectional study enrolled 46 community-dwelling women from three randomly selected public residential aged-care facilities in the city of Zagreb, Croatia, from March 2024 to May 2024. The inclusion criteria were as follows: i) older adults aged ≥ 65 years, ii) free of locomotor and cognitive conditions, iii) free of recovering from acute illness, and iv) walking independently and without aid. The Montreal Cognitive Assessment (MoCA) scale was used to screen for initial thinking and resolving problems, and a score of 27 was used as a cut-off for individuals without cognitive problems (33). Given the observational and exploratory nature of this criterion validity study, a post hoc sensitivity power analysis was conducted using G*Power to determine the minimum detectable effect size based on the final sample size. Assuming a two-tailed correlation analysis, an alpha level of 0.05, and a statistical power of 0.80, a total sample size of 46 participants was sufficient to detect a moderate correlation coefficient ($\rho=0.35$). This effect size is consistent with previously reported validity coefficients in YPAS validation studies comparing questionnaire-based and accelerometer-derived physical activity measures (22-24). All analyses performed in this study were anonymous and followed the regulations of the Declaration of Helsinki (34).

The YPAS Questionnaire

The YPAS was designed to i) capture the time spent in various specific physical activities, grouped into five categories (housework, yardwork, caretaking, exercise, and recreation activities), and ii) assess the level of participation in different types of physical activities (22). The first part included a list of 27 activities, and each participant was required to indicate the time spent on each activity during the week, which was summed to provide the total PA time. To calculate the energy expenditure (EE), the time spent on each activity was multiplied by the corresponding intensity code and summed to obtain the overall EE. The second part included five PA dimensions related to the vigorous, walking, moving, standing, and sitting indexes. Each activity was multiplied by a specific weight factor from 1 (sitting) to 5 (vigorous) to calculate the individual indexes. The summary index was obtained by summing all the indices (22). The YPAS also provided data on the number of steps (10 stairs = 1 flight) taken daily, which was included in the validation model. The YPAS showed satisfactory test-retest reliability ($\alpha=0.70-0.92$) and translational properties in a sample of Croatian older adults (35).

Validity

To assess the validity of the YPAS, we compared the results with those obtained using a GENEActiv accelerometer (Activinsights Ltd, Cambridge, UK) (36). The GENEActiv accelerometer was placed on the non-dominant arm for 7 consecutive days. Each participant was instructed to wear the device throughout the day (including while sleeping) and to keep daily logs to report the wearing and non-wearing times. It consists of three axes and has a seismic acceleration sensor that is small (36×30×12 mm), light (16 g), waterproof, and offers body temperature data to improve the confirmation of energy consumption and non-wear time. Research has shown a strong correlation between the GENEActiv monitor and indirect calorimetry (Pearson's $r=0.79$ to 0.98) (36). The

GENEActiv was set to record at a rate of 80 Hz. To determine the number of steps and intensity of PA, the body posture and position of the arm on which the monitor was placed were assessed. If the heights recorded were greater than 15° below the horizontal, it meant that the wrist was raised, and if the arm position was less than 15° from the horizontal, it indicated a sitting or supine position. A degree of less than 15° below the horizontal represented the arm hanging more vertically and defined a standing position (37). The metabolic equivalent (MET) values were presented as weekly means and categorized as sedentary behavior (<1.5 METs), light (1.5–2.99 METs), moderate (3.0–5.99 METs), and vigorous (≥ 6 METs) PA levels (38). A cut-off of ≥ 3 METs indicated moderate-to-vigorous PA (MVPA). After 7 days, all participants returned the accelerometer and completed the YPAS.

Ethics Statement

Ethical approval was obtained from the Ethics Committee of the Faculty of Kinesiology at the University of Zagreb. This study did not receive any external funding.

Statistical Analyses

The Kolmogorov-Smirnov (K-S) test was used to examine the normality characteristics. Basic descriptive statistics of the study participants are presented as mean and SD or median and interquartile range (IQR) for normally and non-normally distributed variables. As the data did not follow a normal distribution, the correlation between the YPAS and actigraphy data was determined using Spearman's rank-order correlation (ρ). The size of a correlation coefficient was determined by the rule of thumb (39) as follows: i) negligible (0.0–0.3), ii) low (0.3–0.5), iii) moderate (0.5–0.7), iv) high (0.7–0.9), and v) very high (0.9–1.0). All procedures performed in this study were calculated using the Statistical Package for Social Sciences (SPSS, ver. 26, IBM Corporation, Chicago, IL).

Results

A total of 46 community-dwelling older women participated in this study. The general characteristics of the participants are presented in Table 1.

Table 2 presents the YPAS and GENEActiv accelerometry data on PA. According to the YPAS, women spent approximately 17.0 hours in total PA, and the total EE derived from different physical

activities was approximately 76.0 kcal·min⁻¹. For the GENEActiv accelerometry data output, women spent 5.5 hours in light PA, 1.3 hours in moderate PA, 0.01 hours in vigorous PA, and 1.3 hours in MVPA.

The correlations between the YPAS and GENEActiv accelerometry data are presented in Table 3 and Figure 1. The YPAS total PA was positively and moderately correlated with the number of steps, light and moderate PA, and MVPA ($\rho > 0.45$, $P < 0.001$), but a low positive correlation was found with vigorous PA. The YPAS total EE and number of stair performances showed similar correlation patterns with the GENEActiv accelerometry data as the total PA. The summary index score exhibited moderate and positive correlations with the number of steps, light, moderate, and vigorous PA, and MVPA ($0.25 \geq \rho \leq 0.5$, $P < 0.05$).

Table 1. Baseline Characteristics of Participants

Study variables*	Women (N=46)
Age (years)	72.3±1.2
Height (cm)	160.2±5.8
Weight (kg)	69.4±10.8
BMI (kg/m ²)	27.0±3.5
Education (years)	13.6±2.2
MoCA (scale)	27.2±0.9

*Values are presented as mean ± SD.

Table 2. Characteristics of PA Derived from the YPAS and GENEActiv Accelerometry Data (N=46)

Study variables	Mean (SD)	Median (IQR)	Min - max	Range
YPAS				
Total PA time (min·week ⁻¹)	17.1 (6.8)	15.0 (12.5–20.8)	8.0–43.6	35.6
Total EE (kcal·min ⁻¹)	79.2 (36.2)	69.5 (56.2–93.8)	42.8–258.2	215.4
Summary index (score units)	35.3 (19.0)	29.0 (22.0–50.0)	13.0–114.0	101.0
Stair climbing (n)	44.4 (34.6)	30.0 (20.0–65.0)	10.0–140.0	130.0
GENEActiv accelerometry				
Number of steps (n/week)	8847.9 (4251.0)	8582.7 (6175.7–10,408.7)	1460.9–21027.1	15966.3
Light PA (min/week)	331.2 (94.5)	329.6 (289.1–400.2)	100.9–529.0	428.1
Moderate PA (min/week)	75.7 (51.9)	61.6 (41.2–98.6)	5.9–221.4	215.5
Vigorous PA (min/week)	0.6 (1.5)	0.0 (0.0–0.4)	0.0–9.5	9.5
MVPA (min/week)	76.3 (52.8)	61.6 (41.2–98.8)	5.9–231.0	225.1

PA=Physical activity; YPAS=Yale Physical Activity Survey; EE=Energy expenditure; MVPA=Moderate-to-vigorous physical activity; SD=Standard deviation; IQR=Interquartile range; Min=Minimum; Max=Maximum; N=number.

Table 3. Criterion-Related Validity Between the YPAS and GENEActiv Accelerometry Data (N=46); The Data are Presented as Spearman's Correlation Coefficients (ρ)

Study variables	GENEActiv accelerometry				
	Number of steps (n/week)	Light PA (min/week)	Moderate PA (min/week)	Vigorous PA (min/week)	MVPA (min/week)
YPAS					
Total PA time (min·week ⁻¹)	0.64*	0.48*	0.58*	0.33‡	0.59*
Total EE (kcal·min ⁻¹)	0.64*	0.48*	0.59*	0.33‡	0.60*
Summary index (score units)	0.49*	0.28‡	0.36†	0.29‡	0.37†
Stair climbing (n)	0.64*	0.34‡	0.60*	0.35†	0.60*

* $P < 0.001$, † $P < 0.01$, ‡ $P < 0.05$.

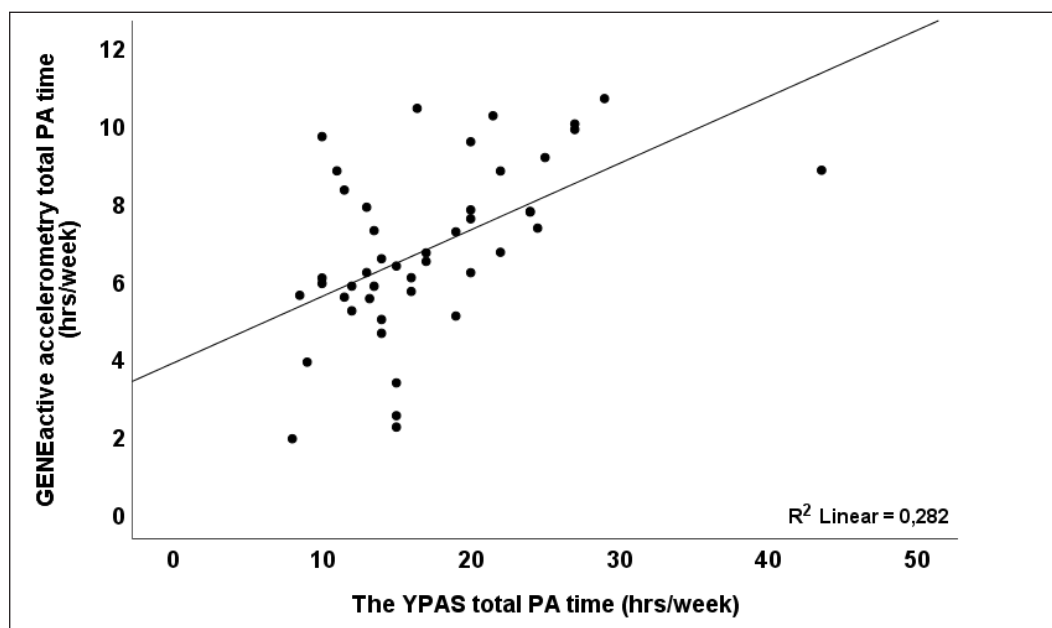


Figure 1. Correlation between the YPAS and GENEActiv accelerometry total PA time (hrs/week).

Discussion

The primary purpose of this study was to investigate the validity properties of the YPAS questionnaire in a sample of Croatian older adults. The findings indicate low-to-moderate positive correlations between the YPAS and accelerometer-based data. The largest correlations were observed between the YPAS outcome variables and the number of steps per week and MVPA.

Based on the study by Terwee et al. (40), the correlation of PA between subjective and objective methods should be above 0.5 to indicate acceptable validity properties. We found that total PA time and EE had moderate correlations with the number of steps, light and moderate PA, and MVPA, and a moderate ($\rho=0.55$) correlation between total PA time from the YPAS and GENEActive accelerometer, which is in line with previous studies (22-25). For example, a study by Dipietro et al. (22) showed a moderate correlation between the YPAS summary ($r=0.58$) and vigorous ($r=0.60$) index with maximal oxygen uptake. Similar findings have also shown that the summary index derived from the YPAS moderately correlated with MVPA ($r=0.51$) and accelerometer counts ($r=0.45$), while total time of PA correlated

somewhat poorer with accelerometer-derived MVPA ($r=0.41$) (41). One study compared ankle- and waist-positioned accelerometer data with the YPAS and showed that total PA derived from both measures had moderate correlations, ranging from 0.36 to 0.59 (ankle) and 0.42 to 0.61 (waist) (42). However, the correlation coefficients obtained in this study were moderate (almost strong), which is inconsistent with other studies aiming to define the validity properties of the YPAS (25, 27). In a study by Young et al. (23), weekly EE and total PA time had lower correlations with daily EE from accelerometers ($r=0.37$). In addition, the total EE index ($r=0.30$), summary index ($r=0.36$), and total PA time ($r=0.27$) showed low-to-moderate correlations with total weekly EE (24). In Spanish older adults, the validity of total PA time ($r=0.20$), total EE ($r=0.23$), summary index ($r=0.24$), leisure walking index ($r=0.26$), and moving index ($r=0.31$) had low correlation properties against accelerometers (27). A recent study conducted among Polish older adults only reported a significant positive correlation between the YPAS- and accelerometer-derived total EE ($r=0.23$), while other components of the YPAS were not significantly correlated with the accelerometer data output (43). In older

adults from Portugal, a study by Domingos *et al.* (44) exhibited low-to-moderate correlations between the YPAS vigorous index ($r=0.42$) and total PA time ($r=0.23$) using the Xiaomi Mi Band 2[®] motion-tracking device, and low agreement between the two methods.

The discrepancies in the correlations across studies may be explained by several factors. Although we included studies that used the YPAS questionnaire, the actigraphy characteristics remained relatively heterogeneous. Despite the intention to measure the acceleration properties of an individual, some studies have used uniaxial (26, 44) or smartwatch monitor trackers (44) instead of triaxial accelerometers (29). Second, different cutoff values have been adopted to characterize the volume and intensity of PA. For example, a few studies have set accelerometer data based on Freedson's equation to measure activity counts, total activity, and total PA (41). However, it has been argued that such an approach may be too high for detecting low-intensity PA (41). Another study using the SenseWear[®] Pro2 Armband monitor defined any, light, or moderate PA to be set at ≥ 1.4 , ≥ 2.5 , and ≥ 3.6 MET (45), which is comparable to our study of any (≥ 1.5 MET), light (< 3 MET), moderate ($\geq 3 - < 6$ MET), and vigorous (≥ 6 MET) PA. For the YPAS, it is possible that participants overestimated the time spent in PA (particularly moderate and vigorous PA) based on their perceived exertion. We reported a moderate correlation between the total time of PA ($r=0.60$) from the YPAS and GENEActiv data. However, the mean total time of PA from the YPAS was 16.9 hours, compared to 6.7 hours from actigraphy, indicating a large overreporting of total PA (mean diff.=10.2 hours, 95% CI 8.5 - 11.9 hours, $P<0.001$). Third, previous studies have placed accelerometers on the hip (26, 43). Since accelerometers project PA counts from body movements, the hip region of the body may not be sensitive enough to capture lower-intensity PA (31). Older adults engage mainly in light PA (32), as confirmed in this study, where they spent approximately 5 hours in light-intensity PA, as opposed to moderate (1.25 hours)

or vigorous (0.06 hours) PA. Thus, arm placement may be a better option for measuring light PA in older adults, as it provides better calibration and cross-validation properties than the hip (46). Finally, the higher correlation coefficients in this study may be attributable to the wearing time of the accelerometer. In contrast to other accelerometers, GENEActiv is a waterproof device that should not be removed during physical activities in water. This advantage was highlighted in a study by Król-Zielińska *et al.* (43), in which the majority of participants showed participation in water activities, which could have influenced the validity of PA derived from accelerometers.

Limitations of the Study

This study has several limitations. Due to its cross-sectional design, causal relationships between YPAS outcomes and GENEActiv accelerometer data cannot be established. However, standardized testing procedures consistent with previous validation studies were applied, with the YPAS questionnaire administered after a 7-day accelerometer assessment period, thereby minimizing potential measurement bias (43). A further limitation is the relatively small sample size ($N=46$), which restricts the generalizability of the findings to other older adult populations. In addition, the study included only female participants within a relatively narrow age range. This approach was adopted following statistical review recommendations, as the original sample included an insufficient number of male participants for reliable sex-based analyses. Consequently, the findings should be interpreted with caution and generalized primarily to community-dwelling older women with similar demographic and functional characteristics. Finally, the sample predominantly consisted of physically active older adults. Given that physically active individuals may be less prone to overreporting physical activity (46), caution is warranted when interpreting the results, particularly in relation to less active or sedentary older populations.

Conclusion

In summary, this study shows that the YPAS is a valid tool for assessing the total time of PA and EE during the week, summary index, and stair climbing related to accelerometer-derived PA. Most correlations yielded moderate power, indicating adequate validity properties. However, we recommend using the YPAS with caution, as it tends to overreport the total PA time in physically active older adults.

What Is Already Known on This Topic:

The Yale Physical Activity Survey (YPAS) is one of the most frequently used self-reported instruments for assessing physical activity patterns among older adults. Previous validation studies conducted in the United States and several high-income European countries have demonstrated low-to-moderate correlations between the YPAS scores and accelerometer-derived physical activity data. Although the questionnaire captures various types and intensities of activity, its accuracy may be influenced by the placement of accelerometers, activity cut-off points, and the tendency of older adults to overestimate their physical activity levels. Despite its translation and reliability testing in Croatia, the criterion validity of the YPAS has not yet been evaluated in older Croatian adults.

What This Study Adds:

This study provides the first evidence on the criterion validity of the Croatian version of the Yale Physical Activity Survey (YPAS) against triaxial accelerometry in older adults. The results demonstrate moderate positive correlations between YPAS-derived total physical activity, energy expenditure, and summary index with accelerometer-based activity measures. These findings indicate that the YPAS is a valid instrument for assessing physical activity patterns in older Croatian adults, although it may overestimate total activity time in physically active individuals.

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